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PREPARED: Friday, 06 December 2019

UCLH PHASE 4 PBT; CONDITION 28 ACOUSTIC REPORT

CONTENTS

LIST OF ATTACHMENTS

Project Ref:	AS8175	**Title:**	UCLH PHASE 4 PBT
Report Ref:	190708.R1.2	**Title:**	CONDITION 28 ACOUSTIC REPORT
Client Name:	Bouygues (UK) Ltd		
Project Manager:	Matt Sugden		
Report Author:	Matt Sugden		

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1.0 EXECUTIVE SUMMARY

1.1 The development of the Proton Beam Therapy (PBT) Unit under Stage 4 of works being undertaken on behalf of University College London Hospital (UCLH) requires considerable mechanical services to provide the necessary ventilation, heating and cooling of the building interior.

1.2 An assessment has been undertaken of predicted noise emissions from the specified plant, as required under Condition 28 of the Camden planning consent.

1.3 This assessment has shown that noise emissions under normal operation are expected to comply with the requirements of the condition during both daytime and night-time scenarios.

2.0 INTRODUCTION

2.1 The development of the Proton Beam Therapy (PBT) Unit under Stage 4 of works being undertaken on behalf of University College London Hospital (UCLH) is subject to a number of planning conditions as set by Camden Council.

2.2 Condition 28 is concerned with the effect of noise emissions from building services plant on nearby receptors. The condition is as follows;

Prior to the installation of any plant (except for the vacuum insulated evaporator and the stand by generator) an acoustic report shall be submitted to and approved by the Local Planning Authority detailing how the required noise criteria as outlined within condition 24 will be met for each item of plant installed. Any attenuation measures detailed within the acoustic report approved by the Local Planning Authority shall be installed and remain in place for the lifetime of the development.

On commissioning the machinery and prior to the building being occupied a noise survey shall be carried out to ascertain the above noise criteria from the machinery are being met. An acoustic report shall be submitted for the approval of the Local Planning Authority. The Acoustic Report shall clearly contain map/plan showing all measurements locations, tabulated and graphically raw data, calculations /façade corrections /assumptions made, time date, etc.(ii) All plant and machinery, and ventilation ducting shall be installed so as to prevent the transmission of noise and vibration within or at the boundary of any noise sensitive premises either attached to or in the vicinity of the premises to which this application refers.

2.3 The referenced Condition 24 states;

Noise levels at a point 1 metre external to sensitive facades shall be at least 5dB(A) less than the existing background measurement (LA90), expressed in dB(A) when all plant/equipment (or any part of it) is in operation unless the plant/equipment hereby permitted will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are distinct impulses (bangs, clicks, clatters, thumps), then the noise levels from that piece of plant/equipment at any sensitive façade shall be at least 10dB(A) below the LA90, expressed in dB(A).

2.4 Please refer to Appendix A for clarification of acoustic terminology used in this report.

2.5 This report describes the approach taken to control noise from installed plant and details the desktop assessment undertaken to validate the plant acoustic design and subsequent noise control specifications.

3.0 OVERVIEW OF BUILDING SERVICES STRATEGY

3.1 The PBT Unit building comprises four below-ground and six above-ground storeys of accommodation for the proton beam unit, treatments areas. Theatres, wards and associated functions. Building services plant is distributed within the building generally as described below.

3.2 BASEMENT B2/M2 PLANTROOMS

3.2.1 The second basement level (B2) and its mezzanine (M2) house the majority of the building's ventilation plant.

3.2.2 Fresh air is drawn into the plant via risers connecting to louvres at fourth floor level on the west and south sides of the Courtyard Building.

3.2.3 Air is exhausted via raised louvres located at ground floor level with the drop-off bay on Grafton Way and louvres at high level in the ground floor façade on Huntley Street.

3.2.4 Please refer to figure AS8175/SP28.1.

3.3 LEVEL 4 ROOF

3.3.1 Dual function ventilation/smoke extract fans are located at the western and southern ends of the Level 4 atrium roof. Fans are arranged in two arrays of three fans. In environmental mode, two fans in each array will run at 40% of full duty.

3.4 LEVEL 6 ROOF

3.4.1 Additional ventilation plant, chillers, boilers and medical gas plant are located at Level 6 roof on the buildings fronting Grafton Way and Huntley Street.

3.4.2 Ventilation fans are arranged around risers located in Cores 1, 2 (Grafton Way west and east, respectively) and Cores 3 and 4 (Huntley Street north and south, respectively).

3.4.3 Four chillers are positioned on the Grafton Way building roof between Cores 1 and 2. The chillers are specified with redundancy such that, during daytime periods, three chillers might operate at full duty or all four at 75% duty. At night, three chillers could run at 75% duty or all four at 56%.

