soundtesting
acoustic consultancy & air leakage specialists

Environmental Noise Report

Citrus House
40-46 Dale Street
Liverpool
L2 5SF

Date of Survey: Tuesday 2nd - Wednesday 3rd April 2013 (original survey ref: 5259)
Monday 29th June - Tuesday 30th June 2015
Thursday 2nd July - Friday 3rd July 2015

Date of Report: 15th September 2015

Reference: 7489E Rev 4

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1.0 General Information

1.1 Site Address

Citrus House
40-46 Dale Street
Liverpool
L2 5SF

1.2 Client Instructing Survey

Whitechapel Enterprises Limited
Citrus House
40-46 Dale Street
Liverpool
L2 5SF

1.3 Date of Noise Survey

Tuesday 2nd - Wednesday 3rd April 2013 (original survey ref: 5259)
Monday 29th June - Tuesday 30th June 2015
Thursday 2nd July - Friday 3rd July 2015

1.4 Survey Consultant

	Name	Position	Signature	Date
Prepared by	Ben Bielicki BSc AMIOA	Acoustic Engineer		15/09/2015
For and on behalf of: Soundtesting.co.uk Ltd				

1.5 Report Approval

	Name	Position	Signature	Date
Report Approval	Martin Hamer AMIOA	Acoustic Engineer		15/09/2015
For and on behalf of: Soundtesting.co.uk Ltd				

2.0 Introduction

Citrus House is an existing eight storey Grade II listed building which is being converted into apartment dwellings with commercial premises on the ground floor.

Soundtesting.co.uk Ltd was instructed to carry out an environmental noise assessment to determine the glazing specification on all façades for the flats on the 1st to 7th floors.

2.1 An Environmental Noise Assessment

Soundtesting.co.uk Ltd have carried out an environmental noise assessment at the above site with noise levels measured externally in five positions over a number of different twenty four hour periods, consisting of sixteen hour days (07:00 – 23:00) and eight hour nights (23:00 – 07:00).

Dominant noise levels were measured, in particular; traffic noise from Dale Street and Stanley Street.

This report will state the measured noise levels, and will refer to guidance contained within BS 8233:2014, Sound Insulation and Noise Reduction for Buildings and WHO Community Noise Guidelines for recommended internal noise levels within living spaces.

3.0 Assumptions & Limitations

a. All suggested specifications require a good level of workmanship and for materials to be installed as the manufacture intends. Any poor workmanship may lead to weaknesses in the sound attenuation provided by the building façade.
b. The noise levels measured on site during the environmental noise survey are typical of the site.
c. It is assumed that the technical data provided by glazing manufacturers is up to date and correct.
d. It is assumed all scale drawings provided by Smith + McHugh Architecture Ltd are correct and up to date.
e. INSUL prediction software by Marshall Day Acoustics has been used for some calculations and therefore relies on the structural information provided in the software.

4.0 Criteria

The criteria listed below are taken from associated relevant guidance documents, all of which should be considered for the internal noise levels.

4.1 BS 8233:2014 Sound Insulation and Noise Reduction for Buildings

BS 8233:2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice suggests the following noise levels:-

Table 1: BS 8233:2014 Recommended Internal Noise Levels

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline may be set in terms of SEL or L_{AFmax} depending on the character and number of events per night. Sporadic noise events could require separate values.

4.2 WHO Community Noise Guidelines

Table 2: A summary of the guidance noise levels can be found below

Specific Environment	Critical Health Effect (s)	L_{Aeq} (dB)	Time base (hours)	L_{AFmax} (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

Figure 2 – (ref: WHO Community Noise Guidelines)

4.3 Local Authority Criteria

Prior to occupation the residential accommodation hereby approved shall be acoustically insulated in accordance with a detailed scheme to be submitted and approved by the local planning authority before development commences on site. The sound mitigation must take the form of secondary glazing to the windows of all habitable rooms in accordance with the specification indicated in Schedule 1 of the Noise Insulation Regulations 1975, or double glazing of an equivalent or better acoustic performance. In addition the proposed noise attenuation measures shall incorporate a suitable scheme of acoustically attenuated continuous mechanical ventilation which removes the need to open windows for ventilation purposes to ensure the same performance criteria can be met.

4.4 Criteria Summary

The client has requested that external measurements are made at significant locations around the building in order to identify specific improvements to the glazing where required.

Whilst considering Noise Insulation Regulations 1975; all recommendations will be made in order to meet the criteria of BS 8233:2014; with reference to WHO Community Noise Guidelines.

Mechanical ventilation will be installed throughout; however; glazing specifications will be designed to meet the criteria of BS 8233:2014; with reference to WHO Community Noise Guidelines, due to the varying noise exposure around the different building facades and levels.

5.0 Site Description

The site is an existing eight storey Grade II listed building in the city centre of Liverpool. The development is on the junction of Dale Street and Stanley Street, with the main entrance on Dale Street. Dale Street is a three lane one-way road running south-west towards the coast. It has a 30mph speed limit and remains very busy with cars, buses, HGVs and pedestrian traffic.

