Report No. SONDHEIMPLANNING.R2.Rev4

For: Delfont Mackintosh Theatres

SONDHEIM THEATRE

ENVIRONMENTAL IMPACT ASSESSMENT

PLANT, ENTERTAINMENT AND REHEARSAL NOISE

Office 20
Wingate Business Exchange
64-66 Wingate Square
London SW4 0AF

t - 020 8671 2223
e - info@gsacoustics.org
m - www.gsacoustics.org

January 2015

Compiled by: ..... Mihalis Bourzoukos MMus DipIOA AMIOA Date: 9/1/2015

Checked by: ..... Paul Gillieron BSc MIOA Date: 9/1/2015

Gillieron Scott Acoustic Design Ltd shall not be responsible for any use of the report or its contents for any purpose other than that for which it was provided. Should the Client require the distribution of the report to other parties for information, the full report should be copied. No professional liability or warranty shall be extended to other parties by Gillieron Scott Acoustic Design Ltd without written agreement from Gillieron Scott Acoustic Design Ltd.

TABLE OF CONTENTS

1.0 INTRODUCTION

The application proposes a new dedicated theatrical transfer house to accommodate productions that have come to the end of their run in the subsidised sector. The proposed theatre will provide the opportunity for subsidised productions that would not otherwise have the opportunity to transfer to the West End.

It is currently very difficult for successful subsidised productions to transfer to the West End because the internal arrangement of most West End theatres differs substantially from more modern arrangements of the subsidised sector. The vast majority of West End theatres have traditional 'proscenium arch' stages whilst most originating theatres in the subsidised sector have more modern arrangements, such as thrust stages or are arranged 'in the round'. This means that a transfer has to be restaged, often at huge cost to the originating subsidised theatre and eroding the original artistic intention of the director, to the detriment of the audience experience.

There are currently no dedicated theatres in the West End to which productions arising in the subsidised theatre sector can transfer in the event of critical acclaim or audience demand. Typically, publically subsidised productions are pre-programmed in advance at the originating playhouses and run for a period of 6-8 weeks only. The proposed new theatre would provide an opportunity for successful subsidised shows to transfer to the West End for a further 8-16 weeks.

This increased run would provide the subsidised sector with an opportunity to increase revenue at a time of consistently squeezed funding pressures and cuts. It will also diversify the offer for theatre goers and open up a range of quality productions to be viewed as originally intended, enhancing the range and quality of productions and cementing London's status as a world cultural capital in theatre.

Such is the shortage of space in the West End that very many successful subsidised productions are simply never seen again after their original run. Others, due to the physical difficulties of restaging in a proscenium setting simply have no prospect of transfer at all, even if a space in the West End were available.
In order to create a modern and flexible internal arrangement, it is proposed that much of the building is demolished and rebuilt behind the retained West Street façade and the stucco return onto Tower Court. Historically significant elements of plasterwork are to be relocated within the new theatre.

The proposed theatre will then provide a much needed resource for the transfer of productions from the subsidised sector. In turn, the subsidised sector will be able to secure a longer run for critically acclaimed productions that would otherwise close for good, frustrating a large unmet demand from the audience. Thus, the cultural life of the West End will be enhanced along with the audience's opportunity to see good quality subsidised productions for a longer period of time. In their turn, the subsidised sector will realise the opportunity to increase their revenue in an environment of constantly reduced funding.

The proposals have attracted wide ranging support from within the industry. Nicholas Hytner (former Artistic Director of the National Theatre) summarised the situation as:

"Over recent years, a large number of the most successful and ambitious productions in the subsidised theatre sector have been unable to find a venue for further life, leaving a significant potential audience without an opportunity to see work it would like to see. Very often this work would not justify the risks involved in a transfer to a large West End theatre. Cameron Mackintosh's plans for his new 450 seat theatre would greatly increase the chances of a future life for successful productions form theatres like the Dorfman, the Almeida, the Royal Court and the Donmar as well as offering a suitable venue for regional transfers."

Full details of the need for a dedicated transfer house and how the proposed theatre meets that need is set out in the Design and Access Statement and Planning and Heritage Statement that accompany this application.

The new Sondheim Theatre will be constructed within the existing shell of the Ambassadors Theatre.
The new theatre will seat around 480 in a raked auditorium with two balconies.
Activities within the new theatre will remain unchanged.
The perimeter of the site will be piled to retain the existing and new structures.
Gillieron Scott Acoustic Design have been commissioned to undertake the acoustic design of all internal and external areas.
For the Planning Application for the Ambassadors Theatre on West Street, Camden, London, Gillieron Scott Acoustic Design (GSAD) carried out a background noise survey, plant noise and entertainment noise impact assessment on surrounding buildings.
The closest residential building to the theatre is at 4, Tower Street. The nearest window is at the rear of this building at +14m (referred to here as the 'reference window'). This is above the level of the existing theatre roof.

The London Borough of Camden Planning Conditions are set out below in section 2.

The acoustic design of the theatre and plant and the compliance with the acoustic planning requirements relate to:

- The control of plant noise and vibration in adjacent buildings and residences to statutory limits

- The control of activity noise from the Sondheim Theatre and new Rehearsal Rooms in adjacent buildings and residences to statutory limits

We have constructed a CadnaA model of the theatre and surrounding buildings extending to a radius of around 40m at all building levels from street level upwards. This was based on three sets of noise measurements >24 hours each, taken on the existing theatre roof.

The CadnaA study is based on minimum L_{A90} and L_{Aeq} values on all adjacent building facades at all floor levels.

The CadnaA study is based on provisional plant selections. Final plant selections will be recalculated, with revised modelling data available to LBC.

The refurbished building will reuse most of the front of house areas. It is proposed that the two rehearsal rooms are to be constructed as acoustically isolated spaces, resting on elastomeric bearings with a deep void below to mitigate sound transfer between the new rehearsal rooms and the theatre below. This will also greatly improve noise transfer to the exterior.

These rehearsal rooms are 5m and 3m high.
These are isolated envelopes, resting on elastomeric bearings with a deep void below.
The outer waterproof envelope (walls, glazing, roof) will be panelised for both spaces.

A new plant room will be constructed on the shallower rehearsal room concrete roof, with primary air handling plant, small plant, a chiller, a quick start generator and other smaller ancillary plant.
This plant area will be effectively screened and attenuated to meet LBC requirements at the reference window. The sealed acoustic plant screen will be 2.5m above plant slab level.
The critical noise source is the main chiller. This will be fitted with low noise fans to meet the LBC requirement at the worst case façade/reference window (see CADNA plan below).

The existing get-in door at ground level will be updated to a high performance Rw55dB door.
The 4th floor get-in door will be rated at Rw45dB.

The findings of the noise impact assessments are presented in the following sections of this report together with the supporting figures and appendices.

CadnaA assessments, based on total plant and acoustically treated chiller noise, show that LBC requirements will be met at the reference window and all other nearby building facades at 2300hrs.
The primary air plant will be internally treated to reduce sound breakout by 10dB.
Plant noise mitigations, to comply with LBC limits are shown in Section 6.0.
No plant will operate after 2300hrs, or before 0700hrs.

Sound breakout from the sound insulated rehearsal rooms, show that the LBC limits will be met during the proposed hours of operation less 5dB at the worst case residential façade.
There will be no activity between 2300 – 0700hrs.

There is no history of complaint from the existing theatre, which presents amplified musical shows.
The sound insulation standard of the new theatre will be equal to or higher than the existing building.

A detailed glossary of terminology used in this report is provided in the Appendix.

2.0 LOCAL AUTHORITY POLICY AND GUIDANCE

2.1 Residential Acoustic Design Criteria

Local authority planning policy and typical design standards as detailed below have been used as design guidance for the recommendations contained within this report.

2.1.1 Camden Council Noise and Vibration Policy

Noise and vibration can have a major effect on amenity and health and therefore quality of life. Camden's high density and mixed-use nature means that disturbance from noise and vibration is a particularly important issue in the borough. Camden's Core Strategy recognises the importance of this issue for Camden's residents and policy DP28 contributes to implement a number of Core Strategy policies, including CS5 - *Managing the impact of growth and development,* CS9 - *Achieving a successful Central London*, CS11 - *Promoting sustainable and efficient travel* and CS16 - *Improving Camden's health and well-being*.

Policy DP28 - Noise and Vibration

The Council will seek to ensure that noise and vibration is controlled and managed and will not grant planning permission for:

a. development likely to generate noise pollution; or

b. development sensitive to noise in locations with noise pollution, unless appropriate attenuation measures are provided.

Development that exceeds Camden's Noise and Vibration Thresholds will not be permitted.
The Council will only grant permission for plant or machinery if it can be operated without cause harm to amenity and does not exceed Camden's noise thresholds.

The Council will seek to minimise the impact on local amenity from the demolition and construction phases of development. Where these phases are likely to cause harm, conditions and planning obligations may be used to minimise the impact.

The effect of noise and vibration can be minimised by separating uses sensitive to noise from development that generates noise and by taking measures to reduce any impact. Noise sensitive development includes housing, schools and hospitals as well as offices, workshops and open spaces, while noise is generated by rail, road and air traffic, industry, entertainment (e.g. nightclubs, restaurants and bars) and other uses.

Conditions may also be imposed to ensure that attenuation measures are kept in place and effective throughout the life of the development.

In assessing applications, we will have regard to the Noise and Vibration Thresholds, set out below. These represent an interpretation of the standards in PPG24 and include an evening period in addition to the day and night standards contained in PPG24, which provide a greater degree of control over noise and vibration during a period when noise is often an issue in the borough.

Table A - Noise levels from places of entertainment on adjoining residential sites at which planning permission will not be granted

Noise description and measurement location	Period	Time	Sites adjoining places of entertainment
Noise at 1 metre external to a sensitive façade	Day and evening	0700-2300	LAeq, 5m shall not increase by more than 5dB*
Noise at 1 metre external to a sensitive façade	Night	2300-0700	LAeq, 5m shall not increase by more than 3dB*
Noise inside any living room of any noise sensitive premises, with the windows open or closed	Night	2300-0700	LAeq, 5m (in the 63Hz octave band measured using the 'fast' time constant) should show no increase in dB*

* As compared to the same measure, from the same position, and over a comparable period, with no entertainment taking place.

Table B - Noise levels from plant and machinery at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise at 1 metre external to sensitive façade where LA90>60dB	Day, evening and night	0000-2400	55dBLAeq

Key references / evidence

- Camden Noise Strategy, 2002
- The London Plan (Consolidated with Alterations since 2004), 2008
- Planning Policy Guidance 24: Planning and noise

2.1.2 Applicable Standards

2.1.4 BS4142: Plant Noise Limits

As per the limits stipulated in section 2.1 Table E noise levels emanating from all proposed items of plant should be designed to be 5dBA below the lowest measured background noise level during the hours of operation at the nearest noise sensitive residential properties.

An assessment in accordance with the methodology of BS4142 will be carried out in the later design stages once all items of plant and their locations have been designed.

3.0 NOISE SURVEY DETAILS

3.1 Noise Survey Positions

Extended unmanned noise surveys have been undertaken at three positions around the Ambassadors theatre as described below and illustrated in the aerial view.

Position 1 – Tower Street and Tower Court corner at a height of approximately 10 meters.

The equipment was set up to measure sound levels at 5 minute intervals between 09:45, Friday 15th August 2014 and 11:00, Tuesday 19th August 2014.

