Report No:
Camden People's Theatre Noise Impact Assessment 15032021

Date:
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For:
Camden People's Theatre

CAMDEN PEOPLE'S THEATRE
PLANT NOISE IMPACT ASSESSMENT

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REVISION SCHEDULE

Document Revision	Date	Document Title	Details	Prepared by	Approved by
00	12/03/2021	Camden People's Theatre – Noise Impact Assessment 12032021	DRAFT FOR COMMENT	Simon Brown	Tim Scott
01	15/03/2021	Camden People's Theatre – Noise Impact Assessment 15032021	FOR ISSUE	Simon Brown	Tim Scott

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Introduction

Camden People's Theatre set in the London Borough of Camden is proposing to install a 3 new Air Handling Unit (AHU) and 3 condensing units as part of its current refurbishment works. All the AHUs are to be located within the building envelope, with all fresh air and exhaust grilles located at ground and first floor level to the rear of the property. The 3 new condenser units are located on the small area of 1st floor roof, also to the rear. The nearest residential buildings have been identified as the flats at 50-52 Hampstead road and 159 Drummond Street, immediately next door to the site. The nearest windows of these residences are between 2 and 3.5m from the proposed plant area.

Gillieron Scott Acoustic Design (GSAD) have been commissioned to undertake a plant noise impact assessment in line with BS4142 and Local Authority adopted noise policy.

GSAD have carried out a background noise survey at one fixed monitoring location from 14:00hrs Friday 5th March to 13:00hrs Monday 8th March 2021. The microphone location was chosen to be representative of the closest residential receptor.

It is understood that the plant will have the facility to operate during daytime (07:00-23:00) Monday to Sunday.

The site location, plant area and nearest residential receptors are indicated in Appendices A, B and C.

1.0 Brief

- Undertake noise measurements at a fixed monitoring location over an extended period.
- Identify noise sensitive dwellings located close to the site and assess the topography of the intervening ground.
- Analyse the site-acquired data and determine the appropriate criteria to adopt from the London Borough of the Camden's noise policy.
- Using representative measured data from the survey and manufacturer's data for the proposed items of plant where possible, verify the impact of the development to satisfy Local Authority's noise policy.
- Provide a technical report detailing findings of the noise survey.

2.0 Context

Camden People's theatre is located at the junction of Hampstead Road and Drummond street in the London Borough of Camden. The buildings surrounding the theatre are a mixture of commercial and residential premises.

All the AHUs are to be located within the building envelope, with all fresh air and exhaust grilles located at ground and first floor level to the rear of the property. The 3 new condenser units are located on the small area of 1st floor roof, also to the rear. The nearest residential buildings have been identified as the flats at 50-52 Hampstead road and 159 Drummond street, immediately next door to the site. The nearest windows of these residences are between 2 and 3.5m from the proposed plant area.

The acoustic environment at the residential receptors located near the building comprises of various typical urban noise sources including road traffic noise, air traffic noise, sirens, and noise from commercial buildings.

3.0 Summary

A background noise survey was undertaken from 14:00hrs Friday 5th March to 13:00hrs Monday 8th March 2021 at a single fixed monitoring location representative of the nearest residential windows.

It is understood that the plant will have facility to operate during daytime (07:00-23:00 hours) Monday to Sunday therefore this assessment will be based on the same reference period. Manufacturer supplied noise data is provided in Appendix I.

Results from the survey show a representative background noise of 46dB $L_{A90,15min}$ during proposed operating hours and days.

A representative background noise level for night-time hours (23:00-07:00) of 42 dB $L_{A90,15min}$ was recorded.

The site location, measurement position and measured results are presented in the following Sections and Appendices.

4.0 Plant Noise Assessment Criteria

4.1 BS4142:2014+A1:2019 "Methods for rating and assessing industrial and commercial sound"

BS4142:2014+A1:2019 provides methods for rating and assessing industrial and commercial sound. The standard is used to rate sound from fixed installations. The standard requires a "Specific Sound Level", in terms of L_{Aeq}, is determined either by measurement or calculation at a receptor location. This Specific Sound Level may then be corrected for the character of sound and is then termed the "Rating Level".

Once the Rating Level has been determined, the background sound level is subtracted from it and the greater the difference, the greater the likelihood of an 'adverse impact'. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact. The standard advocates that each site and situation should take the context of the scenario into consideration and that "not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact".

The standard provides reference periods over which the assessment should take place which have been reproduced in the table below.

Table 1 – Reference Periods

Period	Hours
Typical Daytime	07:00 – 23:00
Typical Night-time	23:00 – 07:00

4.2 Local Authority Noise Policy

Policy A4 of the London Borough of Camden (LBC) Local Plan sets out their policy as follows:

> *"The Council will seek to ensure that noise and vibration is controlled and managed. Development should have regard to Camden's Noise and Vibration Thresholds (Appendix 3). We will not grant planning permission for:*
> *a) development likely to generate unacceptable noise and vibration impacts; or*
> *b) development sensitive to noise in locations which experience high levels of noise unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.*
>
> *We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity."*

The Camden Local plan also sets out noise thresholds in terms of various 'effect levels' described in the National Planning Policy Framework and National Policy Statement for England:

- NOEL – No Observed Effect Level
- LOAEL – Lowest Observed Adverse Effect Level
- SOAEL – Significant Observed Adverse Effect Level

Table 2 below summarises the noise emissions requirements for industrial and commercial noise sources, found in Appendix 3 of the Camden Local Plan:

Table 2 – Camden Local Plan Noise Emissions Limits for industrial and commercial noise

Existing Noise sensitive receiver	Assessment location	Period	NOEL	LOAEL to SOAEL	SOAEL
Dwellings	Garden used for main amenity (free field) and outside living or dining or bedroom window (façade)	Day (07:00 to 23:00)	'Rating level' 10dB* below background	'Rating level' between 9dB below and 5dB above background	'Rating level' greater than 5dB above background
Dwellings	Outside bedroom window	Night (23:00 to 07:00)	'Rating level' 10dB* below Background and no events exceeding 57dB L_{Amax}	'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dB L_{Amax}	'Rating level' greater than 5dB above background and/or events exceeding 88dB L_{Amax}

* 10dB should be increased to 15dB if the noise contains audible tonal elements.

It is proposed that "no observed effect level" should be achieved with the new plant, and as such all plant should achieve a level of 10dB below background at 1m from the nearest noise sensitive receiver.

5.0 Survey Details and Results

A background noise survey was undertaken from 14:00hrs Friday 5th March to 13:00hrs Monday 8th March 2021 at a single fixed monitoring location that was located on the 3rd floor roof of the property, towards the rear of the building. This was deemed to be providing ample shielding from traffic on Hampstead Road (observed to be the main source of noise in the area), and thus be representative of the residences near the proposed plant. Details of the survey site can be found in Appendices A and B. The microphone position is shown in Appendix C.

The levels were recorded in octave bands as L_{eq}, L_{max} and L_{90} with Fast time-weighting along with their respective A-weighted single-figure values. The clock on the sound level meter was synchronised to the correct time before deployment. The meter was then set to integrate sound levels over 15-minute periods in synchronisation mode. A list of the measurement equipment is reported in Appendix G.

The equipment was calibrated at the beginning and end of the survey and a 0.1 dB drift in calibration was noted.

Weather history has also been recorded as part of the assessment to ensure that all data used in the determination of the representative background sound level occurred during conditions that are considered conducive to acoustic measurements. Weather data is available on request.

Full survey results are presented in Appendix F. A graphical representation of the results is presented in Appendix D.

It should be noted that a significant amount of building work was being carried out on and around site at the time of measurement. For this not to influence the conclusions of this survey, the following time periods have been omitted.

- Friday 5th March – 14:00 – 18:00
- Saturday 6th of March – 9am to 14:00
- Monday 8th of March - 8am to 13:00

The remaining time was deemed to provide sufficient data with which to establish the background noise level.

From these results, representative noise levels were selected, based on the distribution of recorded LA90, 15min measurements and are shown in Table 3. These background noise levels were only observed to be below these figures less than 5% of the time. See Appendix E for histograms plots of the background sound levels.

Table 3 – Summary of Representative Background Noise Levels

Representative Background Noise Level L_{A90}	
Daytime (07:00-23:00hrs)	**Night-time (23:00-07:00hrs)**
46 dB(A)	42 dB(A)

The assessment of the newly proposed plant items in the following section will be based on the daytime background noise level of 46 dB $L_{A90,15min}$. If the proposed plant is to be used outside of daytime hours, plant should be assessed against the night-time background noise criteria of 42 dB $L_{A90,15min}$.

6.0 Plant Noise Assessment

Three new AHUs and three condenser units have been proposed. The locations of these units are shown within the drawings in Appendix H.