3.4.4 A medical gases plantroom is located alongside Core 1.

3.4.5 A CHP/boiler plantroom is located to the south of Core 3.

3.4.6 Please refer to figure AS8175/SP28.2.

3.4.7 The L6 roof will be fitted with visual screens of some 3m height. These will be formed of areas of photovoltaic cells interspersed with architectural louvres. Cross-flow of air will not generally be required, such that louvres can be covered at the rear, creating an imperforate barrier at the roof edge on all sides.

4.0 NEAREST AFFECTED RECEPTORS

4.1 Sensitive receptors have been identified as the apartments in the Paramount Court building which borders the PBT site to the west and south. The upper floor of this building is around one storey below the L6 roof, such that apartment windows will benefit from noise reduction from the roof screens.

4.2 The building at 30 - 40 Grafton Way opposite the site has apartments on its upper levels. Again, these receptors are expected to benefit from acoustic screening of roof plant; the lower levels will, however, have a clear view of the Grafton Way B2 plantroom exhaust louvres.

4.3 Windows at the upper levels of the Jeremy Bentham public house on the corner of Huntley Street and University Street have also been assumed to represent sensitive receptors for the purpose of this assessment.

5.0 PLANT NOISE LIMITS (CONDITION 24)

5.1 Environmental noise monitoring was undertaken on the site by CSA prior to commencement of the demolition phase for planning purposes. Details and findings of these surveys have previously been documented for submission to Camden[1]. Further monitoring has been undertaken for the information of Bouygues (UK) Ltd during groundworks phase. The key findings of background noise level, $L_{A90,T}$, during daytime and night-time periods are summarised below.

RECEPTOR (MONITOR LOCATION)	PARAMOUNT COURT REAR (SOUTHERN BOUNDARY OF VACANT SITE)	30 – 40 GRAFTON WAY (NORTHERN SITE BOUNDARY)	JEREMY BENTHAM PUBLIC HOUSE (ALLEY BETWEEN PUBLIC HOUSE AND PARAMOUNT COURT)
Minimum $L_{A90,T}$ Daytime 07:00h – 23:00h	50dB*	54dB*	53dB^{+}
Minimum $L_{A90,T}$ Night-time 07:00h – 23:00h	48dB*	52dB*	52dB^{+}

* T = 15min
$^{+}$ T = 5min

[1] CSA report ref. AS7143.131106.R4, dated 6th December 2013

5.2 Noise emissions limits determined in accordance with Condition 24 are set out below.

RECEPTOR	PARAMOUNT COURT REAR	30 – 40 GRAFTON WAY	JEREMY BENTHAM PUBLIC HOUSE
Plant noise $L_{Aeq,T}$ Daytime 07:00h – 23:00h	≤45dB	≤49dB	≤48dB
Plant noise $L_{Aeq,T}$ Night-time 07:00h – 23:00h	≤43dB	≤47dB	≤47dB

6.0 BASIS OF ASSESSMENT

6.1 The assessment has been based upon manufacturer's plant noise data as provided to Bouygues by the mechanical services subcontractors.

6.2 CHILLERS

6.2.1 The 4 no. chillers mounted at roof level on the Grafton Way building are to be Trane model GVAF – 450 XXLN. Factory acceptance testing of one chiller undertaken by the manufacturer included acoustic measurements using a scanning technique at 1m from the vertical and horizontal faces of the unit when operating at full duty. The results, filtered into octave bands from 125Hz to 8kHz, have been converted to sound power level, and reported as shown below.

FREQUENCY (HZ)	63	125	250	500	1K	2K	4K	8K
Sound power level, dB	n/a	91	93	88	86	83	88	82

dB ref 1pW

6.3 AIR HANDLING UNITS

6.3.1 Air handling units (AHU) are of various sizes and specifications and are generally provided by Trox. All units have integral sound attenuators on the atmosphere and room-sides of the fans.

6.3.2 Calculations have been undertaken using the manufacturer's stated 'in-duct' sound power levels at the fresh air inlet and exhaust connections of the units. Data sheets can be provided by Bouygues upon request.

6.4 SUPPLY / EXTRACT FANS

6.4.1 Fans are of various types and sizes and are generally to be provided by Systemair.

6.4.2 Calculations have been undertaken using the manufacturer's stated 'in-duct' sound power levels at the fan inlet and outlet for supply and extract fans, respectively. Allowance has been made for duct-mounted attenuators on the fans as determined by detailed acoustic calculations of noise emissions from the various plant areas.

6.4.3 Fan data sheets can be provided by Bouygues upon request. Schedules of atmospheric attenuator performances have been enclosed in Appendix B for information.