There is a bus stop outside of the property on Dale Street, Moorfields train station on the opposite side of Dale Street and there are also a number of bars, cafes and shops in the area.

The existing façade is assumed to be solid brick construction with internal separating floors assumed to be concrete. The thickness and density are unknown.

There is some plant machinery (extractors etc.) on the buildings opposite the rear (south-east) façade, particularly on the roofs.

The existing glazing varies throughout the building. On inspection the glazing is assumed to be as follows:

- Front (Dale Street NW) and side (Stanley Street NE) façades 1st to 5th floors – 6mm/50mm/6mm double glazing
- Front (Dale Street NW) and side (Stanley Street NE) 6th and 7th floors – 4mm/12mm/4mm double glazing
- Rear (Progress Place SE) façade all floors – 4mm single glazing

Subjectively the dominant noise source was traffic noise from Dale Street and Stanley Street. The plant machinery was not perceived to be audible therefore it was uncertain as to whether it was in operation at the time of the measurements. At the upper floors of the building the sound of Seagulls was particularly noticeable.

6.0 Noise Measurement Procedure

6.1 Personnel Present

Ben Bielicki BSc AMIOA

Jonathan Howell BSc MIOA

Lee Richardson

Richard Calvert BSc MIOA

6.2 Survey Equipment Used

Table 3: All sound measurement equipment used

Manufacturer	Model	Serial No.	Description
Rion	NL52	01032413	Real Time Analyser Sound Level Meter
Rion	NA28	00211583	Real Time Analyser Sound Level Meter
Rion	NC74	35125832	Calibrator
Norsonic	Type 118	31745	Sound Level Meter
Brüel & Kjær	Type 4231	2564329	Calibrator

Calibration

The sound level meters were calibrated to 94.0 dB @ 1 kHz with the field calibrator prior to the commencement and on the completion of the survey in accordance with the manufacturer's instructions. No significant drift in calibration was observed. The meters used during the survey are precision grade class 1.

Calibration certificates are available on request.

6.3 Weather Conditions

Site Visit in April 2013

The weather was generally fine on Tuesday 2nd April 2013 and Wednesday 3rd April 2013 temperatures remained around 4^0C during the day and fell to approximately 0^0C at night, wind was low (0-1ms^{-1}).

Site Visit in June 2015

On Monday 29th June 2015 to Tuesday 30th June 2015, temperatures averaged around 25^oC during the day and 16^oC at night, the sky was cloudy. Wind was breezy with gusts that may have exceeded 5ms^{-1}.

Site Visit in July 2015

On Thursday 2nd July 2015 to Friday 3rd July 2015, it was cloudy with sunny spells and some precipitation around 16:00-20:00 on Thursday. Temperatures averaged around 21°C during the day and 15°C at night with south-easterly winds. Wind was breezy with gusts that may have exceeded 5.0ms^{-1}.

6.4 Noise Measurement Procedure

The sound level meters were set to measure L_{A90}, L_{A10}, L_{Aeq} and L_{AFmax} in 5 minute periods, as well as A-weighted 1:1 octave spectrum analysis in order to identify any tonal characteristics of the noise.

Measurements were carried out over a 24 hour period to identify any variation in noise at different times of the day and night.

Position 1

A microphone was positioned at the rear (south-east) façade of the building facing Progress Place at the most northerly point (near Stanley Street). The microphone was set on a pole 1m from the façade in a third floor window approximately 12.8m from the pavement surface and 8m across from the central line of Stanley Street.

Position 2

A microphone was positioned at the rear (south-east) façade of the building facing Progress Place at the most southerly point (away from Stanley Street). The microphone was set on a pole 1m from the façade in a third floor window approximately 12.8m from the pavement surface and 23.5m across from the central line of Stanley Street.

Position 3

A microphone was positioned in the middle of the rear (south-east) façade of the building facing Progress Place. The microphone was set on a pole 1m from the façade in a seventh floor window approximately 25.6m from the pavement surface and 16m across from the central line of Stanley Street.

Position 4

A microphone was positioned on the side (north-east) façade of the building facing Stanley Street. The microphone was set on a pole 1m from the façade in a third floor window approximately 12.8m from the pavement surface and 6m across from the central line of the road.

Position 5

A microphone was positioned on the front (north-west) façade of the building facing Dale Street. The microphone was set on a pole 1m from the façade in a fifth floor window approximately 19.2m from the pavement surface and 11m across from the central line of the road.

Audio WAV Recordings

At Position 2; audio WAV files were recorded of noises exceeding 65 dB in order to identify the sources of L_{AFmax} levels.

At Position 3; audio WAV files were recorded of noises exceeding 70 dB in order to identify the sources of L_{AFmax} levels.

7.0 Measurement Results

7.1 Results and Analysis

Table 4 presents the measured results as a quick comparison in order to analyse the results.