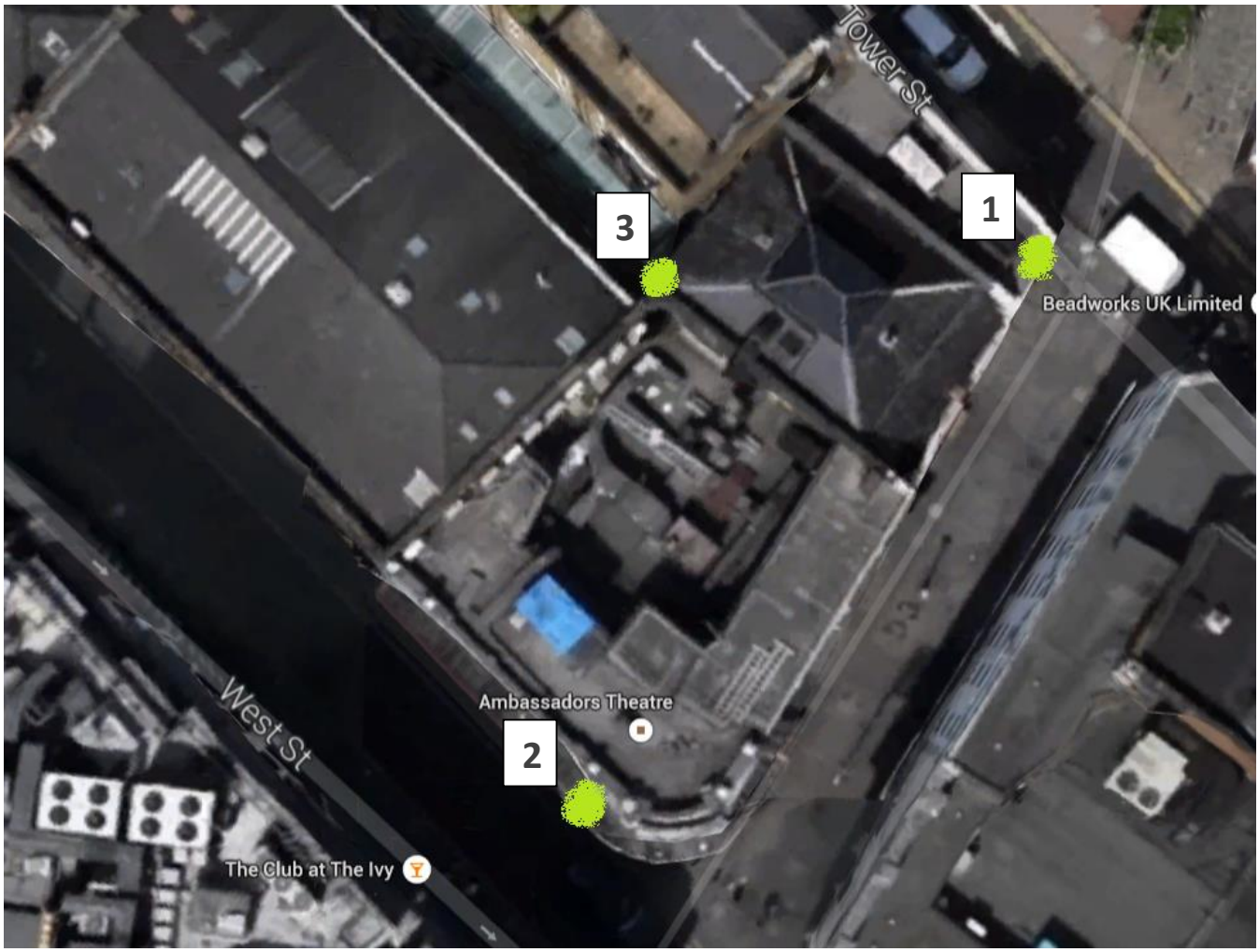
Position 2 – West Street side at a height of approximately 9 meters.

The equipment was set up to measure sound levels at 5 minute intervals between 10:05, Friday 15th August 2014 and 19:20, Monday 18th August 2014.

Position 3 – At the north-western roof site boundary approximately 6 meters from the nearest residential window (the reference window).

The equipment was set up to measure sound levels at 5 minute intervals between 11:55, Monday 18th August 2014 and 11:10, Tuesday 19th August 2014.

Figure 1 - Measurement positions



Details of the measurement equipment and procedure used are shown in Appendix.

3.2 Noise indices

The equipment was set to record octave band sound pressure levels at 5-minute intervals. The following noise indices used in this assessment are as follows:

$L_{Aeq,T}$: The A-weighted equivalent continuous sound pressure level over a period of time, T.

$L_{A90,T}$ *:* The A-weighted sound pressure level exceeded for 90% of the measurement period. Indicative of the background noise level.

The L_{A90} is considered most representative of the background noise level for the purposes of complying with any Local Authority requirements.

Sound pressure level measurements are normally taken with an A-weighting (denoted by a subscript 'A', eg L_{A90}) to approximate the frequency response of the human ear.

4.0 NOISE SURVEY RESULTS

4.1. Airborne Noise Survey Results

A summary of the results from the airborne noise survey are given in the section below.

4.1.1 Position 1 – Tower Street

The results of the airborne noise surveys in Position 1 as are shown in the following table.

Table 3 - Summary of survey results Position 1 – Tower Street

Period	From	Until	L_{A90} dB (lowest)	$L_{Aeq, 5m}$ dB (lowest)
Day	07:00	19:00	51	53
Evening	19:00	23:00	52	54
Night	23:00	07:00	48	49

Measured backgrounds are typical for the location – maxima above 90dB(A) will be sirens, police or ambulance.

4.1.2 Position 2 – West Street

The results of the airborne noise surveys in Position 2 as are shown in the following table.

Table D - Summary of survey results for Position 2 – West Street

Period	From	Until	L_{A90} dB (lowest)	$L_{Aeq, 5m}$ dB (lowest)
Day	07:00	19:00	51	53
Evening	19:00	23:00	52	54
Night	23:00	07:00	49	51

Measured backgrounds are typical for the location – maxima above 90dB(A) will be sirens, police or ambulance.

4.1.3 Position 3 – NW Boundary, Ambassadors Theatre – the reference window + 14m

The results of the airborne noise surveys in Position 3 as are shown in the following table.

Table E - Summary of survey results for Position 3 – Rear

Period	From	Until	L_{A90} dB (lowest)	$L_{Aeq, 5m}$ dB (lowest)
Day	07:00	19:00	49	51
Evening	19:00	23:00	48	50
Night	23:00	07:00	43	44

Measured backgrounds are typical for the location – maxima shown above up to 80 dB(A) will be sirens, police or ambulance. This is a more sheltered location.

The above noise survey measurements have been used to develop CadnaA noise maps of the site which will aid the prediction of the noise levels at all façades of residential and commercial buildings.

5.0 ASSESSMENT OF NOISE SURVEY RESULTS

5.1 Plant noise

5.1.1 Position 1 plant noise limits

Table F - Comparison of airborne noise results in Position 1 with Table B

Noise description and location of measurement	Period	Time	Required Noise level	Noise level that should not be exceeded in this position
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90	51 dB(A) – 5dB = **46 dB(A)**
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90	51 dB(A) – 10dB = **41 dB(A)**
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90	51 dB(A) – 10dB = **41 dB(A)**

The above results are taken from measurements conducted over a 4-day period. If items of plant can be set to switch off between 23:00 and 07:00 (night time) limits may be increased by 2 dB.

5.1.2 Position 2 plant noise limits

Table G - Comparison of airborne noise results in Position 2 with Table B

Noise description and location of measurement	Period	Time	Required Noise level	Noise level that should not be exceeded in this position
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90	51 dB(A) – 5dB = **46 dB(A)**
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre External to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90	51 dB(A) – 10dB = **41 dB(A)**
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90	51 dB(A) – 10dB = **41 dB(A)**

The above results are taken from measurements conducted over a 3-day period. If items of plant can be set to switch off between 23:00 and 07:00 (night time) limits may be increased by 2 dB.

5.1.3 Position 3 plant noise limits

Table H - Comparison of airborne noise results in Position 3 with Table B

Noise description and location of measurement	Period	Time	Required Noise level	Noise level that should not be exceeded in this position
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90	48 dB(A) – 5dB = **43 dB(A)**
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90	48 dB(A) – 10dB = **38dB(A)**
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90	48 dB(A) – 10dB = **38dB(A)**

5.2 Entertainment/Rehearsal Noise

5.2.1 Position 1 Entertainment Noise Limits

Table I - Comparison of airborne noise results in Position 1 with Table A

Noise description and measurement location	Period	Time	Sites adjoining places of entertainment	
Noise at 1 metre external to a sensitive façade	Day and evening	0700-2300	LAeq, 5m shall not increase by more than 5dB*	53 dB(A) + 5 = **58 dB(A)**
Noise at 1 metre external to a sensitive façade	Night	2300-0700	LAeq, 5m shall not increase by more than 3dB*	49 + 3 dB(A) = **52 dB(A)**

5.2.2 Position 2 Entertainment Noise Limits

Table J - Comparison of airborne noise results in Position 2 with Table A

Noise description and measurement location	Period	Time	Sites adjoining places of entertainment	
Noise at 1 metre external to a sensitive façade	Day and evening	0700-2300	LAeq, 5m shall not increase by more than 5dB*	53 dB(A) + 5 = **58 dB(A)**
Noise at 1 metre external to a sensitive façade	Night	2300-0700	LAeq, 5m shall not increase by more than 3dB*	51 + 3 dB(A) = **54 dB(A)**

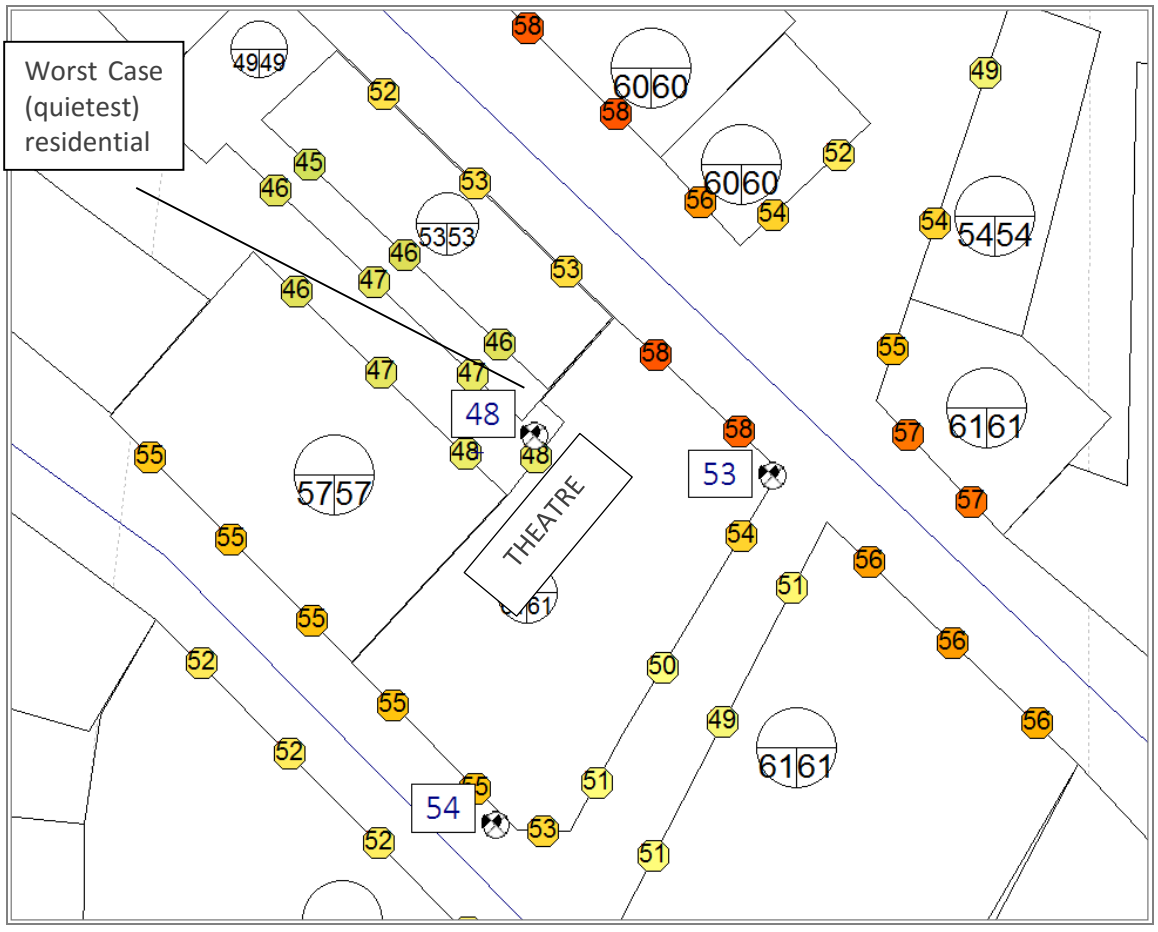
5.2.3 Position 3 Entertainment Noise Limits

Table K - Comparison of airborne noise results in Position 3 with Table A

Noise description and measurement location	Period	Time	Sites adjoining places of entertainment	
Noise at 1 metre external to a sensitive façade	Day and evening	0700-2300	LAeq, 5m shall not increase by more than 5dB*	50 dB(A) + 5 = **55 dB(A)**
Noise at 1 metre external to a sensitive façade	Night	2300-0700	LAeq, 5m shall not increase by more than 3dB*	44 + 3 dB(A) = **47 dB(A)**