A Helios XC 2200 AHU is proposed to supply the auditorium with exhaust and fresh air inlets in the same position as the existing unit, via two turrets on the first-floor roof. Noise data can be found in Appendix I.

A Helios XC 1400 unit is proposed to serve the foyer, with exhaust and fresh air grilles formed above the double door ground floor exit to the rear of the building. Noise data can be found in Appendix I.

A Salda VEKA INT 2000 AHU has been proposed to serve the Rehearsal Room. So far, no sound data has been provided for assessment.

3 condenser units will also be located on the first-floor roof. So far, no information has been received in terms of manufacturer and model number or noise data.

The plant noise impact assessment for the nearest/most affected residential window has been carried out. As sound data is missing the following acoustic requirements for plant have been calculated.

- Total insertion losses for attenuators required for the AHUs serving the Auditorium and the Foyer.
- Overall sound power (sound power of AHU minus attenuation) required at both the exhaust and fresh air grille for the Rehearsal Room AHU
- Sound pressure level limit (at 1m) for the 3 condenser units

Table 4 shows required insertion losses for the Auditorium and Foyer AHU units.

Table 4. Required atmosphere side attenuators for auditorium and foyer.

Fan		Minimum Insertion Losses (dB)							
		63	125	250	500	1k	2k	4k	8k
Auditorium	Exhaust	16	23	29	31	31	31	36	34
Auditorium	Fresh Air	8	19	16	25	9	18	28	13
Foyer	Exhaust	12	20	26	28	30	35	41	41
Foyer	Fresh Air	6	17	12	22	10	22	34	21
All attenuator insertion losses to be assessed by GSAD once proposed data is available									

Table 5 shows the overall sound power required at the exhaust and fresh air grilles for the Rehearsal room. This is effectively the sound power of the AHU minus any attenuation.

Table 5. Required sound power limit at external grilles for the rehearsal room.

Fan		Sound power limit (dB)							
		63	125	250	500	1k	2k	4k	8k
Rehearsal	Exhaust	52	45	41	38	36	31	18	14
Rehearsal	Fresh Air	52	45	41	38	36	31	18	14
All sound power and attenuator insertion losses to be assessed by GSAD once proposed data is available									

Table 6 shows the required sound level limit at 1m for the proposed condenser units. This is assumed to be measured in anechoic conditions.

Table 6. Sound pressure level limits for the 3 new condenser units

Unit	Sound pressure level limit @1m (dB)								dBA
	63	125	250	500	1k	2k	4k	8k	
Condenser 1-3	34	31	31	31	32	27	20	17	35
All sound pressure levels to be assessed by GSAD once proposed data is available									

35 dBA is a low level for a condenser unit: typically, these would be between 55 and 60 dBA. Because of this an acoustic enclosure is required for these units.

All these requirements are based on achieving a cumulative noise level of 36dBA (10dB below background during daytime operation) at the nearest noise sensitive receiver. This is deemed to be at 159 Drummond Street, 2-3m away from the equipment. Detailed calculations can be found in Appendix J.

The AHUs are assumed to have no attention catching features, such as tonality, impulsivity, or intermittency (see Appendix K). The Condenser units are assumed to have a level of tonality so a 3dB penalty has been applied. More stringent requirements will be necessary if the plant equipment has any of these features.

Once information has been received from the contractor, this will have to be reviewed against these requirements and suitable mitigation measures put in place if they are not met.

7.0 Uncertainty

The sound level meter was checked at the beginning and end of the survey and the field calibration a 0.1 dB drift. In the context of this environmental noise survey this level of drift it is considered insignificant.

Weather conditions during the noise survey were recorded near the microphone and it was noted that the wind speed was within the acceptable limits of the windshield's self-noise generation, except for peaks during which recorded level have been excluded from the assessment. Precipitation was absent. Overall, the weather conditions are considered conducive to acoustic measurements.

Overall, the uncertainty within the survey procedure is deemed not to have significant influence on the outcome of the assessment.

All plant information is not available at the time of writing. Further assessment may be required to ensure equipment meets the requirements.

8.0 Conclusion

GSAD has undertaken a background noise survey at the site and the survey results are presented within this report, together with BS4142:2014+A1:2019 and Camden Council's noise policy plant noise assessment for the proposed unit.

A representative background sound level of 46 dB $L_{A90,15min}$ has been determined over the proposed operational hours of the plant items (daytime 07:00-23:00, Monday to Sunday).

Noise limits on unknown plant and insertion loss requirement for silencers have been set out in order that the cumulative rating level from all newly proposed plant will be 10 dB below the representative background sound level, which is a positive indication of a low impact on nearby residential dwellings and demonstrates compliance with Camden Council's adopted noise policy.

To meet the requirements, silencers are required on all exhaust and fresh air paths. The condensers are expected to need acoustic enclosures. Noise data, insertion losses and mitigation measures will be reviewed by GSAD once information is available.

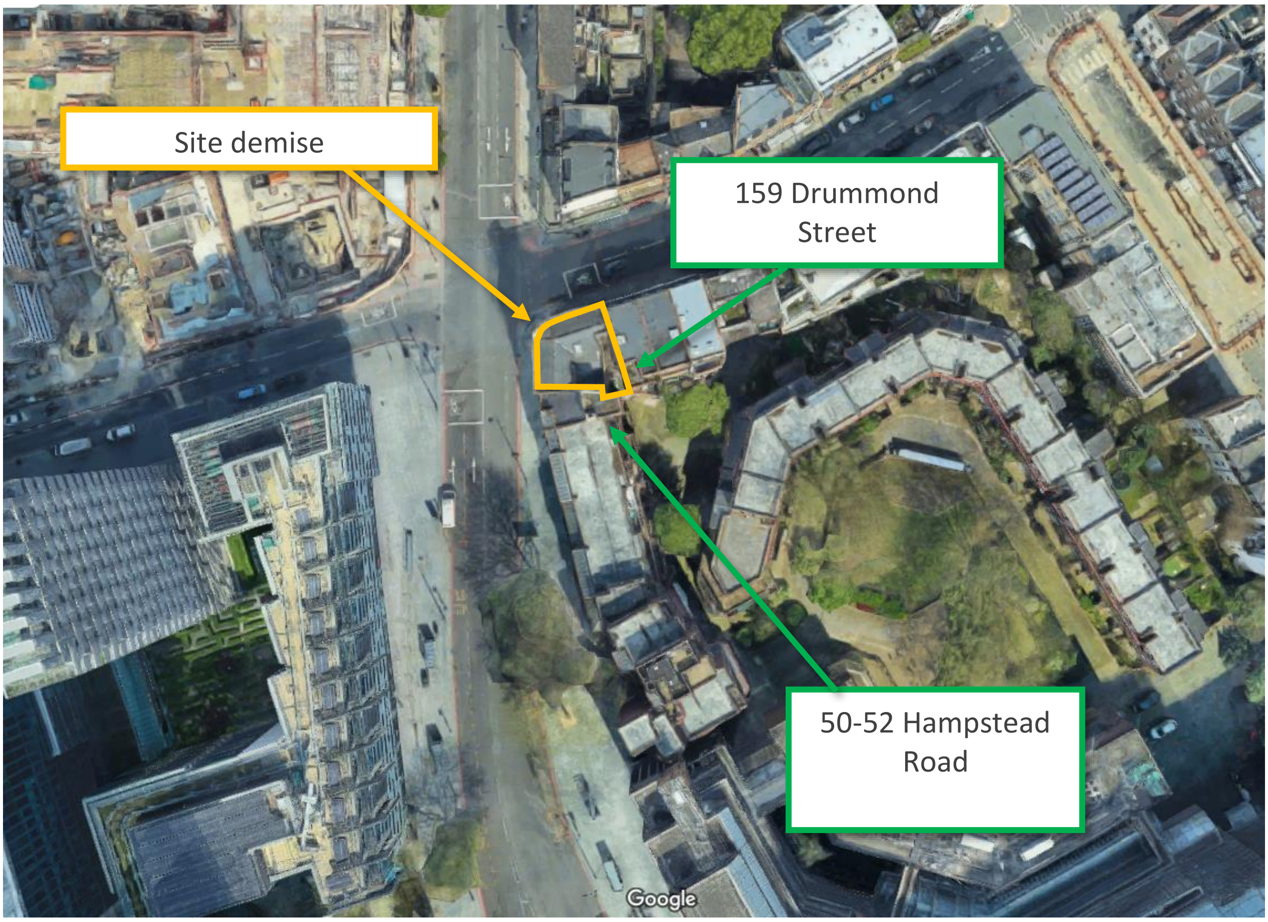
9.0 Statement of Competence

The assessment has been undertaken by the author of this report: Simon Brown BMus (Music and Sound Recording) MSc (Environmental and Architectural Acoustics) MIOA. The author is Senior Consultant of Gillieron Scott Acoustic Design with 5+ years' experience. The author has undertaken numerous noise assessments according to the 1997 revision of the British Standard and the most recent 2014 revision of the standard.