6.5 BOILERS / CHP

6.5.1 Boilers and CHP plant are to be provided as a packaged plantroom. The plantroom will be naturally ventilated by means of louvres in the north and south walls.

6.5.2 Detailed acoustic calculations of noise emissions from the louvres have determined the need for acoustic shrouds to be fitted around burners and gas booster pumps within the plantroom.

7.0 COMPUTER MODELLING

7.1 Specialist modelling software CadnaA has been used to determine overall noise emissions from various plant areas at each receptor. The software uses algorithms based on formulae given in ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors -- Part 2: General method of calculation*. The calculation method assumes that receptors are subject to downwind acoustic propagation at a wind speed of 1.5m/s.

7.2 Louvres and chillers have been entered as two-dimensional plane noise sources, whilst AHU and fan intakes and discharge are modelled as point sources. All plant locations are as shown on drawings supplied by the mechanical services subcontractor, ANEL.

7.3 For the daytime case (07:00h to 23:00h), the model is based on all plant (including three out of four chillers) operating at full duty.

7.4 For the night-time case (23:00h to 07:00h), it is assumed that chillers will ramp down to 75% duty, for which a 2dB reduction in sound power level has been allowed. For ease of calculation, thereby leading to a robust assessment, it is assumed that all ventilation and heating plant will run at full duty.

8.0 COMPUTER MODEL OUTPUT

8.1 Figures AS8175/NM28.1 and AS8175/NM28.2 show the pattern of plant noise emissions as façade-incident levels calculated for daytime and night-time operating periods, respectively.

8.2 Values shown in octagons represent the highest predicted level at any storey of the façade. Actual receptor window locations at the upper levels of the Paramount Court, 30 – 40 Grafton Way and the Jeremy Bentham public house are represented by part-shaded circles, with individual predicted levels shown alongside.

8.3 A receptor position has also been included on the Cruciform Building opposite the site on Huntley Street for information. This building is also owned by UCLH, but is not thought to contain residential uses.

8.4 The figures show that the noise emissions criteria set by Condition 24 are expected to be achieved at all receptors for the daytime and night-time periods.

8.5 Interrogation of the model to establish spectral content of noise levels incident at key receptor locations does not indicate the presence of significant tonal characteristics and, hence, further restriction of noise limits is not warranted.

9.0 CONCLUSION

9.1 This report has been prepared in response to Condition 28 of Camden's planning consent for the Proton Beam Therapy Unit under construction on behalf of the University College London Hospital.

9.2 Extensive and rigorous calculation of noise emissions from building services has enabled development of acoustic performance specifications for plant items and sound attenuators on the basis of limits set by Camden Council within Condition 24.

9.3 A computer model has been created to allow assessment of overall noise emissions at each of the identified receptor locations.

9.4 The model shows that the limits set under Condition 24 of the Camden planning consent are expected to be met under daytime and night-time operational scenarios.