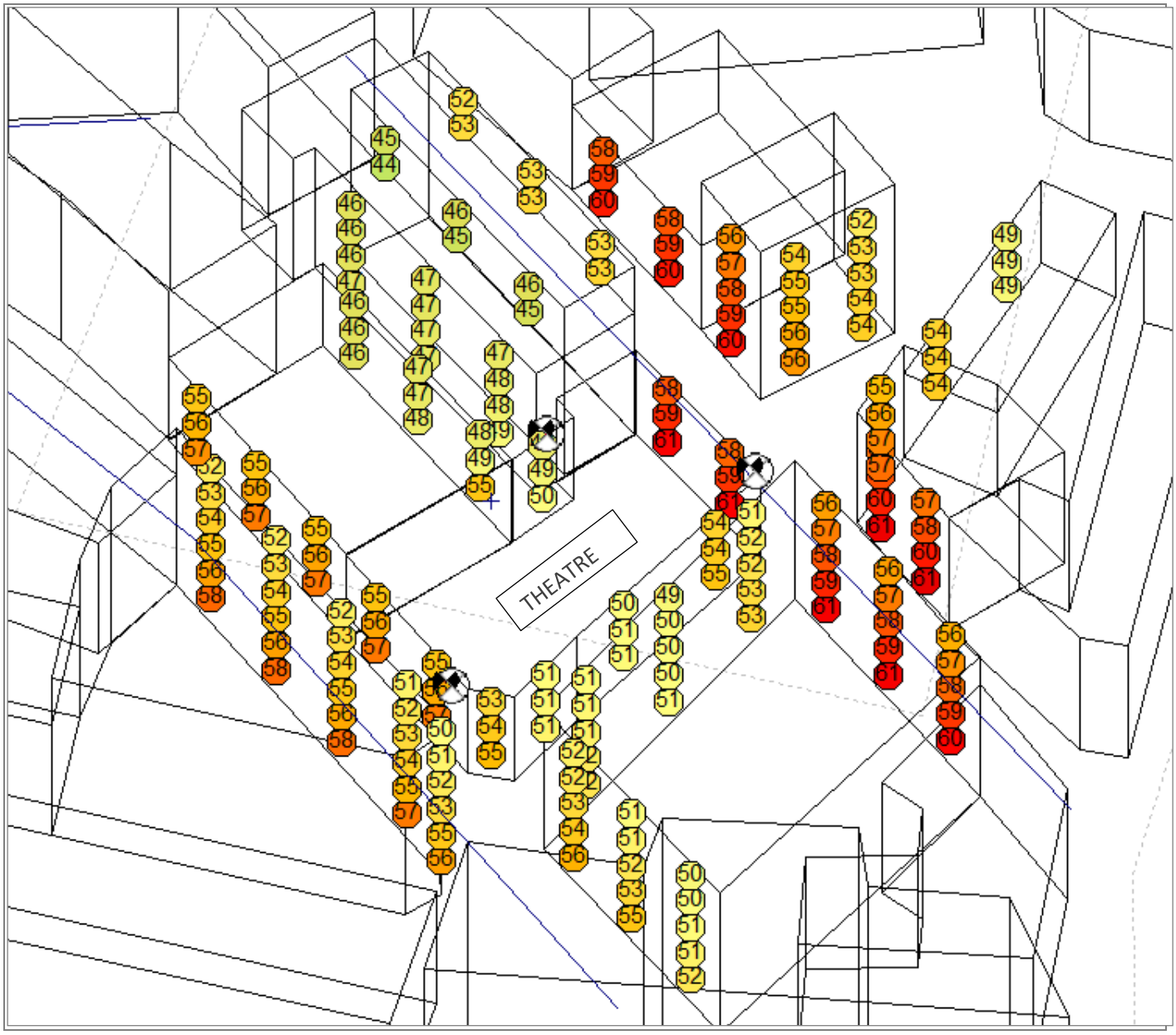
Figure 2 – CadnaA model for existing background noise levels L_{A90} at 23.00hrs

Plan



NB. Worst case residential window marked at 48dBA, rear of 4, Tower Street +14m. Reference window.

Fig 2 – As Figure 1, axonometric view



6.0 NOISE MITIGATION

6.1 Plant Noise

As per the limits stipulated in section 2.1 Table B, noise levels emanating from all proposed items of plant should be designed to be 5dB below the lowest measured background L_{A90} during the hours of operation at the nearest noise sensitive residential properties.

We recommended that in order to protect the nearest noise sensitive properties around the theatre, the mansard screen is to be erected to a height of 2.5 metres. The CadnaA predictions take this into account.

The most affected property from plant noise is the one at the rear of the theatre near measurement position 3. The mitigation measures recommended here are designed to meet the noise criteria for that position that also satisfy the criteria for the rest of the surrounding area.

The primary supply and extract fan chambers will be internally lined with cementitious board, with external ductwork and attenuators acoustically lagged.

The main chiller will be fitted with an acoustic package, with low noise fans and an insulated compressor. This figure has been used in the CADNA model below.

The quick start generator has been selected to meet the LBC limit at all nearby facades. It has a sound insulation package.

6.2 Entertainment/Rehearsal Noise

The rehearsal rooms are designed with an envelope sound insulation value of Dw40dB. The predicted breakout noise levels do not increase the existing minimum $L_{Aeq,5m}$ measured over the survey period. The CadnaA model in Figures E/F shows the predicted noise propagation around the site based on the minimum 5-minute L_{Aeq} measured during daytime hours (07:00-23:00).

The existing acoustic separation to the adjacent office on West Street will be maintained or increased.

APPENDIX A: MEASUREMENT EQUIPMENT AND PROCEDURE

Background noise levels have been measured over a minimum period of 24 hours at the front and rear of the proposed site, the measurement positions are shown in section 3.1.

Position 1 – Tower Street and Tower Court corner at a height of approximately 10 metres.

The equipment was set up to measure sound levels at 5 minute intervals between 09:45, Friday 15th August 2014 and 11:00, Tuesday 19th August 2014.

Position 2 – West Street side at a height of approximately 9 metres.

The equipment was set up to measure sound levels at 5 minute intervals between 10:05, Friday 15th August 2014 and 19:20, Monday 18th August 2014.

Position 3 – At the north-western site boundary approximately 6 metres from the nearest residential (reference window).

The equipment was set up to measure sound levels at 5 minute intervals between 11:55, Monday 18th August 2014 and 11:10, Tuesday 19th August 2014.

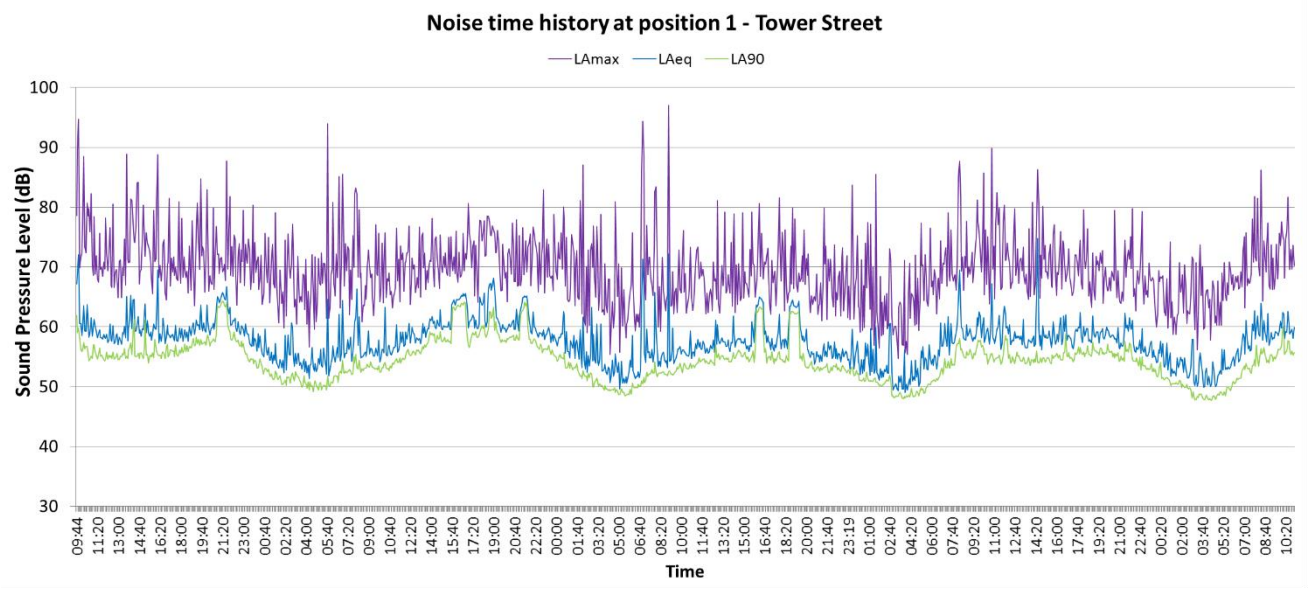
The levels were recorded as A-weighted and octave band L_{eq}, L_{max} and L_{90} using the following equipment.

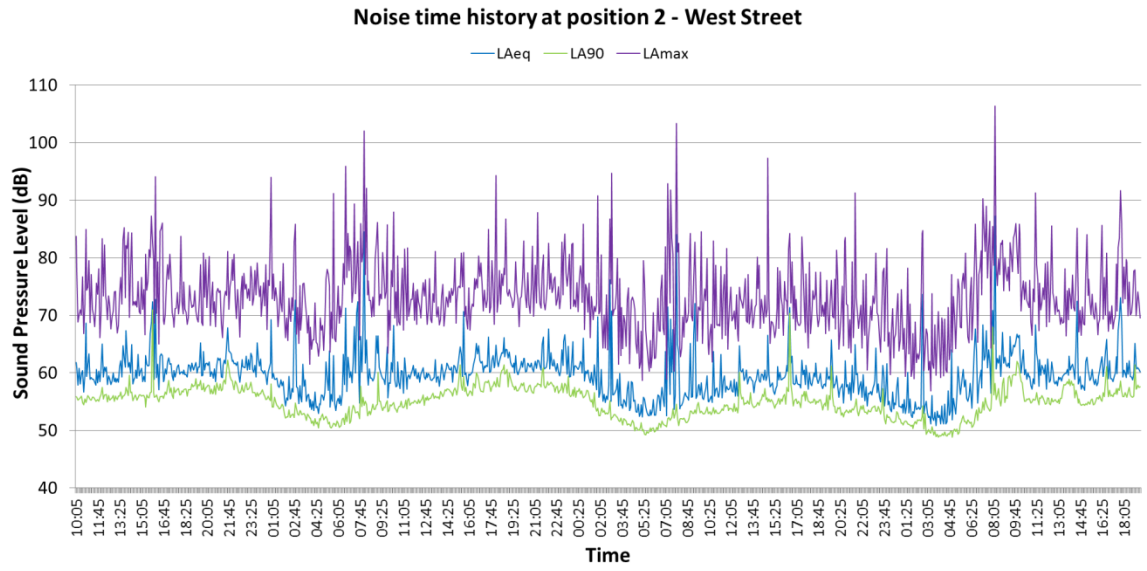
2 x Norsonic 118 Real Time Analyser (serial nos 28282, 28134)
Norsonic 1251 Calibrator
GRAS Environmental Microphone

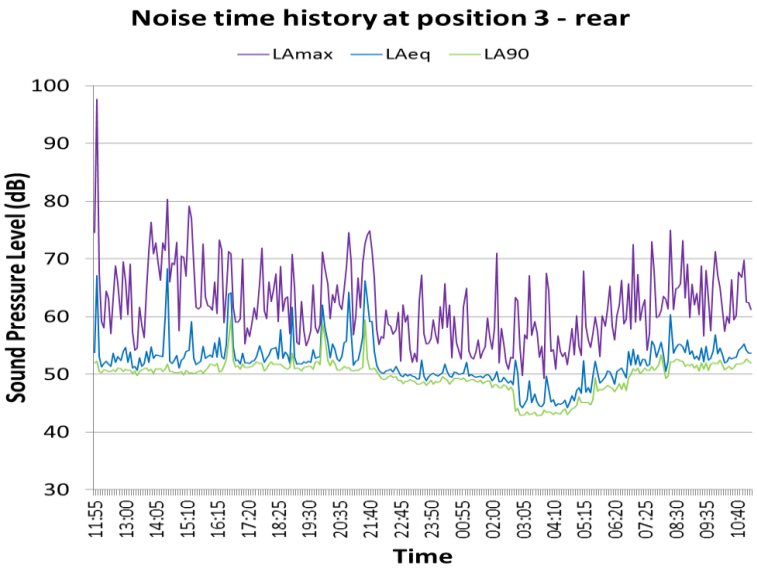
The equipment was calibrated before and after the survey and no drift from calibration was found.

The weather conditions throughout the survey were acceptable throughout.