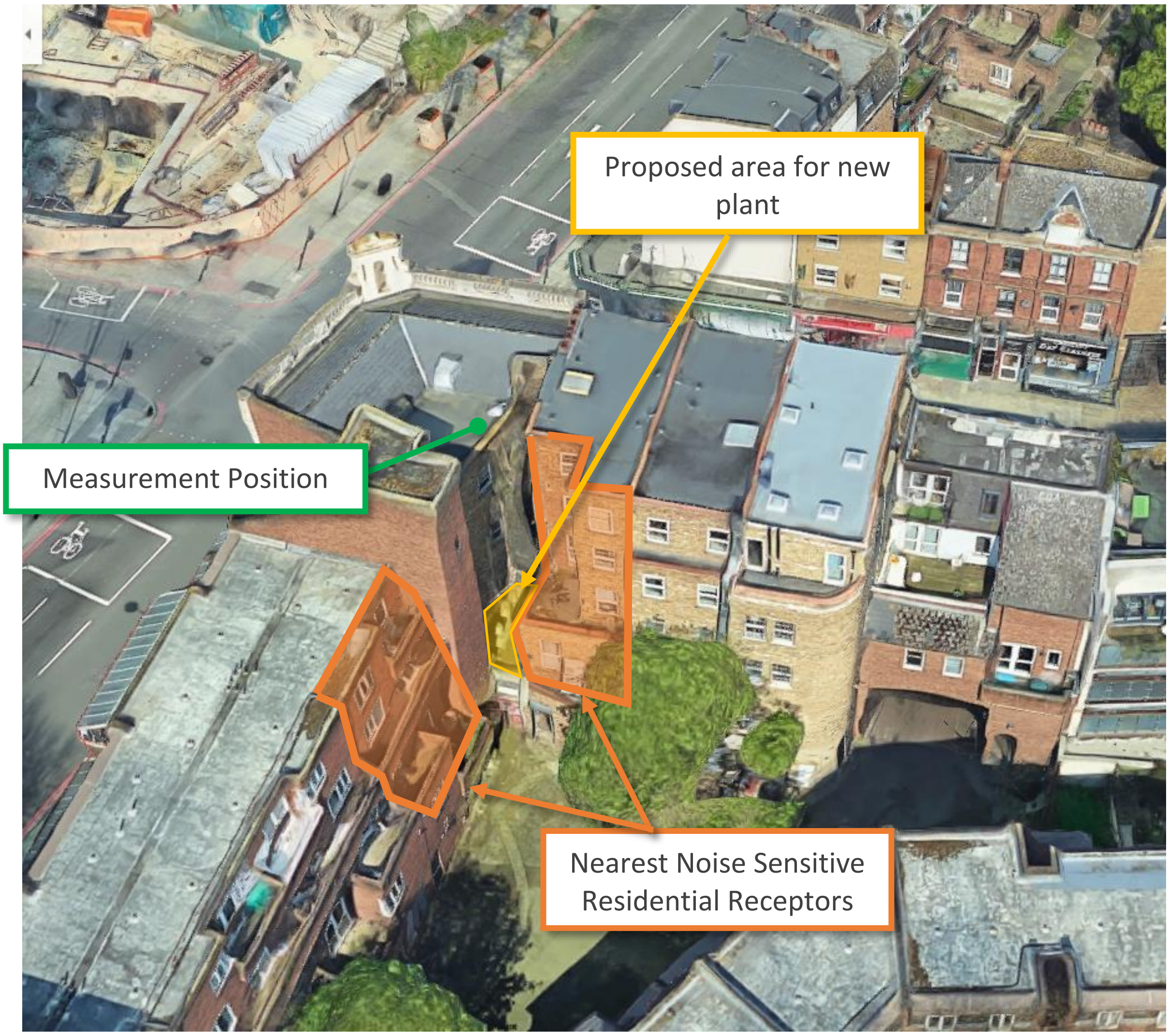
The assessment has been checked by Tim Scott BSc (Hons.), MIOA a Director of Gillieron Scott Acoustic Design with 18+ years' experience since completing a degree in Audio Technology at the University of Salford in the late 1990's who has undertaken numerous assessments according to the 1997 revision of the British Standard and the most recent 2014 revision of the Standard.