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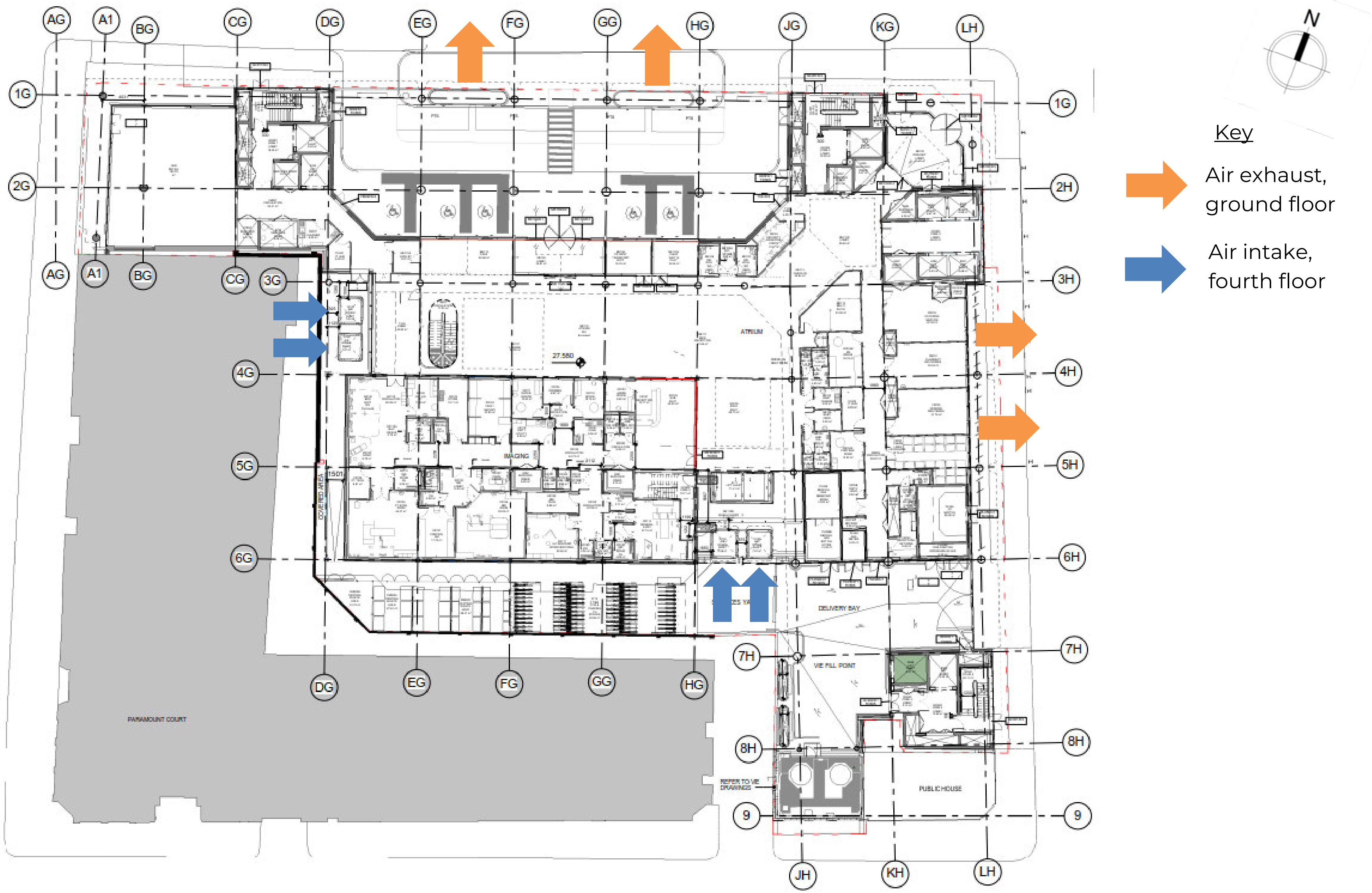
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PUBLIC HOUSE
PARAMOUNT COURT
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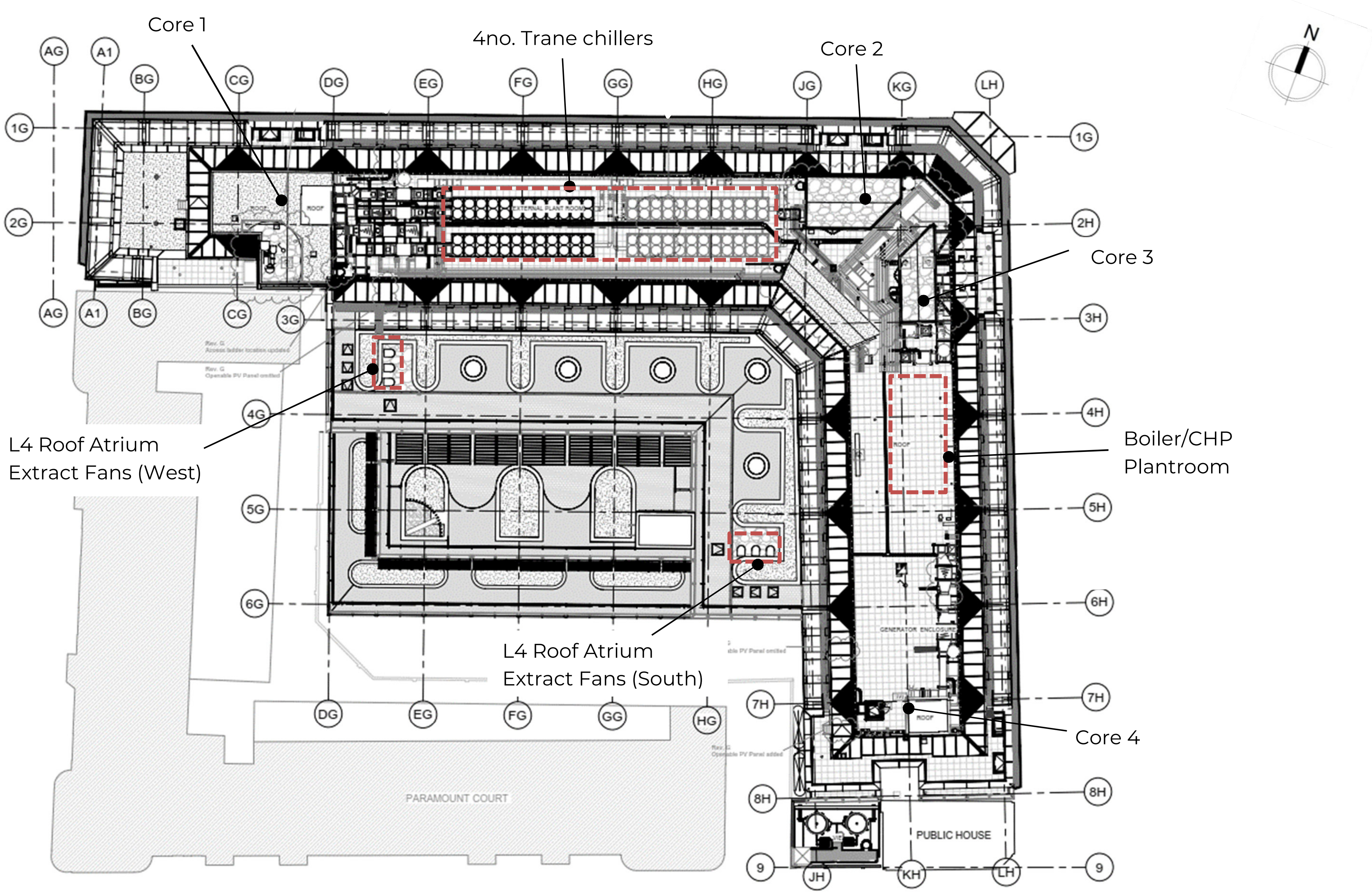