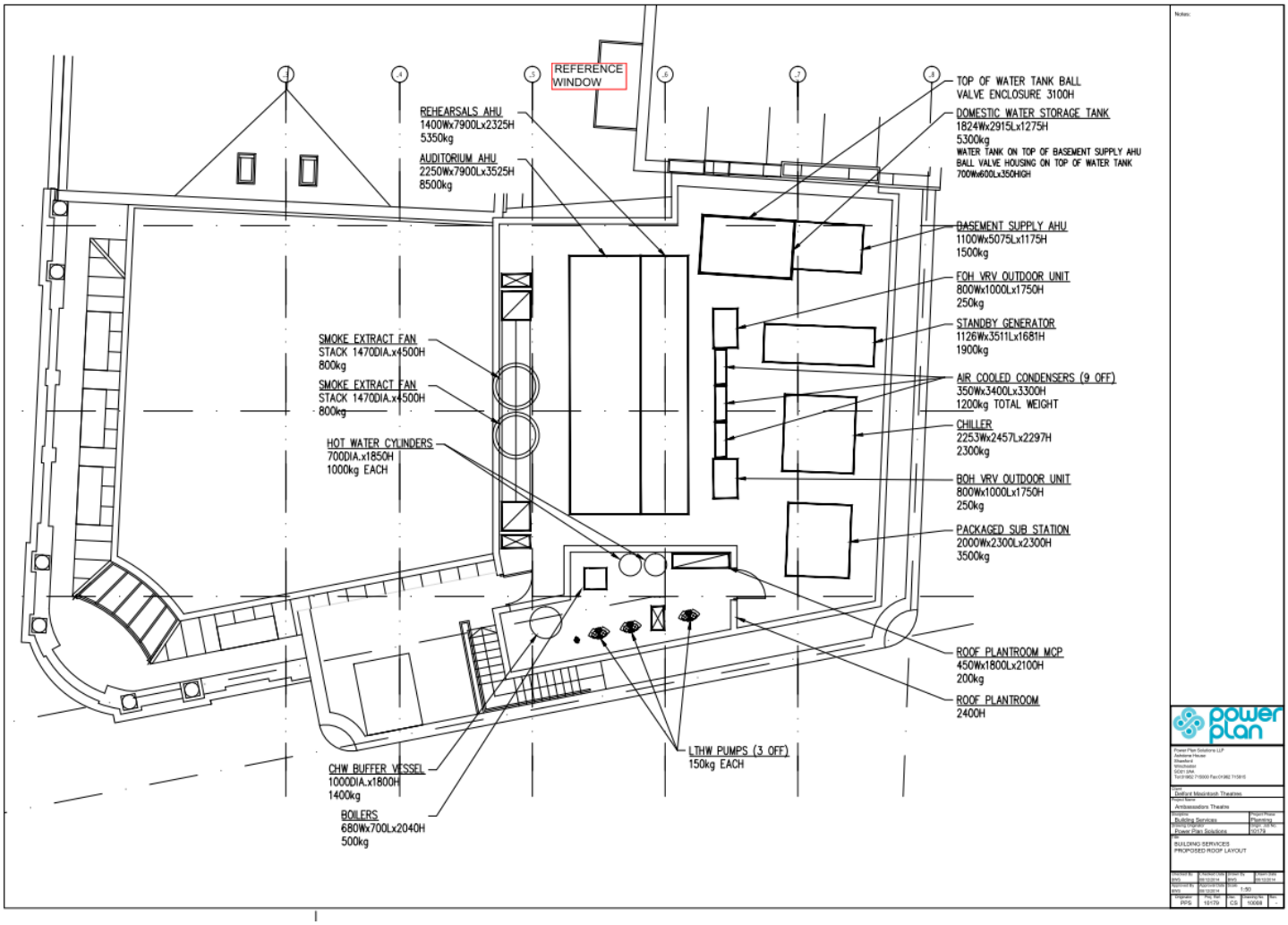
APPENDIX B: NOISE TIME HISTORY CHARTS





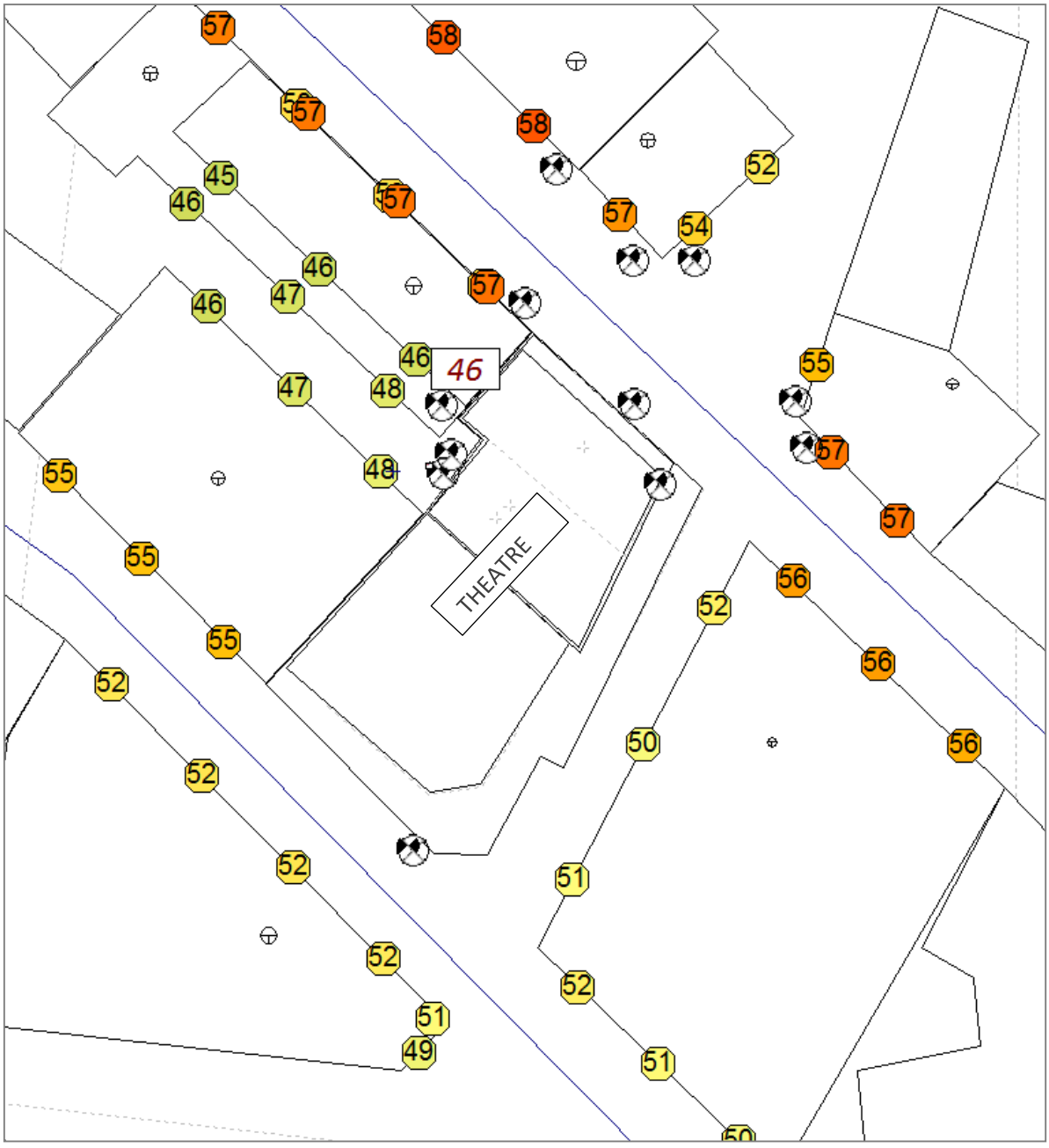

Noise time history at position 3 - rear
LAmax
LAeq
LA90
Sound Pressure Level (dB)
100
90
80
70
60
50
40
30
11:55
13:00
14:05
15:10
16:15
17:20
18:25
19:30
20:35
21:40
22:45
23:50
00:55
02:00
03:05
04:10
05:15
06:20
07:25
08:30
09:35
10:40
Time

APPENDIX C: ROOF PLANT PLAN



APPENDIX D: CADNA A NOISE MAPPING

Figure A – CadnaA model for existing background noise levels L_{A90} at 23.00hrs, with proposed building envelope