APPENDICES

APPENDIX A: Site Overview



APPENDIX B: Survey Arrangement



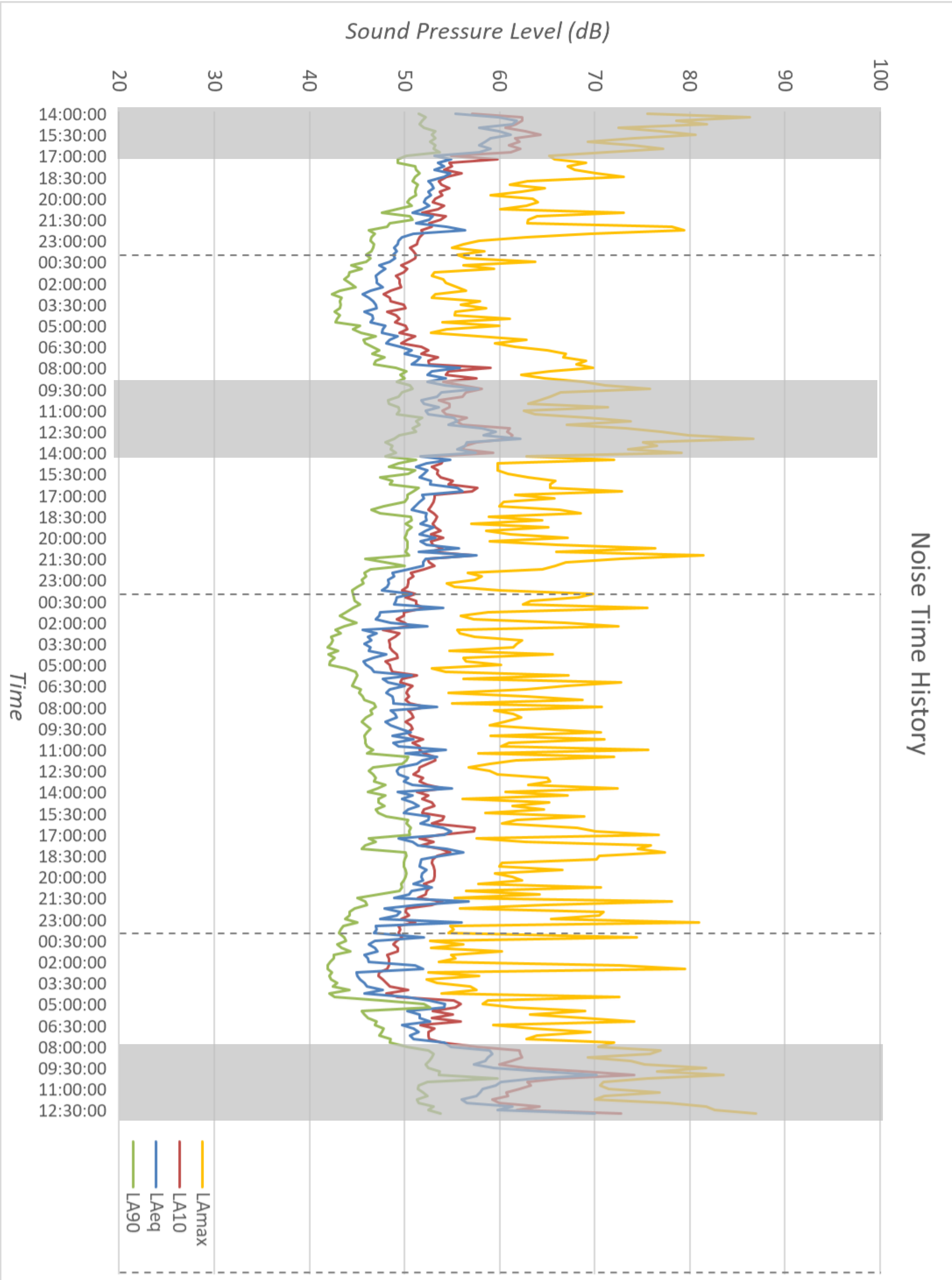
APPENDIX C: Measurement Position

Measurement Position

Nearest Noise Sensitive Residential Receptor

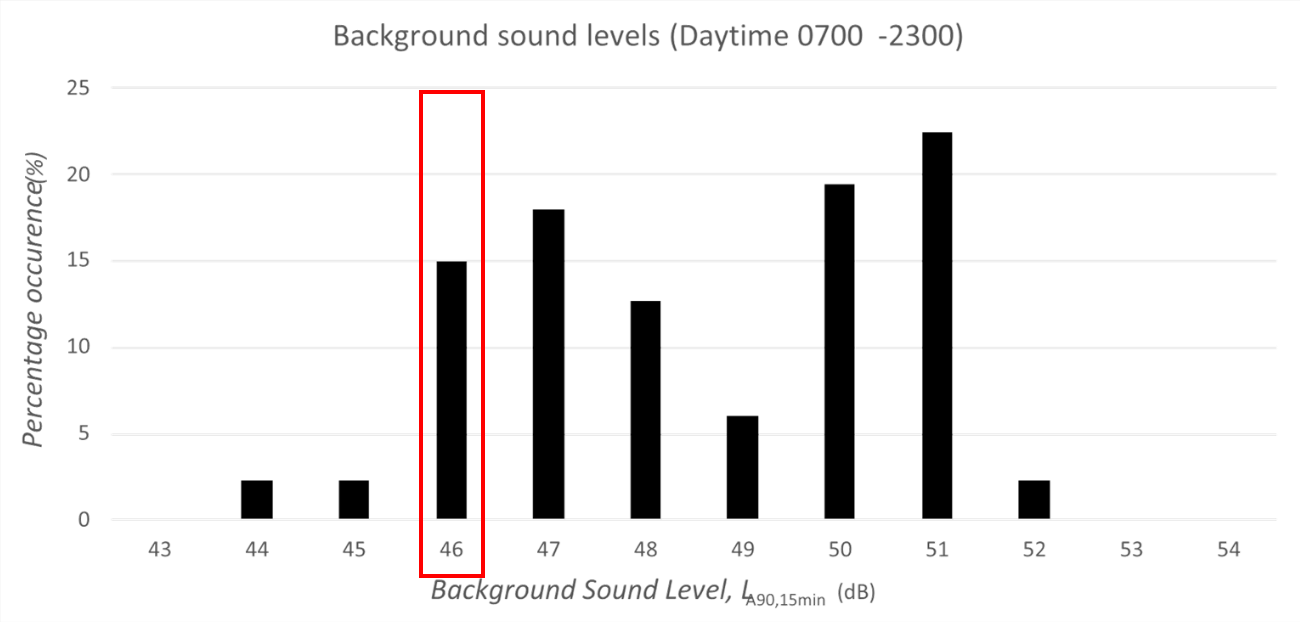
APPENDIX D: Time Series Graph

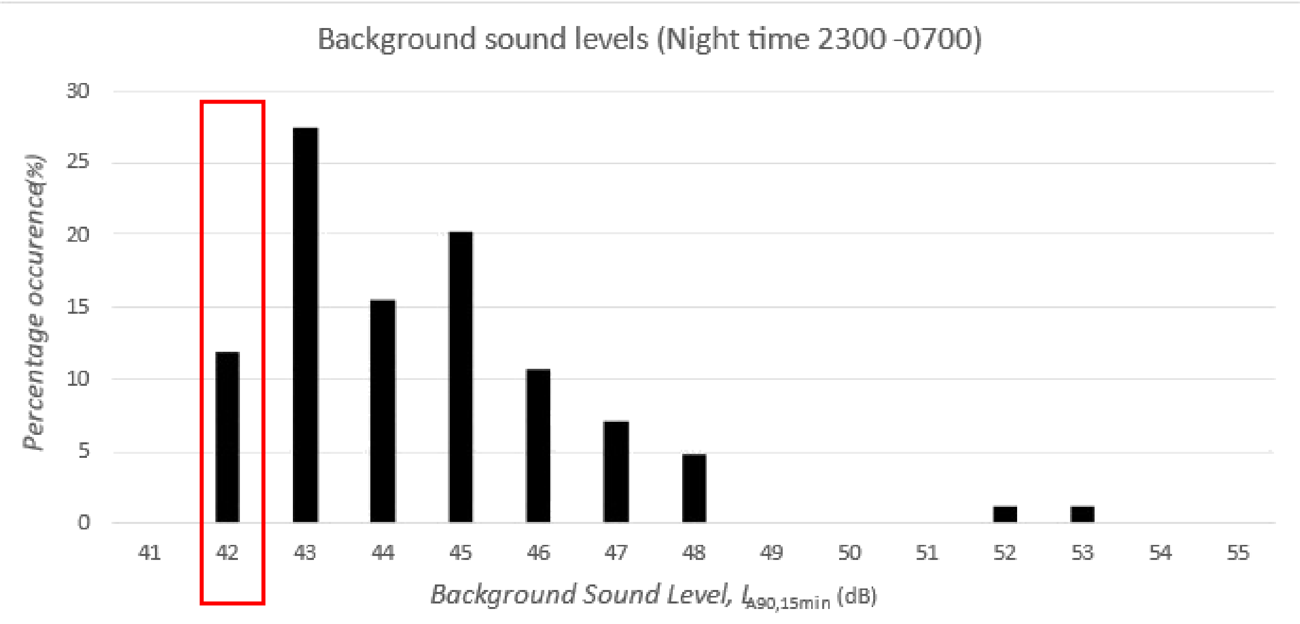
(results shaded in grey have been omitted due to building work)



APPENDIX E: Histogram Plot

Representative background Noise Level during daytime and night-time periods. The measured background noise level only these selected levels <5% of the time.





APPENDIX F: Survey Results

(results shaded in grey have been omitted due to building work)

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
05/03/2021	14:00	55	76	57	52
05/03/2021	14:15	60	86	62	52
05/03/2021	14:30	62	79	62	52
05/03/2021	14:45	61	82	62	52
05/03/2021	15:00	58	73	61	52
05/03/2021	15:15	60	77	63	53
05/03/2021	15:30	61	81	64	53
05/03/2021	15:45	59	74	62	53
05/03/2021	16:00	59	69	62	53
05/03/2021	16:15	58	74	61	53
05/03/2021	16:30	59	77	62	53
05/03/2021	16:45	58	71	61	54
05/03/2021	17:00	53	65	55	50
05/03/2021	17:15	55	66	60	49
05/03/2021	17:30	54	69	55	49
05/03/2021	17:45	54	67	55	51
05/03/2021	18:00	53	68	54	51
05/03/2021	18:15	55	70	56	52
05/03/2021	18:30	54	73	55	51
05/03/2021	18:45	53	63	54	51
05/03/2021	19:00	53	61	54	51
05/03/2021	19:15	53	65	55	51
05/03/2021	19:30	53	62	54	51
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05/03/2021	20:15	52	64	53	50
05/03/2021	20:30	53	63	54	51
05/03/2021	20:45	52	60	54	49
05/03/2021	21:00	51	73	52	48
05/03/2021	21:15	53	64	54	51
05/03/2021	21:30	53	63	54	51
05/03/2021	21:45	51	63	53	49
05/03/2021	22:00	55	78	53	48
05/03/2021	22:15	56	79	52	46
05/03/2021	22:30	51	70	52	47
05/03/2021	22:45	50	63	52	47
05/03/2021	23:00	49	58	51	46
05/03/2021	23:15	49	56	51	47
05/03/2021	23:30	49	55	51	47
05/03/2021	23:45	49	58	51	47
06/03/2021	00:00	49	56	51	46
06/03/2021	00:15	49	57	51	46
06/03/2021	00:30	49	64	51	46

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
06/03/2021	00:45	47	56	50	44
06/03/2021	01:00	48	59	50	46
06/03/2021	01:15	48	53	50	44
06/03/2021	01:30	47	53	49	44
06/03/2021	01:45	47	54	50	44
06/03/2021	02:00	47	54	50	44
06/03/2021	02:15	48	56	50	45
06/03/2021	02:30	46	57	49	43
06/03/2021	02:45	46	53	48	42
06/03/2021	03:00	46	53	49	43
06/03/2021	03:15	47	58	49	43
06/03/2021	03:30	47	56	50	43
06/03/2021	03:45	47	59	50	43
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06/03/2021	05:15	48	55	50	45
06/03/2021	05:30	48	53	50	45
06/03/2021	05:45	49	58	51	47
06/03/2021	06:00	49	63	50	46
06/03/2021	06:15	48	60	50	46
06/03/2021	06:30	50	62	52	47
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06/03/2021	10:15	52	64	54	48
06/03/2021	10:30	52	63	55	48
06/03/2021	10:45	54	71	55	49
06/03/2021	11:00	52	63	54	50
06/03/2021	11:15	53	64	54	49