Figure AS8175/SP28.2

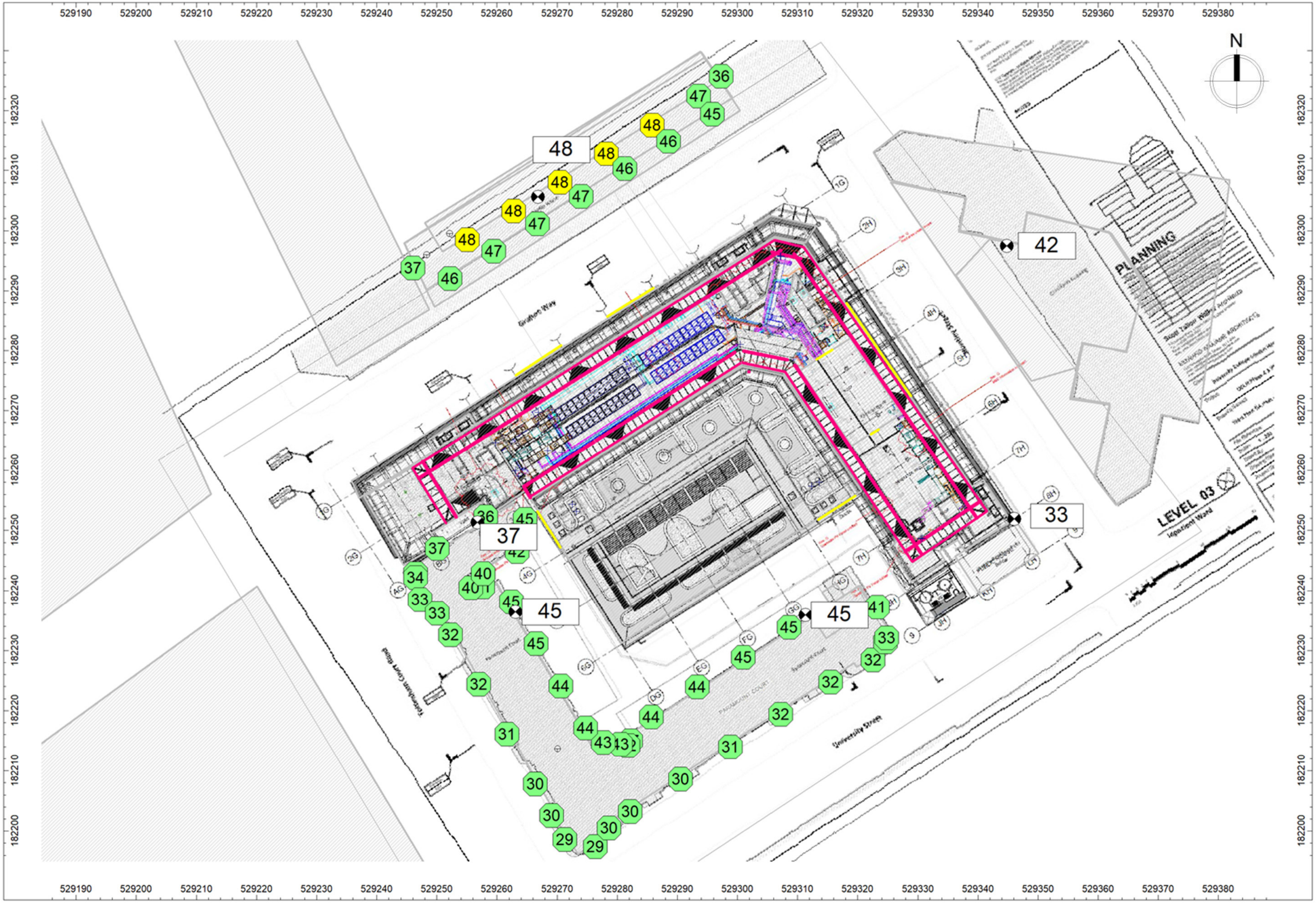
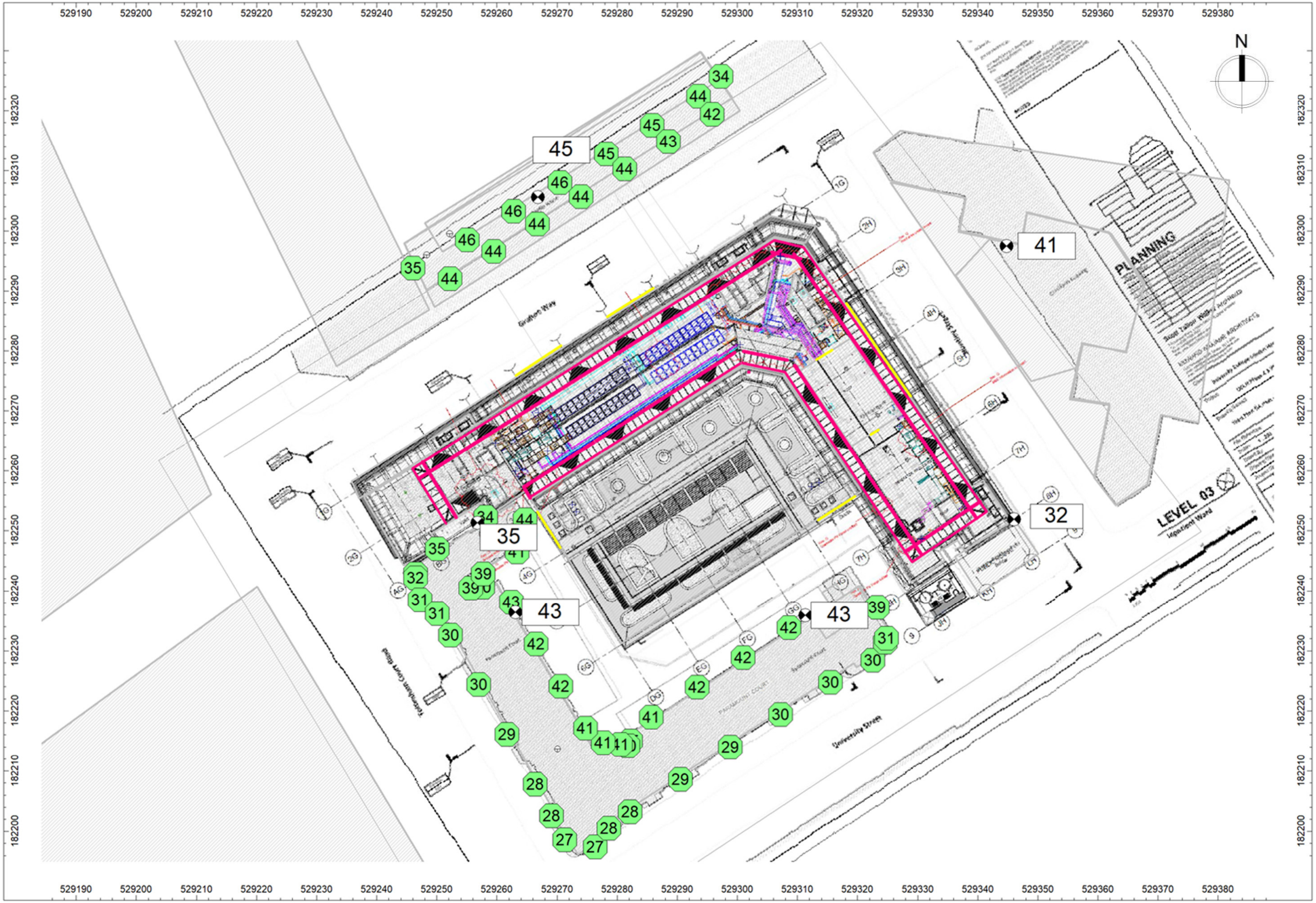


Figure AS8175/NM28.1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1.1 Acoustic Terminology

The human impact of sounds is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and variation in level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

Sound Vibrations propagating through a medium (air, water, etc.) that are detectable by the auditory system.