NB. REFERENCE WINDOW MARKED AT 46dB(A), REAR OF 4, TOWER STREET +14m

Figure B - As Figure A – axonometric view

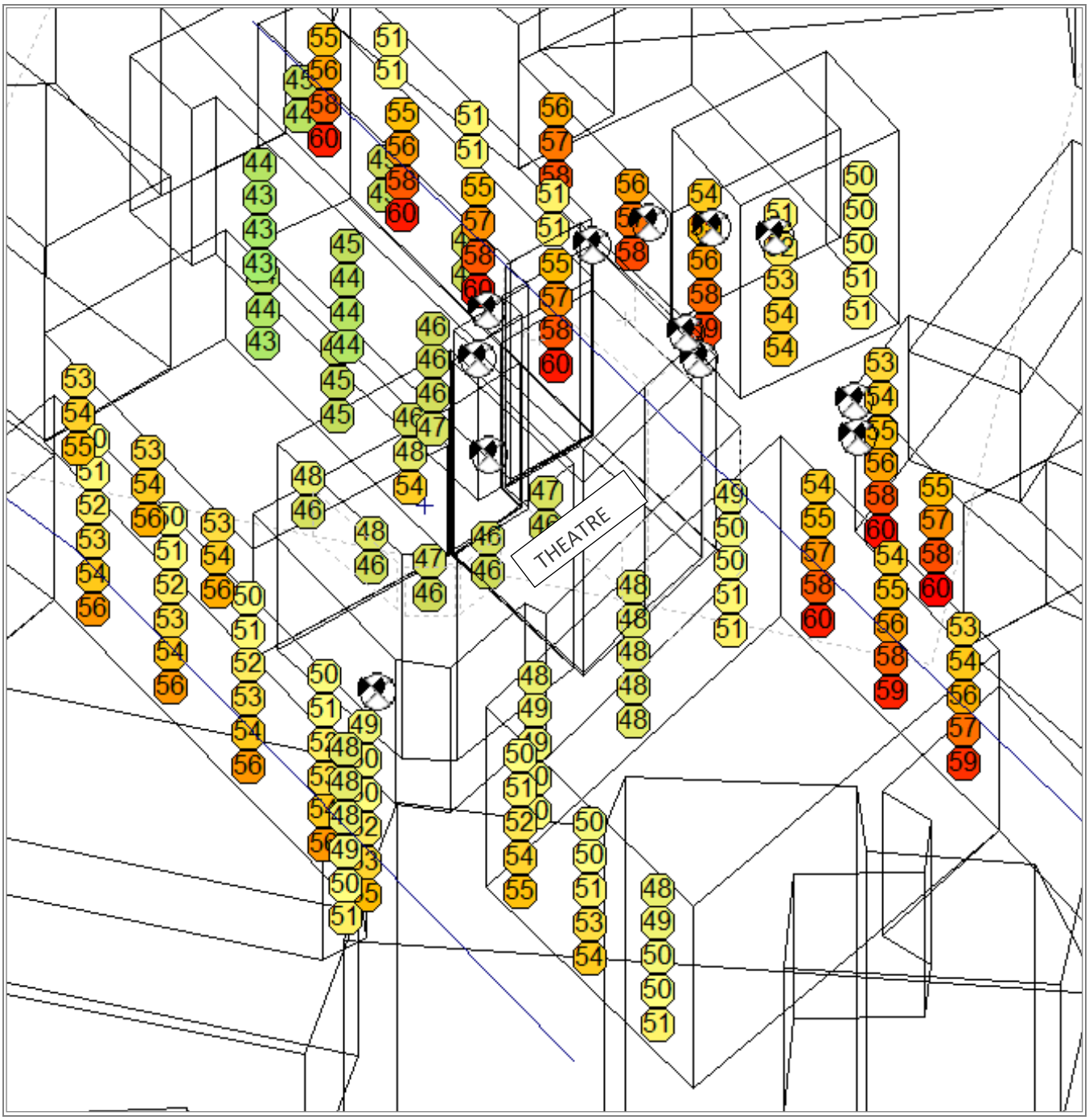


Figure C – AHU + treated chiller total noise impact, plan at 14m

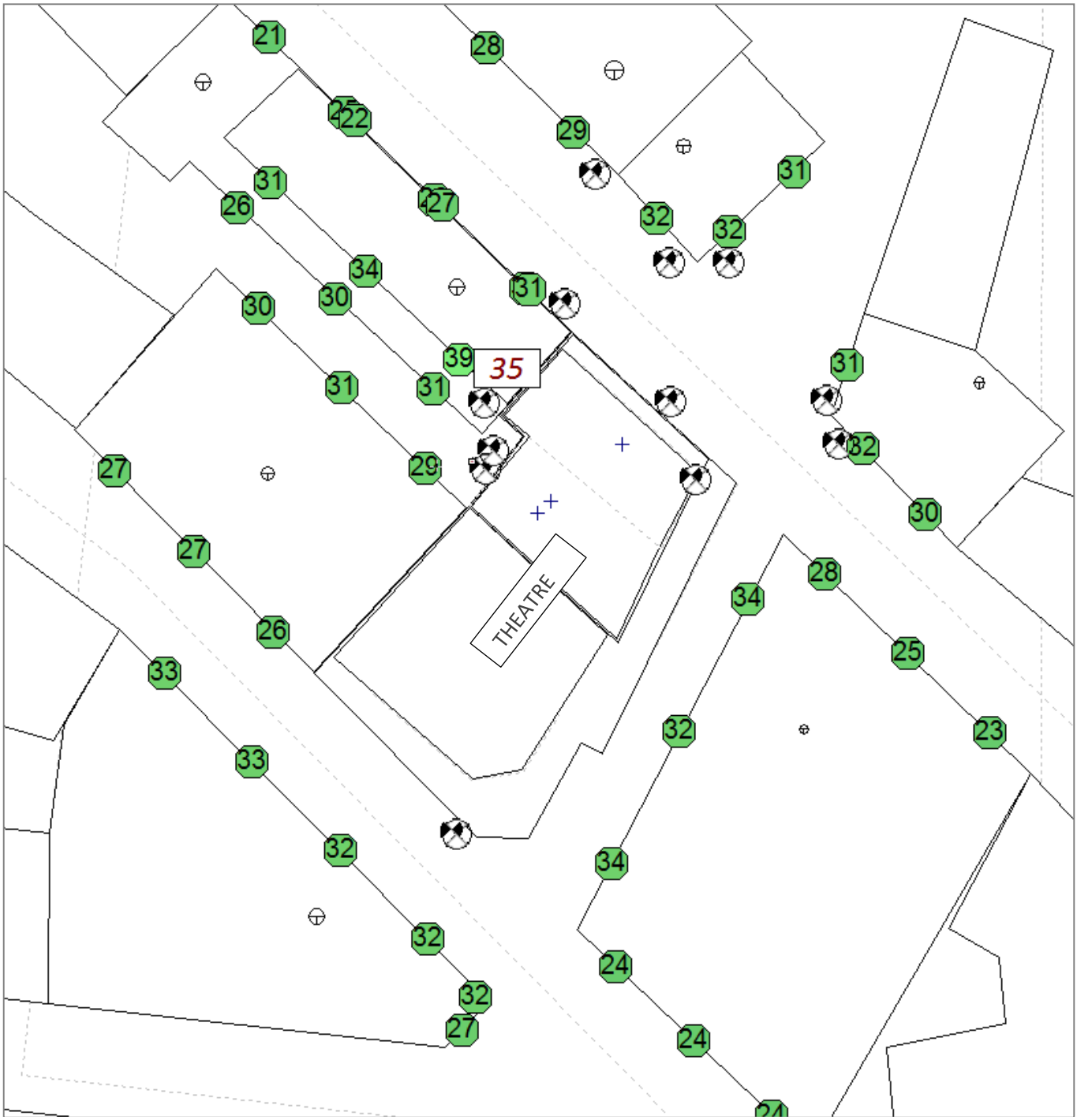


Figure D - As Figure C – axonometric view

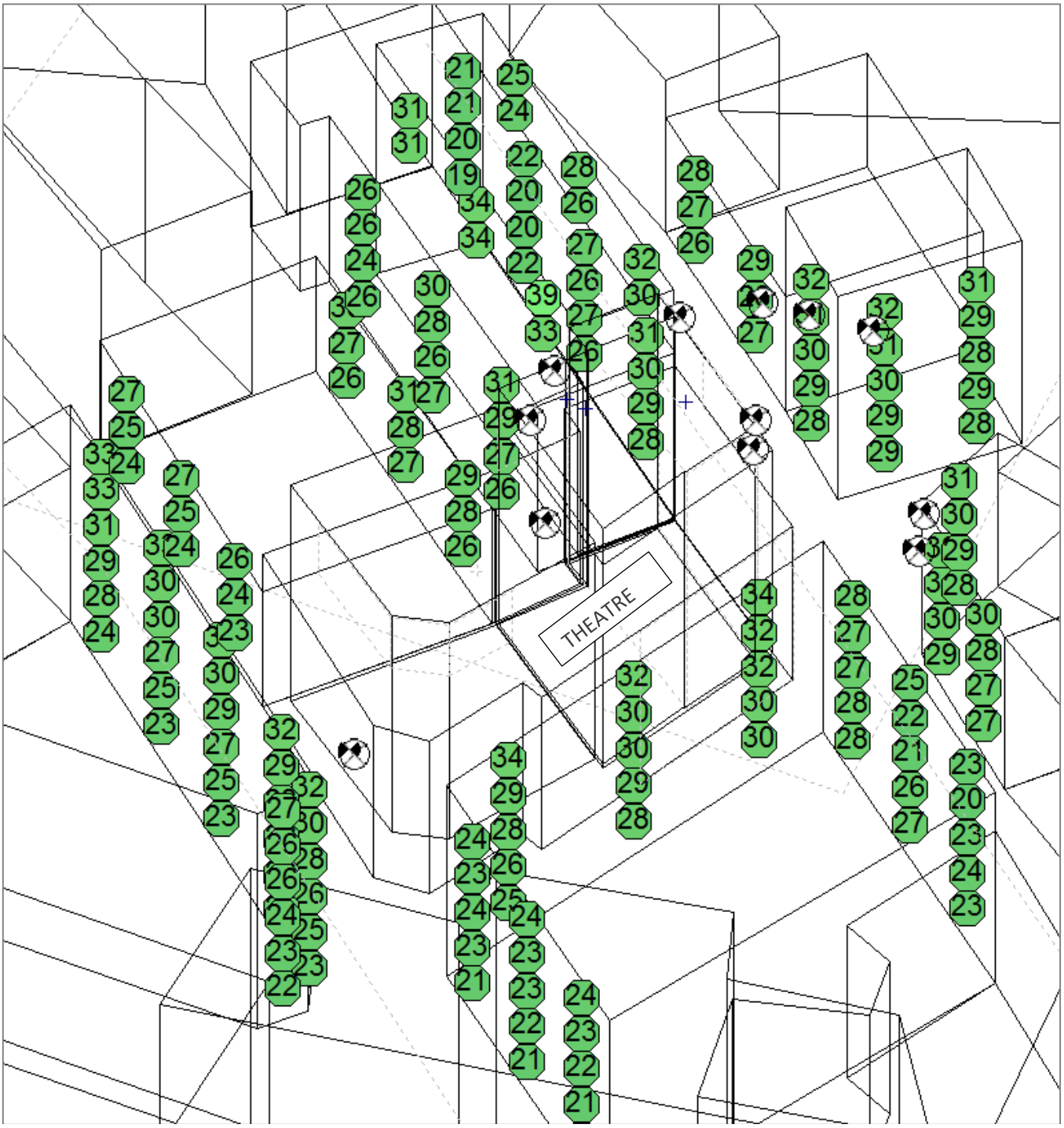


Figure E – Rehearsal break-out impact, plan at + 14m

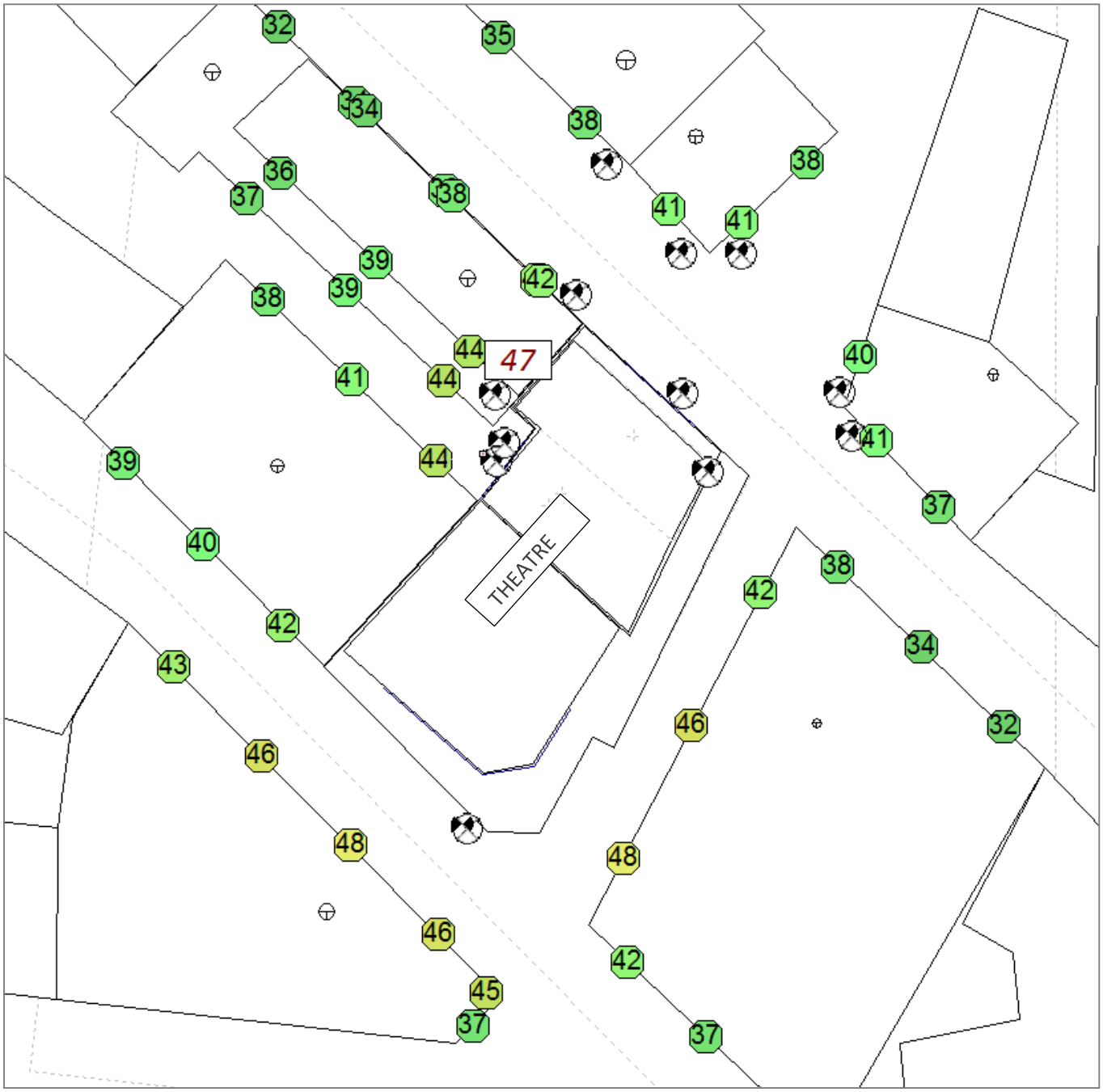
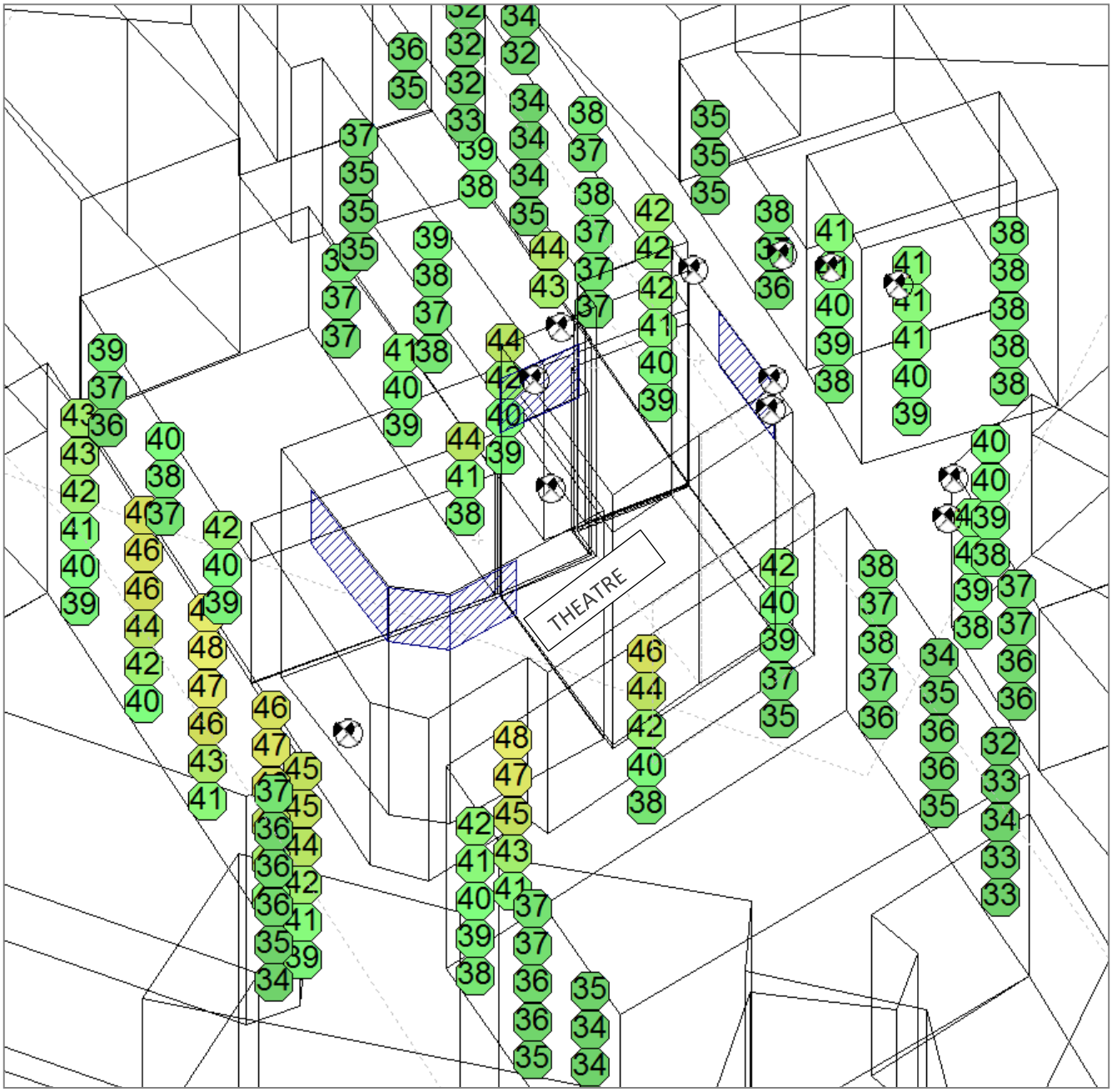


Figure F – as Figure E, axonometric



APPENDIX E: 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 – laboratory measurement.

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

*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.