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
06/03/2021	11:30	55	69	57	52
06/03/2021	11:45	56	74	56	51
06/03/2021	12:00	55	67	56	52
06/03/2021	12:15	58	73	61	51
06/03/2021	12:30	60	77	61	51
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06/03/2021	14:30	55	72	54	51
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06/03/2021	18:15	52	69	53	48
06/03/2021	18:30	52	59	53	51
06/03/2021	18:45	52	65	53	51
06/03/2021	19:00	52	57	53	50
06/03/2021	19:15	53	65	53	51
06/03/2021	19:30	52	59	54	50
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06/03/2021	20:00	53	67	54	50
06/03/2021	20:15	52	59	53	50
06/03/2021	20:30	52	66	53	50
06/03/2021	20:45	56	76	54	50
06/03/2021	21:00	52	66	53	50
06/03/2021	21:15	58	81	57	51
06/03/2021	21:30	52	73	52	46
06/03/2021	21:45	52	67	53	48
06/03/2021	22:00	52	66	53	50
06/03/2021	22:15	50	65	52	46
06/03/2021	22:30	49	57	51	46
06/03/2021	22:45	49	58	51	46

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
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07/03/2021	00:30	49	63	51	45
07/03/2021	00:45	49	63	51	45
07/03/2021	01:00	54	76	52	45
07/03/2021	01:15	48	59	50	44
07/03/2021	01:30	47	56	50	43
07/03/2021	01:45	47	57	49	44
07/03/2021	02:00	49	67	50	45
07/03/2021	02:15	52	73	51	44
07/03/2021	02:30	46	56	48	43
07/03/2021	02:45	47	56	50	43
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07/03/2021	04:00	46	55	49	43
07/03/2021	04:15	48	66	49	42
07/03/2021	04:30	47	56	49	43
07/03/2021	04:45	46	57	48	42
07/03/2021	05:00	46	60	49	42
07/03/2021	05:15	47	53	49	44
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07/03/2021	06:00	48	56	50	45
07/03/2021	06:15	48	73	50	45
07/03/2021	06:30	50	67	51	45
07/03/2021	06:45	49	63	50	45
07/03/2021	07:00	48	55	50	45
07/03/2021	07:15	49	63	51	46
07/03/2021	07:30	49	69	50	46
07/03/2021	07:45	49	55	51	47
07/03/2021	08:00	53	71	52	47
07/03/2021	08:15	49	59	50	46
07/03/2021	08:30	49	62	51	47
07/03/2021	08:45	49	62	51	46
07/03/2021	09:00	48	61	50	46
07/03/2021	09:15	49	59	51	46
07/03/2021	09:30	50	64	51	46
07/03/2021	09:45	51	71	50	46
07/03/2021	10:00	49	59	51	46
07/03/2021	10:15	51	71	52	46

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
07/03/2021	10:30	49	61	51	46
07/03/2021	10:45	49	60	52	46
07/03/2021	11:00	54	76	52	47
07/03/2021	11:15	50	58	52	46
07/03/2021	11:30	53	72	53	50
07/03/2021	11:45	52	62	53	50
07/03/2021	12:00	51	59	52	50
07/03/2021	12:15	50	57	52	47
07/03/2021	12:30	49	59	52	46
07/03/2021	12:45	49	60	51	47
07/03/2021	13:00	50	65	52	47
07/03/2021	13:15	50	65	52	47
07/03/2021	13:30	51	63	52	48
07/03/2021	13:45	55	72	54	47
07/03/2021	14:00	49	61	51	46
07/03/2021	14:15	51	67	53	48
07/03/2021	14:30	50	56	52	47
07/03/2021	14:45	51	65	53	47
07/03/2021	15:00	52	61	53	48
07/03/2021	15:15	50	65	52	47
07/03/2021	15:30	50	59	52	47
07/03/2021	15:45	53	69	54	48
07/03/2021	16:00	53	62	54	50
07/03/2021	16:15	52	60	53	50
07/03/2021	16:30	54	68	57	51
07/03/2021	16:45	55	70	57	51
07/03/2021	17:00	54	77	54	51
07/03/2021	17:15	49	58	52	46
07/03/2021	17:30	51	63	53	47
07/03/2021	17:45	51	76	52	46
07/03/2021	18:00	55	75	54	46
07/03/2021	18:15	56	77	55	50
07/03/2021	18:30	54	71	53	50
07/03/2021	18:45	52	70	53	50
07/03/2021	19:00	52	60	53	50
07/03/2021	19:15	52	60	53	50
07/03/2021	19:30	52	67	53	50
07/03/2021	19:45	52	60	53	50
07/03/2021	20:00	52	61	53	50
07/03/2021	20:15	52	62	53	50
07/03/2021	20:30	51	58	52	50
07/03/2021	20:45	53	71	53	50
07/03/2021	21:00	51	57	52	50
07/03/2021	21:15	51	64	52	47
07/03/2021	21:30	49	55	51	45
07/03/2021	21:45	57	78	54	46

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
07/03/2021	22:00	51	65	53	46
07/03/2021	22:15	48	56	50	45
07/03/2021	22:30	50	71	50	44
07/03/2021	22:45	49	71	51	44
07/03/2021	23:00	48	65	50	44
07/03/2021	23:15	56	81	51	45
07/03/2021	23:30	47	55	49	44
07/03/2021	23:45	47	55	50	43
08/03/2021	00:00	47	55	49	43
08/03/2021	00:15	52	74	50	44
08/03/2021	00:30	47	53	49	44
08/03/2021	00:45	46	56	49	43
08/03/2021	01:00	47	53	49	43
08/03/2021	01:15	47	60	49	44
08/03/2021	01:30	46	55	48	43
08/03/2021	01:45	46	55	48	43
08/03/2021	02:00	46	54	48	42
08/03/2021	02:15	51	73	48	42
08/03/2021	02:30	52	80	48	42
08/03/2021	02:45	45	53	47	42
08/03/2021	03:00	45	58	47	42
08/03/2021	03:15	45	52	48	42
08/03/2021	03:30	46	53	48	43
08/03/2021	03:45	46	57	49	43
08/03/2021	04:00	48	58	50	44
08/03/2021	04:15	46	54	48	42
08/03/2021	04:30	50	73	49	43
08/03/2021	04:45	53	59	55	48
08/03/2021	05:00	54	58	56	52
08/03/2021	05:15	54	62	55	53
08/03/2021	05:30	50	69	53	46
08/03/2021	05:45	52	63	55	46
08/03/2021	06:00	52	69	53	46
08/03/2021	06:15	53	74	56	47
08/03/2021	06:30	50	59	52	47
08/03/2021	06:45	51	64	53	48
08/03/2021	07:00	52	70	53	48
08/03/2021	07:15	51	64	53	47
08/03/2021	07:30	51	63	53	49
08/03/2021	07:45	54	72	54	49
08/03/2021	08:00	55	70	58	50
08/03/2021	08:15	59	77	62	53
08/03/2021	08:30	59	76	62	53
08/03/2021	08:45	59	69	62	53
08/03/2021	09:00	59	74	61	53
08/03/2021	09:15	57	75	60	52

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
08/03/2021	09:30	59	82	63	53
08/03/2021	09:45	65	77	69	54
08/03/2021	10:00	70	84	74	54
08/03/2021	10:15	64	76	66	60
08/03/2021	10:30	60	71	63	52
08/03/2021	10:45	60	71	63	52
08/03/2021	11:00	58	72	62	51

Date	Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
08/03/2021	11:15	58	77	61	52
08/03/2021	11:30	58	71	61	52
08/03/2021	11:45	56	70	59	51
08/03/2021	12:00	57	78	60	52
08/03/2021	12:15	61	82	64	53
08/03/2021	12:30	60	83	62	53
08/03/2021	12:45	70	87	73	54