Noise Sound that is unwanted by or disturbing to the perceiver.

Frequency The rate per second of vibration constituting a wave, measured in Hertz (Hz), where 1Hz = 1 vibration cycle per second. The human hearing can generally detect sound having frequencies in the range 20Hz to 20kHz. Frequency corresponds to the perception of 'pitch', with low frequencies producing low 'notes' and higher frequencies producing high 'notes'.

dB(A): Human hearing is more susceptible to mid-frequency sounds than those at high and low frequencies. To take account of this in measurements and predictions, the 'A' weighting scale is used so that the level of sound corresponds roughly to the level as it is typically discerned by humans. The measured or calculated 'A' weighted sound level is designated as dB(A) or L_A.

L_{eq}: A notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (e.g. 8 hour, 1 hour, etc).

The concept of L_{eq} (equivalent continuous sound level) has primarily been used in assessing noise from industry, although its use is becoming more widespread in defining many other types of sounds, such as from amplified music and environmental sources such as aircraft and construction.

Because L_{eq} is effectively a summation of a number of events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute sound limit.

L_{10} & L_{90}: Statistical L_n indices are used to describe the level and the degree of fluctuation of non-steady sound. The term refers to the level exceeded for n% of the time. Hence, L_{10} is the level exceeded for 10% of the time and as such can be regarded as a typical maximum level. Similarly, L_{90} is the typical minimum level and is often used to describe background noise.

It is common practice to use the L_{10} index to describe noise from traffic as, being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic flow.

L_{max}: The maximum sound pressure level recorded over a given period. L_{max} is sometimes used in assessing environmental noise, where occasional loud events occur which might not be adequately represented by a time-averaged L_{eq} value.

1.2 Octave Band Frequencies

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation has agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, e.g. 250 Hz octave band extends from 176 Hz to 353 Hz. The most commonly used octave bands are:

Octave Band Centre Frequency Hz	63	125	250	500	1000	2000	4000	8000

1.3 Human Perception of Broadband Noise

Because of the logarithmic nature of the decibel scale, it should be borne in mind that sound levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) sound level is not twice as loud as 50dB(A). It has been found experimentally that changes in the average level of fluctuating sound, such as from traffic, need to be of the order of 3dB before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10dB is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in environmental sound level can be given.

INTERPRETATION

Change in Sound Level dB	Subjective Impression	Human Response
0 to 2	Imperceptible change in loudness	Marginal
3 to 5	Perceptible change in loudness	Noticeable
6 to 10	Up to a doubling or halving of loudness	Significant
11 to 15	More than a doubling or halving of loudness	Substantial
16 to 20	Up to a quadrupling or quartering of loudness	Substantial
21 or more	More than a quadrupling or quartering of loudness	Very Substantial

1.4 Earth Bunds and Barriers - Effective Screen Height

When considering the reduction in sound level of a source provided by a barrier, it is necessary to establish the "effective screen height". For example if a tall barrier exists between a sound source and a listener, with the barrier close to the listener, the listener will perceive the sound as being louder if he climbs up a ladder (and is closer to the top of the barrier) than if he were standing at ground level. Equally if he sat on the ground the sound would seem quieter than if he were standing. This is explained by the fact that the "effective screen height" is changing with the three cases above. In general, the greater the effective screen height, the greater the perceived reduction in sound level.

Similarly, the attenuation provided by a barrier will be greater where it is aligned close to either the source or the listener than where the barrier is midway between the two.