APPENDIX F: CALIBRATION CERTIFICATES FOR ANALYSERS

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 1 of 2

APPROVED SIGNATORIES
Claire Lomax [✓] Andy Moorhouse [ ]
Gary Phillips [ ] Danny McCaul [ ]

acoustic calibration laboratory
The University of Salford, Salford, Greater Manchester, M5 4WT, UK
http://www.acoustics.salford.ac.uk
t: 0161 295 3628/3641 295 3319 f: 0161 295 4456 e: c.lomax1@salford.ac.uk

UKAS CALIBRATION
0801

University of Salford MANCHESTER

Certificate Number: 01815/1 Date of Issue: 9 May 2014

VERIFICATION OF A TYPE 1 SOUND LEVEL METER to BS7580 Part 1

FOR:	Gillieron Scott Acoustic Design 130 Brixton Hill London SW2 1RS
FOR THE ATTENTION OF:	James Patterson
CALIBRATION DATE:	09/05/2014
TEST PROCEDURE:	CTP08 (Laboratory Manual)

Sound Level Meter
Manu: Norsonic Model: 118 Serial No: 28282

Microphone
Manu: Norsonic Model: 1225 Serial No: 29862

Preamp
Manu: Norsonic Model: 1206 Serial No: 27171

Associated Calibrator
Manu: Norsonic Model: 1251 Serial No: 28836 Adaptor: 1443

Test Engineer (initial): _____ Name: Gary Phillips

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to the units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Certificate Number: 01815/1 Date of Issue: 9 May 2014

SET-UP INFORMATION

The instrument version was 2.0. The reference range, reference SPL, primary indicator range, pulse range and linearity range as specified by the manufacturer have been used. The instrument was adjusted to read 114.1 dB (A) in response to the associated calibrator. This reading was obtained from the calibration certificate of the calibrator, U15871 and information in the manufacturer's instruction manual, when the instrument is configured as follows; Windscr: OFF, Random: OFF, Preamp: ON. The instrument was calibrated without a windshield. Consult manufacturer's instructions if using a windshield.

MEASUREMENTS

The levels of self-generated noise were:

A:	**9.4 dB**
C:	**9.8 dB**
Z:	**18.2 dB**

At the end of the tests the indication of the sound level meter in response to the associated sound calibrator was 114.1 dB (A) which corresponds to the following level at 101.325 kPa:

Sound Pressure Level 114.1 dB (A)
This reading should be used henceforth to set up the sound level meter for field use.

THE SOUND LEVEL METER WAS VERIFIED ACCORDING TO THE PROCEDURE GIVEN IN BS7580: Part 1 1997 WITH THE FOLLOWING EXCEPTIONS:

The microphone corrections applied as specified in BS 7580: Part 1: 1997 were obtained from a frequency response measurement by this Laboratory using the electrostatic actuator method. The response in isolation is not covered by our UKAS accreditation.

A stricter test than that specified in 5.5.10 and 5.5.11 of BS 7580 has been used by not applying the low level signal.

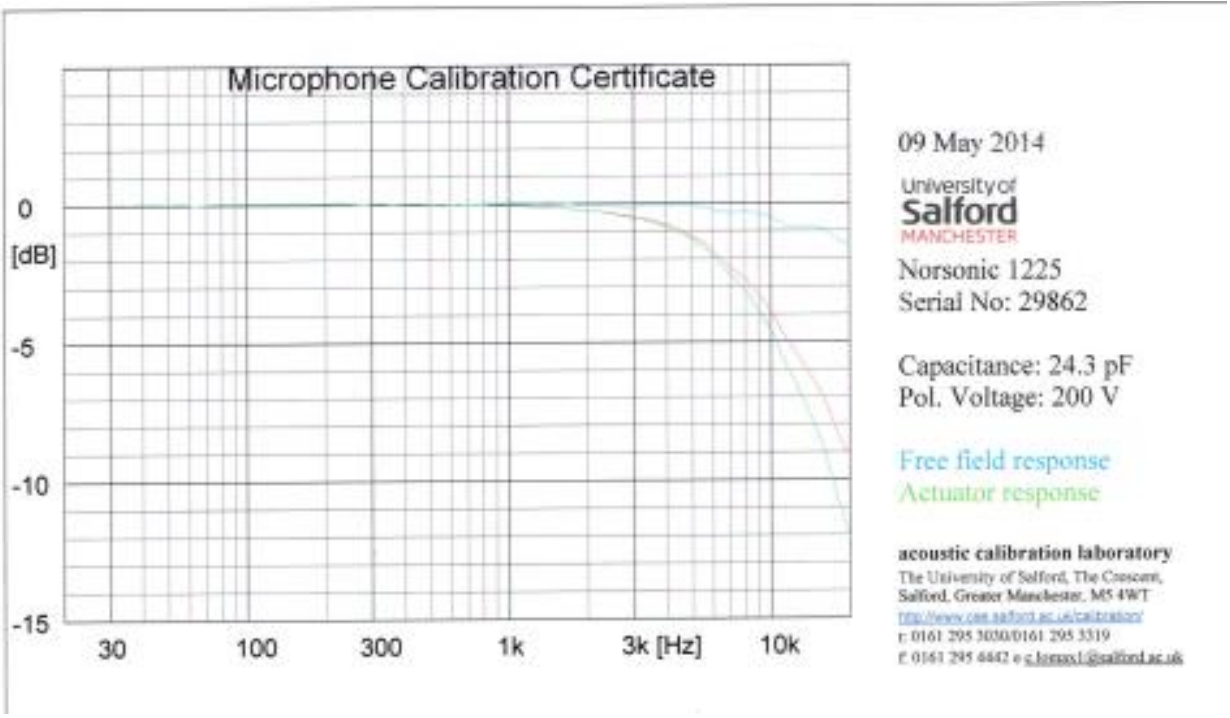
STATEMENT OF RESULT:

THE SOUND LEVEL METER CONFORMS TO THE TYPE 1 REQUIREMENTS OF BS7580: PART1 1997

Instruments used in the verification procedure were traceable to National Standards. The method of acoustic calibration employed a standard sound pressure calibrator for the 1 kHz test whilst the tests at 125 Hz and 8 kHz were performed by the electrostatic actuator method. The uncertainty of the Laboratory's 1 kHz calibrator was ±0.10 dB. The uncertainty of the standard calibrator is not included in the applied tolerances. It is assumed that the sound level meter was manufactured in accordance with BSEN60651: 1994 Type 1, and BSEN60804: 1994 Type 1.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements. All measurement results are retained at the acoustic calibration laboratory for at least four years.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to the units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.


Microphone Calibration Certificate
0
[dB]
-5
-10
-15
30
100
300
1k
3k [Hz]
10k
09 May 2014
University of
Salford
MANCHESTER
Norsonic 1225
Serial No: 29862
Capacitance: 24.3 pF
Pol. Voltage: 200 V
Free field response
Actuator response
acoustic calibration laboratory
The University of Salford, The Crescent,
Salford, Greater Manchester, M5 4WT
http://www.cas.salford.ac.uk/calibratory/
t: 0161 295 3030/0161 295 3319
f: 0161 295 4442 e: c.lomax1@salford.ac.uk

Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, GB-CM6 1HD
www.campbell-associates.co.uk
Phone 01371 871030 Facsimile 01371879106

CALIBRATION UKAS Laboratory 0789

Certificate of Calibration

Certificate number: U15873

Test object:	**Sound Level Meter, Type 1 (Precision)**
Manufacturer:	**Norsonic**
Type:	**118**
Serial no:	**28134**
Customer:	**Gillieron Scott Acoustic Design Ltd**
Address:	**130 Brixton Hill,**
	London. SW2 1RS.
Contact Person:	**James Patterson.**

Method :
Calibration has been performed as set out in CA Technical Procedures TP01 & 02 as appropriate. The following items have been calibrated as set out in BS 7580 Part 1:1997

	Producer:	Type:	Serial No:	Certificate number
Microphone	Norsonic	1225	25170	15872
Calibrator*	Norsonic	1251	28836	U15871
Preamplifier	Norsonic	1206	28548	Included

Additional items that also have been submitted for verification

Wind shield	Norsonic	Nor1451
Attenuator	None	
Extension cable	None	

These items have been taken into account wherever appropriate.

Environmental conditions:	Pressure:	Temperature:	Relative humidity:
Reference conditions:	101.325 kPa	23.0 °C	50 %RH
Measurement conditions:	100.681 kPa	22.7 °C	38.5 %RH

Date received : 17/03/2014
Date of calibration: 27/03/2014
Date of issue: 27/03/2014

Engineer

Michael Tickner

Supervisor

Darren Batten TechIOA

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognized national standards, and to the units of measurement realized at the National Physical Laboratory or other recognized national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

* The calibrator was complete with any required coupler for the microphone specified

Calibration Certificate
UKAS Laboratory Number 0789

Certificate Number:- U15873

Method

From markings on the sound level meter or by reference to the manufacturer's published literature it has been determined that the instrument submitted for verification was originally manufactured to BS EN 60651 and or BS EN 60804. The reference range, reference sound pressure level, primary indicator range, secondary indicator range, pulse range, linearity range and display range as specified by the manufacturer were used for the verification. The sound level meter was set to A weighting and adjusted to read correctly in response to the associated sound calibrator the reading was derived from the calibrator calibration certificate and manufacturer's instruction manuals. A measurement of the self noise of the sound level meter was then made using a dummy microphone having a capacitance of ±20% of the associated microphones self capacitance. The sound level meter was then tested, and its overall sensitivity adjusted, in accordance with Section 5 of BS 7580:Part 1:1997. The acoustic calibration at 1 kHz specified in sub-clause 5.6.1 of the standard was performed by application of a reference sound calibrator, whilst the tests at 125 Hz and 8k Hz (sub-clause 5.6.2) were performed by the electrostatic actuator method. At the end of the test, the associated sound calibrator was reapplied to the sound level meter and the meter reading was recorded and is noted below in the statements section.

Traceability :

The following measured values are traceable to the National Physical Laboratory, United Kingdom.
Sound Pressure Level, Voltage, Frequency, Barometric Pressure, Temperature & Relative Humidity

Measurement Results:

Indication at the calibration check frequency - BS7580 #5.4	Passed
Noise test - BS 7580 #5.5.2	Passed
Level Linearity Test - BS 7580, #5.5.3	Passed
Frequency weightings: A Network - BS 7580 #5.5.4	Passed
Frequency weightings: C Network - BS 7580 #5.5.4	Passed
Frequency weightings: Z Network - BS 7580 #5.5.4	Passed
Time weightings F and S - BS7580 #5.5.5	Passed
Peak response - BS7580 #5.5.6	Passed
RMS accuracy - BS7580 #5.5.7	Passed
Time weighting I - BS7580 #5.5.8	Passed
Integrating Test : Time averaging - BS7580 #5.5.9	Passed
Integrating Test : Pulse range - BS7580 #5.5.10	Passed
Integrating Test : Sound exposure level - BS7580 #5.5.11	Passed
Overload SPL Test - BS 7580 #5.5.12	Passed
Overload Leq Test - BS 7580 #5.5.12	Passed
Acoustic tests - BS 7580 #5.4 and 5.6	Passed
Summation of acoustic tests - BS 7580 #5.5.4	Passed

Statements

The self-generated noise recorded in the test specified in § 5.5.2 was: 10.4 (Below MSD)dB(A), 10.6 (Below MSD)dB(C) and 16.0 (Below MSD)dB(Z).
The final response obtained using the associated calibrator was (§5.6.3): 114.0dB(A)
This reading should be used henceforth to set up the sound level meter for field use.
A stricter test than that specified in paragraphs 5.5.6 of BS7580:1997 has been used by verifying that the 10 ms reference pulse is also correct. The level uncertainty of the Laboratory's 1 kHz sound calibrator used during this verification is ± 0.1 dB.
The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The sound level meter in the configuration tested was found to comply with BS 7580:1997 part 1 for a type 1 device. The associated calibrator has been corrected for barometric pressure at the time of calibration in accordance with the relevant manufacturer's instructions

APPENDIX G: SURVEY RESULTS (sample raw data for each position) – part only.