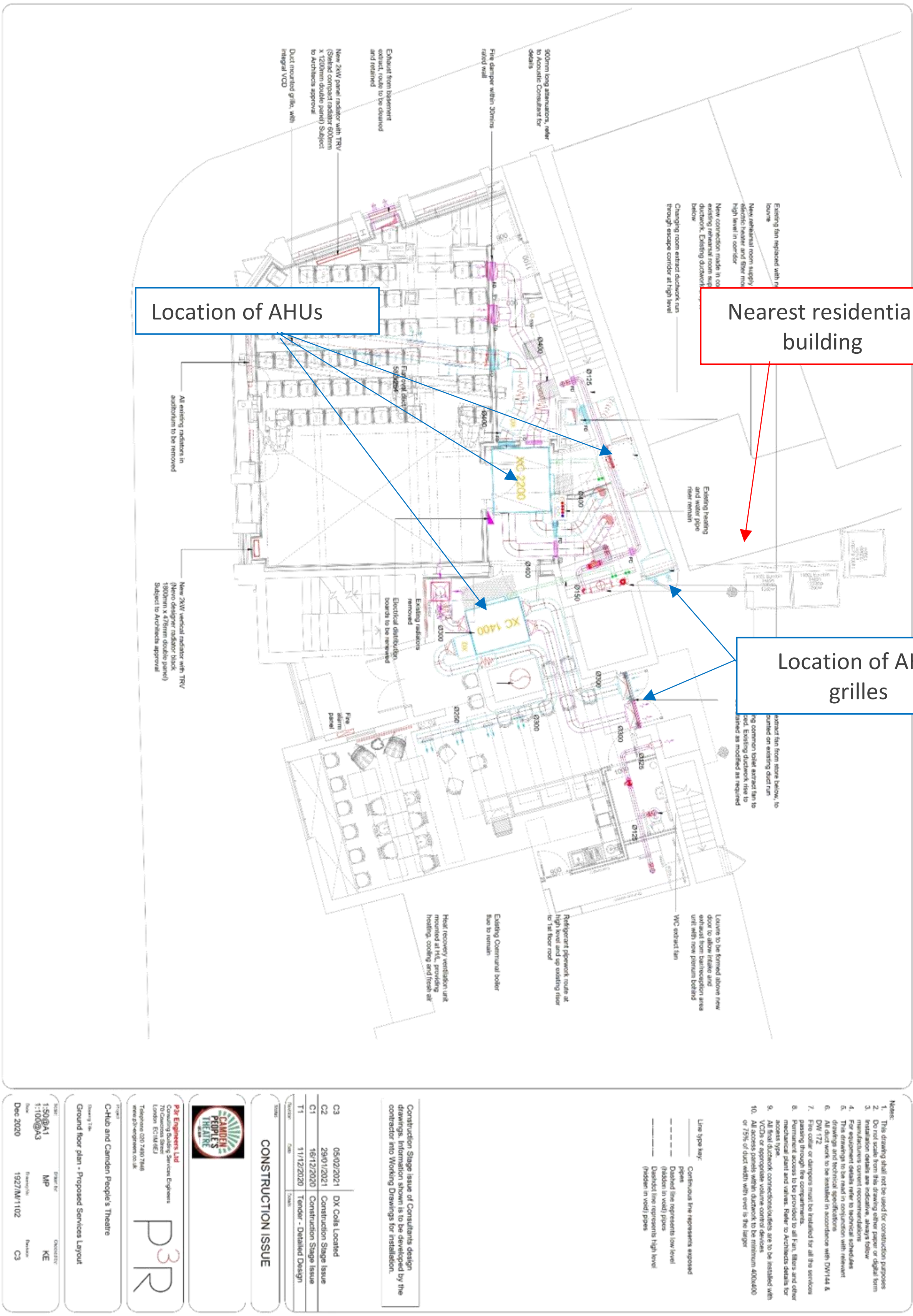
APPENDIX G: Equipment

- NTi XL2 Real Time Analyser
- Bruel & Kjaer 4231 Calibrator
- NTi outdoor kit

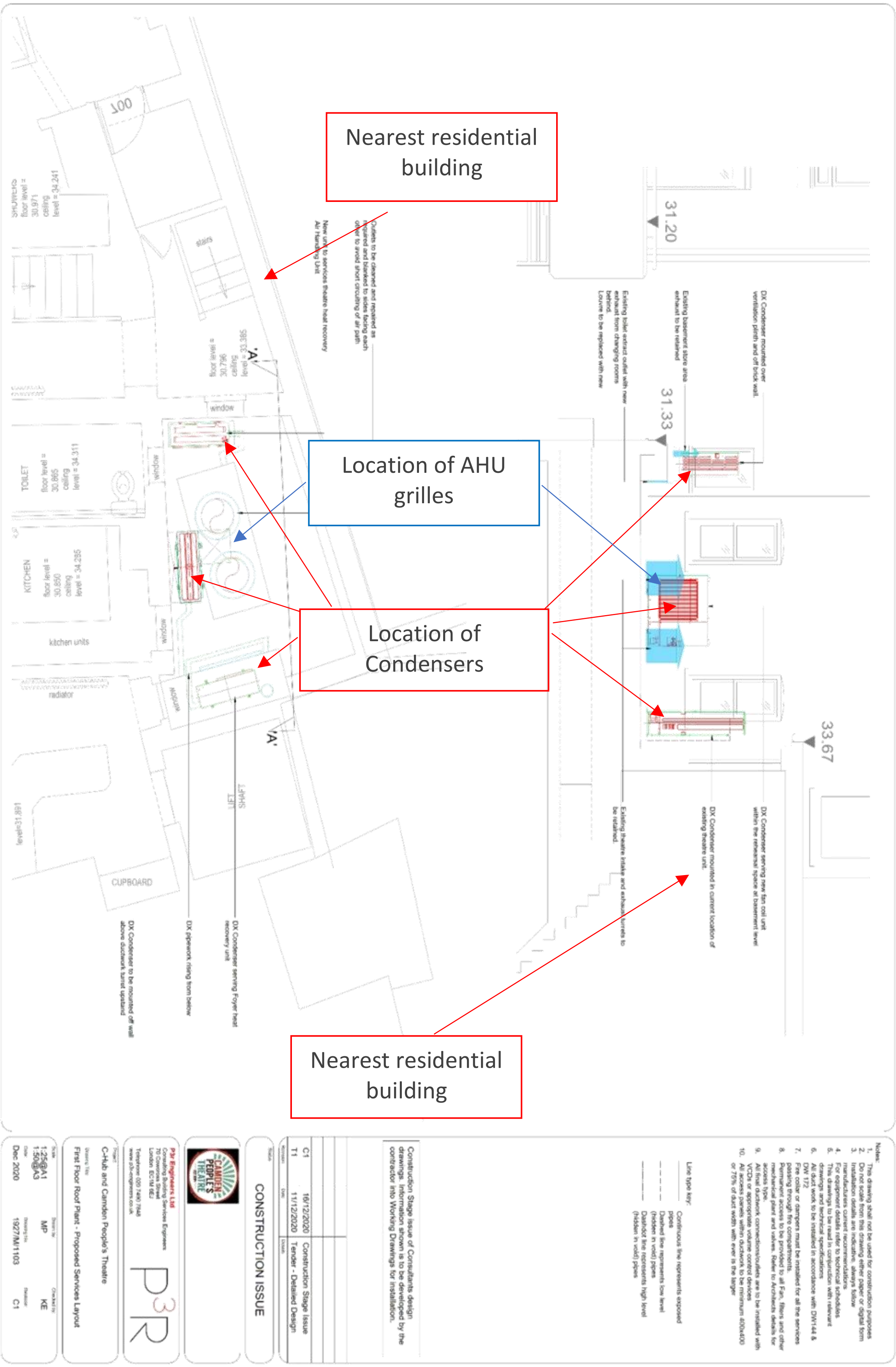
Calibration certificates are available on request.

APPENDIX H: Proposed Mechanical Layout

Ground Floor Plan



First Floor Roof Plan



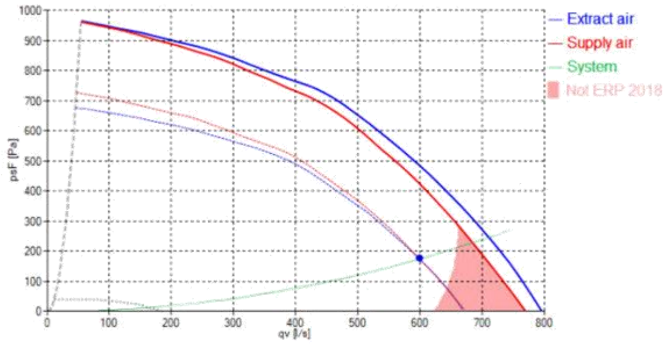
APPENDIX I: Manufacturer Noise Data

Auditorium AHU

Project-ID	Project name	Description	Editor	Date
				20.01.2021

Order ref. number	04333	Unit type	AIR1 XC 2200

Performance curve



Acoustic

Sound power level	63	125	250	500	1 k	2 k	4 k	8 k	Total dB(A)
Lw supply	66	68	73	73	75	73	67	63	79
Lw exhaust	66	67	72	73	74	72	67	62	78
Lw outdoor	58	63	59	67	52	59	59	40	67
Lw extract	63	66	65	70	60	62	61	50	70
Lw airborn sound pwr	40	55	45	54	44	49	54	28	58
Sound pressure level LpA dB(A)									
Sound pressure level at 1 m									50
Sound pressure level at 3 m									40
Sound pressure level at 5 m									36

The sound power level at the spigots is calculated for the simultaneous operation of both fans at the operation point. The sound pressure level is determined for the simultaneous operation of both fans at a distance of 1, 3 and 5 m at the operation point.