AS8175 UCLH PROTON BEAM THERAPY UNIT

APPENDIX B

SCHEDULE OF ATMOSPHERE-SIDE ATTENUATION

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UCLH P4 PBT

ATMOSPHERE SIDE SILENCER SCHEDULE

Ref:	AS 8175/ AAS- 4	Revision:	3	Date:	*6 December 2019*	Engineer		*MS*					
Silencer Ref.	Description	Dimensions (mm)			Volume duty (m^3/s)	Pressure drop (Pa)	Octave Band Mid Frequency (Hz)						
		W	H	L			63	125	250	500	1k	2k	4k	8k
	SEF/M2/01/A-B	TBC	TBC	TBC	7.409	≤50	4	8	13	22	27	21	18	15
	SEF/M2/02/A-B	TBC	TBC	TBC	6.415	≤50	5	10	16	25	28	26	22	17
	SEF/M2/03/A-B	TBC	TBC	TBC	3.17	≤50	4	8	13	22	27	21	18	15
	SEF/M2/04/A-B	TBC	TBC	TBC	1.98	≤50	7	12	20	33	39	40	35	28
	SEF/M2/05/A-B	TBC	TBC	TBC	3.89	≤50	5	10	16	25	28	26	22	17
	SEF/M2/06/A-B	TBC	TBC	TBC	3.03	≤50	4	8	13	20	26	24	19	15
	SEF/B2/08/A-B	TBC	TBC	TBC	4.97	≤50	5	11	19	30	40	31	17	16
	SEF/B2/05/A-B	TBC	TBC	TBC	0.684	≤50	5	11	19	30	40	31	17	16
	SEF/M2/09/A-B, C-D, E-F	TBC	TBC	TBC	10.9	≤50	5	11	19	30	40	31	17	16
	SEF/M2/10/A-B	TBC	TBC	TBC	0.359	≤50	3	10	15	24	30	30	28	24
	SEF/M2/11/A-B	TBC	TBC	TBC	0.608	≤50	3	9	14	22	30	30	27	23
	SEF/M2/12/A-B	TBC	TBC	TBC	0.81	≤50	3	9	14	22	28	24	20	17
	EF/M2/01						None Required							
	EF/M2/02						None Required							
	EF/M2/03						None Required							
	EF/M2/04						None Required							
	SF/M2/01	TBC	TBC	TBC	1.12	≤50	4	8	14	21	27	27	21	16
	SF/M2/02	TBC	TBC	TBC	1.12	≤50	4	8	14	21	27	27	21	16
	SEF/B2/01/A-B	TBC	TBC	TBC	0.51	≤50	3	10	15	24	30	30	28	24
	SEF/B2/04/A-B	TBC	TBC	TBC	0.753	≤50	3	9	14	22	30	30	27	23
	SEF/B2/05/A-B	TBC	TBC	TBC	0.713	≤50	5	11	19	30	40	31	27	16

Notes: + Acoustic infill assumed wrapped in Melinex, or similar

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UCLH P4 PBT

ATMOSPHERE SIDE SILENCER SCHEDULE

Ref:	AS 8175/ AAS- 4	Revision:	3	Date:	*6 December 2019*		Engineer		*MS*					
Silencer Ref.	Description	Dimensions (mm)			Volume duty (m³/s)	Pressure drop (Pa)	Octave Band Mid Frequency (Hz)							
		W	H	L			63	125	250	500	1k	2k	4k	8k
	SEF/B2/06/A-B	TBC	TBC	TBC	1.611	≤50	5	9	15	24	28	23	19	16
	SEF/B2/09/A-B	TBC	TBC	TBC	5.313	≤50	4	8	13	22	27	21	18	15
	EF/B2/01						None Required							
	EF/B2/02						None Required							
	EF/B2/03						None Required							
	EF/B2/04						None Required							
	SEF/4/01 - 06	TBC	TBC	TBC	9	≤50	5	6	13	22	25	21	17	14
	Daily vent fan	TBC	TBC	TBC	2	≤50	5	11	21	33	37	36	27	18
	SEF/601/A-B (N)	TBC	TBC	TBC	4.778	≤50	4	9	18	34	49	39	34	21
	EF/6/12/A-B	TBC	TBC	TBC	1.289	≤50	5	9	16	26	37	30	26	16
	EF/6/13/A-B	TBC	TBC	TBC	1.337	≤50	5	9	16	26	37	30	26	16
	EF/6/14/A-B	TBC	TBC	TBC	1.192	≤50	5	9	16	26	37	30	26	16
	EF/6/15/A-B	TBC	TBC	TBC	1.144	≤50	5	9	16	26	37	30	26	16
	EF/6/16/A-B	TBC	TBC	TBC	1.29	≤50	4	7	11	19	27	30	25	18
	EF/6/17/A-B	TBC	TBC	TBC	2.3	≤50	5	11	19	29	36	37	27	18
	EF/6/18⁺	TBC	TBC	TBC	1.8	≤50	3	6	7	7	9	7	6	7
	TGF/6/01/02 (N)	TBC	TBC	TBC	0.29	≤50	4	8	13	22	27	21	18	15
	EF/6/19-A	TBC	TBC	TBC	5.03	≤50	2	4	8	12	13	13	9	8
	EF/6/19-B	TBC	TBC	TBC	5.03	≤50	2	4	8	12	13	13	9	8
	EF/6/19-C	TBC	TBC	TBC	5.03	≤50	2	4	8	12	13	13	9	8

Notes: ⁺ Acoustic infill assumed wrapped in Melinex, or similar