Position 1 – Tower Street and Tower Court corner

Date	Time	L_{Aeq}	L_{A90}	L_{A90}							
				63	125	250	500	1k	2k	4k	8k
15/08/2014	09:45:00	68.7	59.0	67.0	59.3	57.5	55.7	53.6	50.9	46.4	39.5
15/08/2014	09:50:00	72.1	59.8	68.5	59.2	58.3	56.4	54.0	51.9	47.2	39.9
15/08/2014	09:55:00	60.6	58.1	67.0	58.6	57.2	55.6	52.2	49.5	44.8	37.8
15/08/2014	10:00:00	60.6	56.2	67.5	57.3	56.1	53.8	50.7	47.2	42.6	33.5
15/08/2014	10:05:00	58.5	55.9	67.1	56.6	55.6	53.2	50.3	46.9	42.1	32.8
15/08/2014	10:10:00	61.4	56.5	67.1	57.4	56.3	53.4	51.0	47.4	42.4	33.2
15/08/2014	10:15:00	63.5	57.4	66.8	57.3	56.1	54.4	52.3	48.7	43.6	34.9
15/08/2014	10:20:00	59.3	56.3	66.6	56.7	55.7	53.5	50.9	47.5	42.7	33.4
15/08/2014	10:25:00	59.2	56.7	68.0	57.3	55.8	53.9	51.1	47.4	42.7	33.8
15/08/2014	10:30:00	63.7	56.7	66.3	57.0	55.7	54.0	51.4	47.6	42.4	33.3
15/08/2014	10:35:00	60.2	55.3	63.7	55.2	54.0	53.0	49.8	46.8	41.2	32.0
15/08/2014	10:40:00	58.3	54.3	63.0	54.6	53.6	52.5	48.7	45.1	39.1	29.5
15/08/2014	10:45:00	59.1	54.6	64.3	55.8	54.6	52.5	48.9	45.5	39.1	29.7
15/08/2014	10:50:00	61.5	55.1	64.1	56.0	54.5	52.9	49.7	46.0	39.7	30.2
15/08/2014	10:55:00	58.4	54.7	63.4	55.1	53.9	52.7	49.5	45.6	39.3	30.6
15/08/2014	11:00:00	60.3	57.0	65.2	56.6	55.4	53.8	52.5	48.4	42.5	34.3
15/08/2014	11:05:00	61.2	57.0	64.6	56.3	55.2	53.4	52.2	48.8	43.6	35.2
15/08/2014	11:10:00	60.1	55.8	64.2	56.3	54.8	52.9	51.3	46.6	40.7	30.9
15/08/2014	11:15:00	59.2	55.2	63.6	55.7	54.4	53.1	49.7	45.8	39.4	30.8
15/08/2014	11:20:00	58.2	54.6	63.6	55.7	53.9	52.2	49.2	45.6	38.9	29.9
15/08/2014	11:25:00	58.9	55.5	64.7	56.3	54.9	53.0	50.3	46.7	40.6	31.1
15/08/2014	11:30:00	59.5	56.4	64.3	56.1	54.6	53.5	51.4	47.9	42.2	31.9
15/08/2014	11:35:00	58.3	55.1	63.8	55.6	54.4	52.9	49.8	46.2	40.8	31.5
15/08/2014	11:40:00	58.2	55.3	63.9	55.9	54.5	52.7	49.9	46.5	40.3	30.5
15/08/2014	11:45:00	58.0	54.9	63.4	55.6	54.3	52.4	49.5	46.3	40.0	30.7
15/08/2014	11:50:00	58.7	54.5	63.2	55.2	54.2	52.1	49.1	45.6	39.3	29.9
15/08/2014	11:55:00	58.2	54.3	63.5	55.2	54.0	52.2	48.7	44.9	39.4	30.3
15/08/2014	12:00:00	58.1	54.6	63.4	55.3	54.3	52.6	49.3	45.0	39.7	30.7
15/08/2014	12:05:00	58.7	55.8	63.8	56.0	54.8	53.6	50.6	46.6	40.2	30.2
15/08/2014	12:10:00	57.4	54.6	63.3	55.5	54.0	52.5	49.4	45.7	39.3	29.1
15/08/2014	12:15:00	57.8	55.3	63.6	55.7	54.5	53.1	50.0	45.8	39.7	29.9
15/08/2014	12:20:00	60.5	54.9	63.6	55.3	54.2	53.1	49.5	45.5	39.3	29.8
15/08/2014	12:25:00	57.8	55.2	63.7	56.0	54.5	53.0	49.8	46.2	40.0	30.1
15/08/2014	12:30:00	57.6	54.7	63.5	55.3	54.1	52.8	49.3	45.2	39.7	30.5
15/08/2014	12:35:00	60.2	55.8	63.7	56.2	54.7	53.5	50.7	46.7	41.0	31.6
15/08/2014	12:40:00	57.2	54.6	63.2	55.3	53.9	52.7	49.2	45.1	38.5	28.7
15/08/2014	12:45:00	57.5	54.8	63.5	56.0	54.3	52.5	49.6	45.4	38.6	28.8
15/08/2014	12:50:00	58.6	55.1	63.5	55.9	54.1	52.8	49.9	46.2	39.5	30.1
15/08/2014	12:55:00	58.8	55.6	63.8	56.8	54.7	53.5	50.2	46.2	39.4	29.8

Position 2 – West Street

Date	Time	L_{Aeq}	L_{A90}	L_{A90}							
				63	125	250	500	1k	2k	4k	8k
15/08/2014	10:05:00	61.8	55.9	62.7	58.0	55.4	52.8	49.9	46.9	43.1	34.7
15/08/2014	10:10:00	60.9	55.8	63.1	58.2	55.3	53.1	50.2	46.7	41.3	33.0
15/08/2014	10:15:00	57.9	55.3	62.8	58.8	54.8	53.1	49.3	46.0	40.8	32.3
15/08/2014	10:20:00	60.8	55.5	62.8	58.7	55.3	53.1	49.9	46.8	42.1	33.8
15/08/2014	10:25:00	58.1	55.7	62.9	58.6	55.0	53.3	49.9	46.2	41.7	33.8
15/08/2014	10:30:00	59.8	56.0	63.0	58.5	55.1	53.6	50.5	46.7	42.0	33.9
15/08/2014	10:35:00	60.4	54.9	62.3	57.3	54.2	52.8	49.1	45.8	41.2	33.5
15/08/2014	10:40:00	56.7	54.5	62.1	57.2	54.3	52.5	48.7	45.1	40.8	33.1
15/08/2014	10:45:00	59.6	55.5	62.9	57.7	55.2	52.8	49.6	46.5	41.7	33.6
15/08/2014	10:50:00	68.6	54.9	62.5	57.6	54.7	52.6	49.2	45.9	42.0	33.6
15/08/2014	10:55:00	59.4	55.3	62.0	57.0	54.7	53.2	49.6	46.0	41.9	34.1
15/08/2014	11:00:00	61.4	56.1	63.2	58.1	54.9	53.8	50.5	47.1	42.2	34.5
15/08/2014	11:05:00	63.3	55.8	62.6	57.6	54.9	53.1	50.4	46.8	43.1	34.5
15/08/2014	11:10:00	58.9	55.4	62.8	57.6	55.1	52.9	49.8	46.4	42.2	33.7
15/08/2014	11:15:00	59.2	55.3	62.4	57.5	54.4	53.3	49.7	46.0	41.6	33.3
15/08/2014	11:20:00	58.9	55.8	62.3	57.3	54.7	53.4	50.2	47.0	42.3	34.0
15/08/2014	11:25:00	58.9	55.8	62.9	57.8	55.2	53.2	50.6	46.9	42.0	33.4
15/08/2014	11:30:00	58.4	55.5	62.4	57.8	54.9	53.1	49.8	46.5	42.0	33.4
15/08/2014	11:35:00	57.9	55.1	62.3	57.5	54.6	52.7	49.6	46.1	42.0	33.2
15/08/2014	11:40:00	60.6	55.2	62.5	57.3	55.0	52.8	49.5	46.1	42.3	33.5
15/08/2014	11:45:00	58.3	55.4	62.3	57.3	54.5	53.1	49.7	46.3	42.2	33.7
15/08/2014	11:50:00	60.3	55.1	62.4	57.3	54.5	53.2	49.4	45.6	41.5	33.5
15/08/2014	11:55:00	58.5	55.8	62.2	57.3	54.7	53.5	49.8	46.5	43.4	34.9
15/08/2014	12:00:00	60.9	56.3	62.7	57.7	55.5	54.1	50.6	46.7	44.0	35.7
15/08/2014	12:05:00	65.0	57.5	63.2	59.1	56.7	54.8	52.2	48.9	44.9	35.7
15/08/2014	12:10:00	59.3	55.5	62.2	57.7	55.5	53.0	49.4	46.1	43.4	33.8
15/08/2014	12:15:00	61.0	56.2	62.7	57.9	55.8	53.8	50.3	46.2	43.6	34.6
15/08/2014	12:20:00	60.3	56.2	63.1	57.9	55.7	53.9	50.5	46.7	42.7	34.8
15/08/2014	12:25:00	61.0	56.3	62.9	58.4	55.8	54.1	50.5	46.6	43.1	34.6
15/08/2014	12:30:00	58.0	55.0	62.4	57.5	54.7	52.7	49.0	45.2	42.9	33.5
15/08/2014	12:35:00	59.5	56.1	63.4	58.3	55.5	53.5	50.2	46.7	43.3	34.6
15/08/2014	12:40:00	58.9	55.3	62.5	57.2	54.5	53.1	50.1	46.2	41.2	32.7
15/08/2014	12:45:00	58.0	55.5	62.5	57.3	54.8	53.2	50.1	46.4	40.2	31.7
15/08/2014	12:50:00	58.6	55.7	62.4	57.5	54.5	53.3	50.2	46.6	41.4	33.4
15/08/2014	12:55:00	60.0	56.1	63.0	58.1	55.4	53.9	50.8	46.7	41.6	32.6
15/08/2014	13:00:00	58.5	55.1	62.7	57.1	54.4	52.9	49.5	45.9	40.8	32.1
15/08/2014	13:05:00	59.1	56.0	63.2	57.5	54.8	53.7	50.5	46.9	41.5	32.7
15/08/2014	13:10:00	58.4	55.7	62.7	57.2	54.7	53.3	50.2	46.7	41.6	32.7
15/08/2014	13:15:00	59.0	55.4	62.5	57.3	54.6	53.4	49.9	46.4	41.4	33.4
15/08/2014	13:20:00	58.4	56.0	62.9	57.6	55.2	53.7	50.4	46.8	41.6	32.2

Position 3 – Rear (north-western site boundary)

Date	Time	L_{Aeq}	L_{A90}	L_{90}							
				63	125	250	500	1k	2k	4k	8k
18/08/2014	11:55:00	53.8	52.0	60.3	55.3	52.0	50.2	45.6	41.8	36.6	27.6
18/08/2014	12:00:00	67.1	52.3	61.3	55.9	52.5	50.5	45.7	39.6	35.0	28.2
18/08/2014	12:05:00	53.1	50.5	60.6	55.1	51.4	49.0	43.6	39.4	34.7	26.3
18/08/2014	12:10:00	51.3	50.3	59.9	54.9	51.2	48.7	43.4	39.1	34.4	25.4
18/08/2014	12:15:00	51.9	50.8	60.5	55.1	51.9	49.1	44.2	39.7	34.5	25.9
18/08/2014	12:20:00	52.3	50.7	60.2	55.0	51.8	49.1	44.1	39.5	34.4	25.7
18/08/2014	12:25:00	51.8	50.5	60.0	55.0	51.3	48.8	43.8	39.4	34.9	26.3
18/08/2014	12:30:00	51.4	50.5	60.2	54.8	51.2	48.9	43.9	39.4	34.4	25.6
18/08/2014	12:35:00	53.7	50.8	60.3	55.1	51.7	49.4	44.0	39.5	34.6	25.9
18/08/2014	12:40:00	52.1	50.5	59.7	54.7	51.4	49.2	43.6	39.5	34.3	25.8
18/08/2014	12:45:00	53.1	51.1	60.2	55.2	52.0	49.6	44.4	40.1	34.8	26.2
18/08/2014	12:50:00	52.4	51.0	60.4	55.2	51.7	49.2	43.9	40.1	34.0	25.0
18/08/2014	12:55:00	54.0	50.5	60.5	54.8	51.3	48.8	43.6	39.7	34.3	26.1
18/08/2014	13:00:00	54.7	50.9	60.4	55.4	51.7	49.3	43.8	40.1	34.1	25.0
18/08/2014	13:05:00	52.1	50.7	60.0	54.8	51.5	49.4	44.1	39.8	33.9	25.0
18/08/2014	13:10:00	53.9	50.7	60.0	54.9	51.5	49.6	43.6	39.2	32.7	23.2
18/08/2014	13:15:00	51.1	50.2	59.6	54.5	51.0	49.1	43.3	38.7	32.9	22.8
18/08/2014	13:20:00	51.4	50.6	60.4	54.9	51.2	49.1	44.0	39.4	33.8	24.6
18/08/2014	13:25:00	50.7	49.8	60.0	54.6	50.8	48.0	43.3	38.8	33.3	24.4
18/08/2014	13:30:00	52.9	50.5	59.9	54.6	50.9	49.0	43.7	39.1	33.4	24.1
18/08/2014	13:35:00	51.4	50.8	59.8	54.8	51.0	49.8	43.7	39.3	32.7	23.1
18/08/2014	13:40:00	51.9	51.0	60.2	55.0	51.5	50.0	43.8	39.1	35.9	26.3
18/08/2014	13:45:00	54.0	51.1	60.3	55.2	51.9	50.0	43.9	39.1	35.8	26.2
18/08/2014	13:50:00	52.1	50.6	59.6	54.6	51.1	49.5	43.7	38.7	35.7	26.4
18/08/2014	13:55:00	54.8	50.9	59.8	54.8	51.6	49.8	44.0	39.1	35.8	26.3
18/08/2014	14:00:00	52.8	50.2	59.5	54.3	50.8	49.1	43.1	38.6	35.0	25.4
18/08/2014	14:05:00	53.4	51.0	60.1	54.6	51.1	50.4	43.7	38.8	35.3	25.6
18/08/2014	14:10:00	53.3	50.9	60.0	54.9	51.3	50.1	43.6	38.7	35.2	25.0
18/08/2014	14:15:00	53.2	51.0	59.8	54.8	51.5	49.9	44.1	39.2	35.3	25.7
18/08/2014	14:20:00	53.1	50.5	59.9	54.6	51.0	49.4	43.3	38.6	35.0	25.6
18/08/2014	14:25:00	59.6	50.9	60.4	55.2	51.5	49.8	44.1	39.3	35.7	26.1
18/08/2014	14:30:00	68.3	51.8	61.2	56.3	52.6	51.2	44.5	39.2	36.0	26.4
18/08/2014	14:35:00	52.3	50.5	59.4	54.4	50.9	50.3	42.7	37.8	34.2	25.4
18/08/2014	14:40:00	51.9	50.5	59.7	54.6	51.1	49.5	43.3	38.2	34.5	26.2
18/08/2014	14:45:00	52.5	50.3	59.8	54.7	50.9	48.9	43.4	38.7	35.5	26.5
18/08/2014	14:50:00	53.3	50.3	59.5	54.5	51.0	49.0	43.4	38.3	35.3	26.6
18/08/2014	14:55:00	51.1	50.3	59.8	54.4	50.9	49.3	43.1	38.0	35.0	25.9
18/08/2014	15:00:00	52.5	50.5	60.0	54.9	51.1	49.4	43.3	38.4	35.2	26.1
18/08/2014	15:05:00	52.8	49.9	59.9	54.6	50.7	48.8	42.8	37.6	35.2	25.5
18/08/2014	15:10:00	54.0	50.7	60.0	55.1	51.1	49.4	43.2	38.5	36.1	26.1