Filter

	Filter class	Filter dimensions / quantity	Pressure drop filter Pa			Energy Performance kw/h
			Clean	Average	Maximal	
Prefilter	-	-	-	-	-	-
Outdoor air	ePM1 55% (F7)	358 x 400 x 96 / 2	74	124	174	761
Extract air	ePM10 50% (M5)	358 x 400 x 96 / 2	62	112	162	692

Casing design

Casing strength class	Casing air leakage class at -400 Pa	Casing air leakage class at +400 Pa	Filter leakage class	Thermal transmittance class	Thermal bridging factor class
-	-	-	-	-	-

Preheater

Installation position	Heater type	Heating battery type	Available capacity	
Internal	Electric	Heater battery	7.05 [kW]	

Heat recovery system

Heat exchanger type	Heat exchanger material		
Counterflow	Aluminium		

Cooling coil

Installation position	Cooling coil type	Coil Type	Connectors in/out	Coil int. volume
extern	R410A	Cooling coil	1/2"	2.7 dm³

Fan

Fan	Fan type	Motor type (controller)	Nom. power max.	Nom. current max.
Supply air	EC	variable speed	0.78 kW	3.9 A
Extract air	EC	variable speed	0.78 kW	3.9 A

Electrical data

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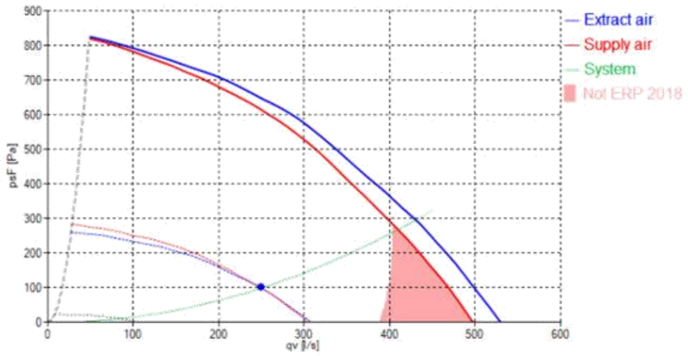
Foyer AHU

Helios

Project-ID	Project name	Description	Editor	Date
				20.01.2021

Order ref. number	04332	Unit type	AIR1 XC 1400

Performance curve



Acoustic

Sound power level	63	125	250	500	1 k	2 k	4 k	8 k	Total dB(A)
Lw supply	64	62	65	63	63	62	55	49	68
Lw exhaust	62	61	63	62	62	61	54	48	67
Lw outdoor	56	58	49	56	42	48	47	28	56
Lw extract	59	60	54	58	50	50	48	37	58
Lw airborn sound pwr	36	48	34	43	31	38	41	13	46
Sound pressure level LpA dB(A)									
Sound pressure level at 1 m									38
Sound pressure level at 3 m									28
Sound pressure level at 5 m									24

The sound power level at the spigots is calculated for the simultaneous operation of both fans at the operation point. The sound pressure level is determined for the simultaneous operation of both fans at a distance of 1, 3 and 5 m at the operation point.

Filter

	Filter class	Filter dimensions / quantity	Pressure drop filter Pa			Energy Performance kw/h
			Clean	Average	Maximal	
Prefilter	-	-	-	-	-	-
Outdoor air	ePM1 55% (F7)	275 x 642 x 96 / 1	40	79	119	231
Extract air	ePM10 50% (M5)	275 x 642 x 96 / 1	32	63	95	187

Casing design

Casing strength class	Casing air leakage class at -400 Pa	Casing air leakage class at +400 Pa	Filter leakage class	Thermal transmittance class	Thermal bridging factor class
-	-	-	-	-	-

Preheater

Installation position	Heater type	Heating battery type	Available capacity	
Internal	Electric	Heater battery	4.50 [kW]	

Heat recovery system

Heat exchanger type	Heat exchanger material		
Counterflow	Aluminium		

Cooling coil

Installation position	Cooling coil type	Coil Type	Connectors in/out	Coil int. volume
extern	R410A	Cooling coil	3/8"	1.7 dm³

Fan

Fan	Fan type	Motor type (controller)	Nom. power max.	Nom. current max.
Supply air	EC	variable speed	0.50 kW	2.5 A
Extract air	EC	variable speed	0.50 kW	2.5 A

Electrical data

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APPENDIX J: Plant Nose Calculations

Auditorium AHU Exhaust

		Unit	Frequency Hz								dBA	Comment
			63	125	250	500	1k	2k	4k	8k		
A	Exhaust Sound power	Lw	66	67	72	73	74	72	67	62	78	From Manufacturers data
B	End Reflection		-4	-1	0	0	0	0	0	0		Opening of 1000 x 1000 mm on 1st floor roof
C	Directivity		-2	-2	-2	-3	-3	-3	-3	-3		Assumed 50 degrees
D	Surface reflections		+9	+9	+9	+9	+9	+9	+9	+9		3 surfaces in proximity
E	Distance Attenuation		-21	-21	-21	-21	-21	-21	-21	-21		3m to nearest receiver
F	Barrier		-5	-6	-8	-11	-14	-17	-20	-23		2.5m wall between plant and nearest receiver
G	Safety Factor		+3	+3	+3	+3	+3	+3	+3	+3		
H	**Total**	**SPL**	50	53	57	56	54	49	41	33	**58**	**A+B+C+D+E+F+G**
I	Background noise level	L90	53	49	47	44	42	37	24	18	46	Day time, 0700-2300 hours
J	Difference		-3	+4	+10	+12	+12	+12	+17	+15		H-I
K	**Required Insertion Loss**	**IL**	**16**	**23**	**29**	**31**	**31**	**31**	**36**	**34**		**J + 10 (to get to Background -10dB) + 9dB to compensate for cumulation of plant equipment**
L	Resultant Noise Level	SPL	34	30	28	25	23	18	5	-1	27	H-K

Auditorium AHU Fresh Air

		Unit	Frequency Hz								dBA	Comment
			63	125	250	500	1k	2k	4k	8k		
A	Outdoor Sound power	Lw	58	63	59	67	52	59	59	40	56	From Manufacturers data
B	End Reflection		-4	-1	0	0	0	0	0	0		Opening of 1000 x 1000 mm on roof
C	Directivity		-2	-2	-2	-3	-3	-3	-3	-3		Assumed 50 degrees
D	Surface reflections		+3	+3	+3	+3	+3	+3	+3	+3		3 surfaces in proximity
E	Distance Attenuation		-21	-21	-21	-21	-21	-21	-21	-21		2m to nearest receiver
F	Barrier		-5	-6	-8	-11	-14	-17	-20	-23		2.5m wall between plant and nearest receiver
G	Safety Factor		+3	+3	+3	+3	+3	+3	+3	+3		
H	**Total**	**SPL**	**42**	**49**	**44**	**50**	**32**	**36**	**33**	**12**	**48**	**A+B+C+D+E+F+G**
I	Background noise level	L90	53	49	47	44	42	37	24	18	46	Day time, 0700-2300 hours
J	Difference		-11	0	-3	+6	+10	-1	+9	-6		H-I
K	**Required Insertion Loss**	**IL**	**8**	**19**	**16**	**25**	**9**	**18**	**28**	**13**		**J + 10 (to get to Background -10dB) + 9dB to compensate for cumulation of plant equipment**
L	Resultant Noise Level	SPL	34	30	28	25	23	18	5	-1	27	H-K

Foyer AHU Exhaust

		Unit	Frequency Hz								dBA	Comment
			63	125	250	500	1k	2k	4k	8k		
A	Exhaust Sound power	Lw	62	61	63	62	62	61	54	48	67	From Manufacturers data
B	End Reflection		-6	-2	0	0	0	0	0	0		Opening of 750x750mm at ground floor high level
C	Directivity		-2	-2	-2	-3	-3	-3	-3	-3		Assumed 50 degrees
D	Surface reflections		+3	+3	+3	+3	+3	+3	+3	+3		1 surface in proximity
E	Distance Attenuation		-17	-17	-17	-17	-17	-17	-17	-17		2m to nearest receiver
F	Safety Factor		+3	+3	+3	+3	+3	+3	+3	+3		
G	**Total**	**SPL**	**46**	**50**	**54**	**53**	**53**	**53**	**46**	**40**	**58**	**A+B+C+D+E+F+G**
H	Background noise level	L90	53	49	47	44	42	37	24	18	46	Day time, 0700-2300 hours
I	Difference		-7	-1	+7	+9	+11	+16	+22	+22		G-H
J	**Required Insertion Loss**	**IL**	**12**	**20**	**26**	**28**	**30**	**35**	**41**	**41**		**I + 10 (to get to Background -10dB) + 9dB to compensate for cumulation of plant equipment**
K	Resultant Noise Level	**SPL**	34	30	28	25	23	18	5	-1	27	G-J