APPENDIX H: PROVISIONAL PLANT SELECTIONS

A/ MAIN SUPPLY/EXTRACT AHUs

AMBASSADORS THEATRE
NOISE DATA

Equipment	Location	Noise SWL (dB(A))							
		63	125	250	500	1000	2000	4000	8000
Air Cooled Chiller	Roof		94	91	91	87	83	76	
AHU Panel Insertion Losses	Roof	17	20	25	25	31	33	37	26
Auditorium AHU Extract Fan Discharge	Roof	98	92	89	88	85	81	76	68
Auditorium AHU Extract Fan Discharge 1200 mm Long Attenuator Insertion Loss	Roof	8	13	27	39	45	45	35	24
Auditorium AHU Supply Fan Discharge	Roof	98	92	89	88	85	81	76	68
Auditorium AHU Supply Fan Intake 1200 mm Long Attenuator Insertion Loss	Roof	8	13	27	39	45	45	35	24
AHU Panel Insertion Losses	Roof	17	20	25	25	31	33	37	26
Rehearsals AHU Extract Fan Discharge	Roof	95	90	88	83	78	72	68	60
Rehearsals AHU Extract Fan Discharge 1200 mm Long Attenuator Insertion Loss	Roof	8	13	27	39	45	45	35	24
Rehearsals AHU Supply Fan Discharge	Roof	95	90	88	83	78	72	68	60
Rehearsals AHU Supply Fan Intake 1200 mm Long Attenuator Insertion Loss	Roof	8	13	27	39	45	45	35	24
AHU Panel Insertion Losses	Roof	17	20	25	25	31	33	37	26
Basement AHU Supply Fan Discharge	Roof	90	89	84	82	80	78	71	60
Basement AHU Supply Fan Intake 1200 mm Long Attenuator Insertion Loss	Roof	8	13	27	39	45	45	35	24
Boiler	Roof	61							
Stalls Bar Toilet Extract Fan	Roof	78							
Basement Toilet Extract Fan	Roof	78							
Circle Bar Male Toilet Extract Fan	Roof	76							
Circle Bar Female Toilet Extract Fan	Roof	76							
Smoke Fans Inlet	Roof	113	106	108	105	104	102	99	96
Smoke Fans Outlet	Roof	115	108	109	105	104	102	98	97
Smoke Fans Break Out	Roof	105	85	81	78	77	73	77	74
Basement VRV Outdoor Unit	Roof	79							
FOH VRV Outdoor Unit	Roof	79							
IT Hub/Comms DX Outdoor Units (2 off)	Roof	SPL - 51 dB(A)							
Dimmer DX Outdoor Units (3 off)	Roof	SPL - 51 dB(A)							
Stage Cooling DX Outdoor Units (2 off)	Roof	SPL - 51 dB(A)							
AV Rack DX Outdoor Units (3 off)	Roof	SPL - 51 dB(A)							
Standby Generator	Roof	SPL - 83.9 dB(A) @ 1 m							

PANEL INSERTION LOSSES TO BE INCREASED BY 10dB ON THE ABOVE

B/ CHILLER (LOW NOISE PACKAGE – AA203)

30RB CHILLER RANGE - ACOUSTIC PACKAGE SELECTION

v02_12

Hydronic Option only up to 522

PROJECT : Theatre Project

PROJECT No:

Model:	**232**
Factory Noise Option:	**15LS**

Chiller Length	2.47	m
Chiller Width	2.25	m
Chiller Height	2.30	m
Distance	**5**	m - *Enter zero for Lw calc*
5SB area	514	m2
5SB corr	-27	dB

ALLAWAY ACOUSTICS LIMITED
email: enquiries@alllawayacoustics.co.uk

	Octave Band Centre Frequency, Hz							*Global*
	125	*250*	*500*	*1k*	*2k*	*4k*	*8k*	*dB(A)*
Chiller LwA	68	79	80	80	78	71	71	
Chiller Lw Lin	84	88	83	80	77	70	72	86
Lp untreated	57	61	56	53	50	43	45	59
Lp with AA202	57	60	54	50	47	40	43	56
Lp with AA203L	56	59	52	48	45	39	41	55
Lp with AA203	55	57	48	43	41	35	38	52
Lp with AA204	53	55	45	40	37	31	34	49
Lp with AA205	49	49	38	33	31	25	31	43
Lp with AA301	52	53	43	37	34	29	33	47
Lp with AA303	49	48	34	29	29	25	31	41

Notes:
Lw is Sound Power Level, dB re 10-12W (1pW); **Lp** is Sound Pressure Level, dB re 2 x 10-5Pa.
Propagation in accordance with 5-sided box (conformal surface) model, with chiller on reflecting plane in otherwise free field.
Measurement position 1.5m above surface upon which chiller stands.
Data are derived from tests carried out in accordance with ISO9614, and are stated according to standard Eurovent tolerances.
Octave band levels are provided for information only.
Noise levels shown are a logarithmic average around the machine. Individual points can be noisier or quieter.

Package Code	**Summary**
AA202	900mm high discharge attenuator
AA203L	Lift-off aluminium intake acoustic louvres
AA203	Lift-off intake acoustic louvres + 900mm high discharge attenuator
AA204	Sliding intake acoustic louvres + 900mm high discharge attenuator
AA205	Vertical intake attenuator + 900mm high discharge attenuator
AA301	Free-standing enclosure with sliding intake acoustic louvres + 1200mm high discharge attenuator
AA303	Free-standing enclosure with sliding intake attenuators + 1200mm high discharge attenuator

C/ STANDBY GENERATOR (ACOUSTIC PACKAGE)

ELCOS GENERATING SETS

GE.YA.047/044.SS

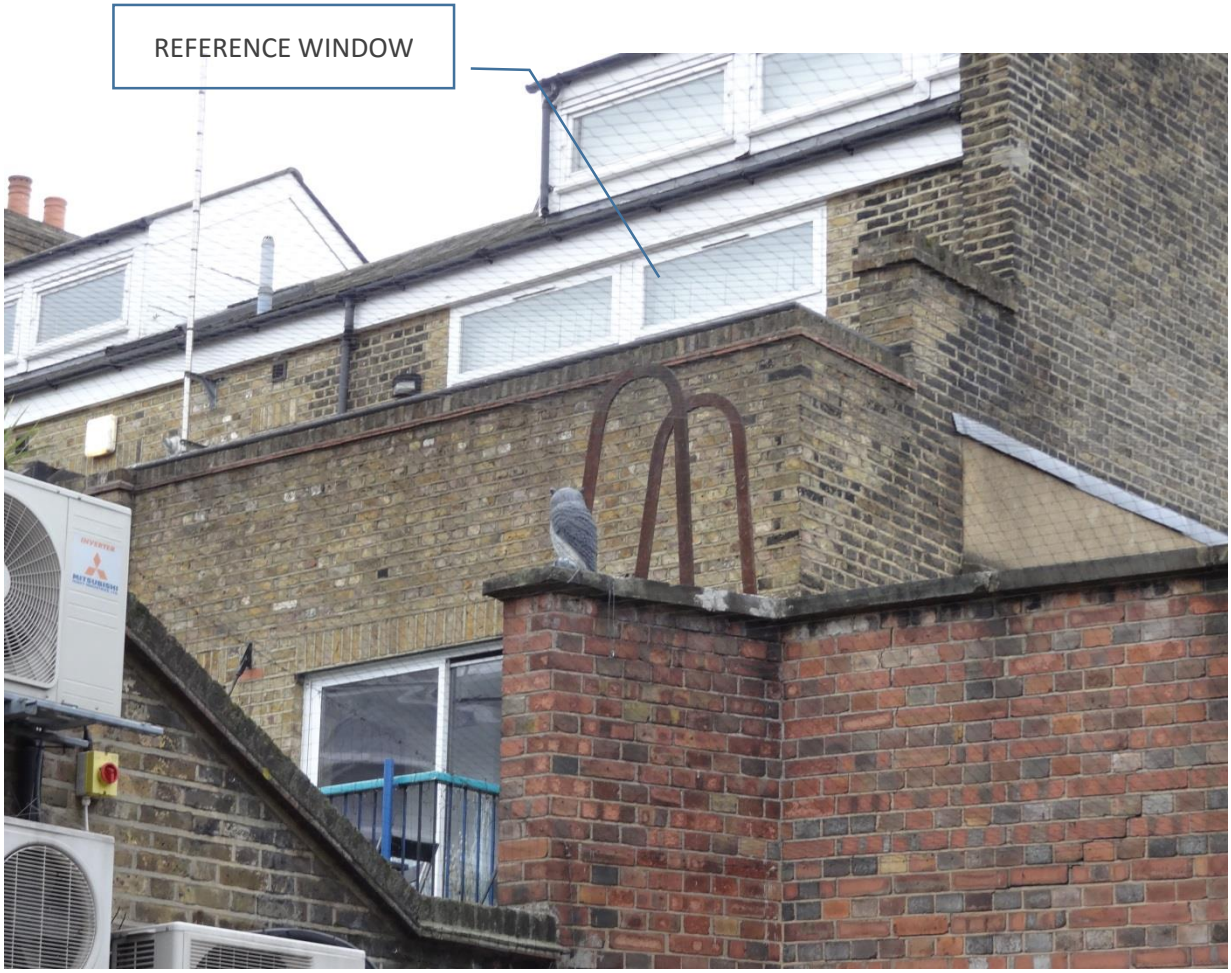
Generating Set		
Speed	rpm	1500
Frequency	Hz	50
PRP Prime power	kVA	**44**
Prime power (cosfi 0,8)	KW	35
LTP Limited-time running power	kVA	47
Limited time running pow. (cosfi 0,8)	KW	38
Voltage standard	V	400/230
Current PRP (cosfi 0,8)	A	64
Noise level		
LwA	dB(A)	88
Acoustic pressure level to 7 mt	dB(A)	63
Acoustic pressure level to 1 mt	dB(A)	72
Fuel consumption		
Fuel type	Type	Diesel
Fuel tank capacity	lt	110
Autonomy at 3/4 load	h	15.7
Fuel consumption at 4/4 load	l/h	9.4
Fuel consumption at 3/4 load	l/h	7
Fuel consumption at 2/4 load	l/h	4.7
General Features		
Battery capacity	Ah	1x100
Voltage	Vdc	12
Exhaust tube diameter	mm	60
Exhaust temperature	°C	460
Dimensions / weight		
Dimensions (L x w x h)	cm	190x90x150
Weight inclusive of liquids (oil and antifreeze)	kg	890

APPENDIX I: GENERATOR NOISE TRANSMISSION CALCULATION

Element	Level	Comments
Units sound power level	88 dB(A)	
Directivity	+ 3 dB	One additional reflective surface
Correction factor	- 11	Sound power to pressure correction
Acoustic screening	- 15	
Distance losses	- 20	Approximately 10m away to 1m from window
Cumulative SPL at building opposite	**45 dB(A)**	Meets design criterion of 54 L_{A90} + 10 dB

The level at the window is well below the LBC limit.

APPENDIX J: SITE PHOTOGRAPHS



REAR OF 4, TOWER STREET

VIEW TOWARDS TOWER STREET, REAR THEATRE ROOF

VIEW TOWARDS TOWER STREET, REAR THEATRE ROOF

VIEW TOWARDS WEST STREET, REAR THEATRE ROOF

VIEW TOWARDS TOWER STREET, REAR THEATRE ROOF