Foyer AHU Fresh Air

		Unit	Frequency Hz								dBA	Comment
			63	125	250	500	1k	2k	4k	8k		
A	Outdoor Sound power	Lw	56	58	49	56	42	48	47	28	56	From Manufacturers data
B	End Reflection		-6	-2	0	0	0	0	0	0		Opening of 750x750mm at ground floor high level
C	Directivity		-2	-2	-2	-3	-3	-3	-3	-3		Assumed 50 degrees
D	Surface reflections		+3	+3	+3	+3	+3	+3	+3	+3		1 surface in proximity
E	Distance Attenuation		-17	-17	-17	-17	-17	-17	-17	-17		2m to nearest receiver
F	Safety Factor		+3	+3	+3	+3	+3	+3	+3	+3		
G	**Total**	**SPL**	40	47	40	47	33	40	39	20	**47**	**A+B+C+D+E+F+G**
H	Background noise level	L90	53	49	47	44	42	37	24	18	46	Day time, 0700-2300 hours
I	Difference		-13	-2	-7	+3	-9	+3	+15	+2		G-H
J	**Required Insertion Loss**	**IL**	**6**	**17**	**12**	**22**	**10**	**22**	**34**	**21**		**I + 10 (to get to Background -10dB) + 9dB to compensate for cumulation of plant equipment**
K	Resultant Noise Level	SPL	34	30	28	25	23	18	5	-1	27	G-J

Rehearsal Room AHU Exhaust

Sound power data unknown. Calculation to provide limits of sound power for both AHU outlet and duct attenuation.

		Unit	Frequency Hz								dBA	Comment
			63	125	250	500	1k	2k	4k	8k		
A	Required External Noise level	SPL	34	30	28	25	23	18	5	-1	27dB	10dB below background - 9dB to compensate for cumulation of plant equipment
B	Safety Factor		-3	-3	-3	-3	-3	-3	-3	-3		
C	Distance Attenuation		+17	+17	+17	+17	+17	+17	+17	+17		2m to nearest receiver
D	Surface Reflections		-3	-3	-3	-3	-3	-3	-3	-3		1 surface in proximity
E	Directivity		+1	+2	+2	+2	+2	+3	+3	+3		Assumed 50 degrees
F	End Reflection		+6	+2	0	0	0	0	0	0		Opening of 750x750mm at ground floor high level
G	**Required power limit**	**Lw**	**52**	**45**	**41**	**38**	**36**	**31**	**18**	**14**	**41**	**A+B+C+D+E+F AHU Lw of outlet minus attenuation**

Rehearsal Room AHU Fresh Air

Sound power data unknown. Calculation to provide limits of sound power for both AHU outlet and duct attenuation.

		Unit	Frequency Hz								dBA	Comment
			63	125	250	500	1k	2k	4k	8k		
A	Required External Noise level	SPL	34	30	28	25	23	18	5	-1	27dB	10dB below background - 9dB to compensate for cumulation of plant equipment
B	Safety Factor		-3	-3	-3	-3	-3	-3	-3	-3		
C	Distance Attenuation		+17	+17	+17	+17	+17	+17	+17	+17		2m to nearest receiver
D	Surface Reflections		-3	-3	-3	-3	-3	-3	-3	-3		1 surface in proximity
E	Directivity		+1	+2	+2	+2	+2	+3	+3	+3		Assumed 50 degrees
F	End Reflection		+6	+2	0	0	0	0	0	0		Opening of 750x750mm at ground floor high level
G	**Required power limit**	**Lw**	**52**	**45**	**41**	**38**	**36**	**31**	**18**	**14**	**41**	**A+B+C+D+E+F AHU Lw of outlet minus attenuation**

Condenser units

Sound data unknown. Calculation to provide limits of sound pressure level at 1m for each of the 3 units.

		Unit	Frequency Hz								dBA	Comment
			63	125	250	500	1k	2k	4k	8k		
A	Required External Noise level	SPL	34	30	28	25	23	18	5	-1	27	10dB below background - 9dB to compensate for cumulation of plant equipment
B	Safety Factor		-3	-3	-3	-3	-3	-3	-3	-3		
C	Penalty		-3	-3	-3	-3	-3	-3	-3	-3		Tonality
D	Barrier		+5	+6	+8	+11	+14	+17	+20	+23		
E	Distance Attenuation		+10	+10	+10	+10	+10	+10	+10	+10		3m to nearest receiver
F	Surface Reflections		-9	-9	-9	-9	-9	-9	-9	-9		3 surfaces in proximity
G	**Required sound pressure level at 1m for each unit**	**SPL**	**34**	**31**	**31**	**31**	**32**	**27**	**20**	**17**	**35**	**A+B+C+D+E+F**

Cumulation of noise levels at nearest receiver

	Unit	Frequency Hz								dBA	Comments
		63	125	250	500	1k	2k	4k	8k		
Auditorium Exhaust	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Auditorium Fresh Air	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Foyer Exhaust	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Foyer Fresh Air	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Rehearsal Exhaust	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Rehearsal Fresh Air	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Condenser 1	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Condenser 2	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Condenser 3	dB SPL	34	30	28	25	23	18	5	-1	27	At 1m from window of nearest residence
Total	**dB SPL**	**43**	**39**	**37**	**34**	**32**	**27**	**14**	**8**	**36**	**Energy summation of all outlets**
Background	dB L_{90}	53	49	47	44	42	37	24	18	46	$L_{90,\ 15min}$, representative background 0700-2300
Difference		-10	-10	-10	-10	-10	-10	-10	-10	-10	

APPENDIX K: Acoustic Feature Correction

Tonality

For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible.

Impulsivity

A correction of up to +9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible and 9 dB where it is highly perceptible.

Intermittency

When the specific sound has identifiable on/off conditions, the specific sound level should be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time. This can necessitate measuring the specific sound over a number of shorter sampling periods that are in combination less than the reference time interval in total, and then calculating the specific sound level for the reference time interval allowing for time when the specific sound is not present. If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.

Other sound characteristics

Where the specific sound features characteristics that are neither tonal nor impulsive, nor intermittent, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.

APPENDIX L: Glossary of Acoustic Terms

DECIBEL (dB) - A unit of sound pressure measurement
Sound Pressure Level in dB (*L*p) = 20 log (Measured sound pressure/Reference sound pressure = 20 µPa)

dB(A) - The A -weighted sound pressure level, the weighting network reduces low frequency sound in a similar way to the human ear.

REVERBERATION TIME (RT or *T*) – decay of sound in rooms
The time taken for a sound, once terminated, to fall through 60dB i.e., to one millionth of its original sound intensity. *T*30 – RT for first 30dB of decay. RT_{500} - Mid frequency RT.
HERTZ (Hz) - a unit of frequency measurement. The normal range of hearing is from 20Hz to about 15kHz.

ABSORPTION COEFFICIENT – degree to which a material absorbs sound.
The ratio of absorbed to incident sound energy (perfect absorber = 1)

SOUND REDUCTION INDEX *R* – quantity which describes a material's ability to reduce the sound pressure level across it (e.g., a wall or floor)

$R = L1 - L2 + 10\log (S/A)$

*L*1 - Average sound pressure level in source room (averaged from 100 Hz – 3150 Hz)
*L*2 - Average sound pressure level in receiving room (averaged from 100 Hz – 3150 Hz)
S – Wall Area (m^2)
A – Total absorption in receiving room (m^2 units)

*R*w – weighted sound reduction index

AVERAGE ROOM TO ROOM LEVEL DIFFERENCE – *D*, dB = *L*1 – *L*2, averaged 1/3 octave bands from 100Hz – 3150kHz.

*D*w – weighted value of D (usually 2 - 3dB higher)

*D*nT, w – *D*w corrected for reverberation time of receiving room.

NOISE RATING CURVES (NR CURVES) – set of curves used to describe optimum background noise levels for different tasks.

*L*10/90 LEVEL (dB) - The level in dB of a time varying sound pressured level (e.g., traffic) exceeded for 10%/90% of the time of measurement.
*L*90 is usually called the BACKGROUND NOISE LEVEL.

*L*eq AVERAGE SOUND PRESSURE LEVEL – level dB of a time varying sound pressure level with equal amounts of energy above and below it, for the time of measurement.

TONAL NOISE – noise of a single frequency (or a narrow band of frequencies that can be perceived as a tone), audible above the broad band noise background. Noise which is at least 5dB above the average of the 1/3 octave band sound pressure levels immediately on either side of it.