Table 4: Comparison Chart

Monitoring position	Measurement Date	Time Period	Time Base T (hours)	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	L_{A90} (dB)	L_{A10} (dB)
1	29-30 June 15	Daytime	16	61.0	-	53.9	62.6
1	29-30 June 15	Night time	8	57.6	65.1 – 81.7	48.6	57.9
2	29-30 June 15	Daytime	16	58.9	-	54.8	59.8
2	29-30 June 15	Night time	8	54.9	57.6 – 78.9	48.6	55.9
3	2-3 July 15	Daytime	15	61.1	-	54.0	57.4
3	2-3 July 15	Night time	8	58.1	59.9 – 87.7	50.95	57.9
4	2-3 July 15	Daytime	15	65.9	-	53.3	62.8
4	2-3 July 15	Night time	8	64.2	72.8 – 87.0	51.9	64.5
5	2-3 April 13	Daytime	16	68.5	-	61.0	70.7
5	2-3 April 13	Night time	8	62.9	66.9 – 88.7	48.9	64.5

L_{AFmax} Analysis

The L_{AFmax} measured during the night time (23:00-07:00) has been analysed.

Position 1 - the maximum measured L_{AFmax} is 81.7 dB, which occurs at 05:50. 80 dB is exceeded twice and 75.0 dB is exceeded 13 times.

Position 2 - the maximum measured L_{AFmax} is 78.9 dB, which occurs at 05:50. 75 dB is exceeded three times and 70 dB is exceeded 23 times.

Position 3 - the maximum measured L_{AFmax} is 87.7 dB, which occurs at 05:00. 80 dB is exceeded 7 times and 75 dB is exceeded 17 times.

Position 4 - the maximum measured L_{AFmax} is 87.0 dB, which occurs at 06:10. 85 dB is exceeded three times and 80 dB is exceeded 29 times.

Position 5 - the maximum measured L_{AFmax} is 88.7 dB, which occurs at 00:50. 85 dB is exceeded four times and 80 dB is exceeded 16 times.

Audio Recordings

WAV files were recorded at positions 2 and 3 which will also represent sounds captured at positions 1 and 4 respectively as these measurements were taken at the same times. There are no WAV files for position 5. On inspection of the audio recordings, it is noted that one of the loudest noise sources was seagulls (in particular at position 3 – on the top floor at the rear of the building). For the purpose of this assessment, only man-made noise sources will be considered. The loudest man-made noise source sounded like a road sweeper or some other slow moving vehicle. This occurred at position 1 (81.7 dB) and position 2 (78.9 dB) between 05:50 - 05:55 on Monday 29th June 2015, and at position 3 (80.8 dB) and position 4 (87.0 dB) between 06:15 – 06:20 on Thursday 2nd July 2015. This implies this noise source may be a daily occurrence around the same time. Other sounds noted were various vehicles and street noise throughout the night and some people shouting in the early hours of the morning (around 00:00 – 02:00).

Noise samples and WAV files are available by request.

When only considering man-made noises, the following L_{AFmax} values will be used for calculations:

Table 5:

Measurement Location	L_{AFmax}
Position 1	81.7 dB(A)
Position 2	78.9 dB(A)
Position 3	80.8 dB(A)
Position 4	87.0 dB(A)
Position 5	88.7 dB(A)

8.0 Recommendations

The external noise measurements in Table 4 and Table 5 have been used as the starting point of the calculations of the predicted internal noise levels, within the flats.

Specifications for existing glazing to remain in place are providing further works are done to the frames ensuring they are well sealed and airtight, without trickle vents.

No ventilation has been specified as the development is believed to be using a mechanical ventilation system.

Table 6: Recommended Glazing

Flat	Floor	Room	Recommended Glazing*
All	All	Lounge/Dining/Living	Existing glazing to remain
1	1st	Bed 1	Pilkington Optiphon 10/16/9.1/100/10
1	2nd	Bed 1	Pilkington Optiphon 10/16/9.1/100/10
1	3rd	Bed 1	Pilkington Optiphon 10/16/9.1
1	4th	Bed 1	Pilkington Optiphon 6/16/6.8
1	5th	Bed 1	Pilkington Optiphon 6/16/6.8
1	6th	Bed 1	Existing glazing to remain
1	7th	Bed 1	Existing glazing to remain
1	1st	Beds 2 & 3	Pilkington Optiphon 6/16/8.8
1	2nd	Beds 2 & 3	Pilkington Optiphon 6/16/8.8
1	3rd	Beds 2 & 3	Pilkington Optiphon 6/16/8.8
1	4th	Beds 2 & 3	Pilkington Optiphon 6/16/8.8
1	5th	Beds 2 & 3	Existing glazing to remain
1	6th	Beds 2 & 3	Existing glazing to remain
1	7th	Beds 2 & 3	Existing glazing to remain
2	1st	Bed 2	Pilkington Optiphon 6/16/8.8
2	2nd	Bed 2	Pilkington Optiphon 6/16/8.8
2	3rd	Bed 2	Pilkington Optiphon 6/16/8.8
2	4th	Bed 2	Pilkington Optiphon 6/16/8.8
2	5th	Bed 2	Existing glazing to remain
2	6th	Bed 2	Existing glazing to remain
2	All Floors	Bed 1	Existing glazing to remain
3 & 4	1st	All Beds	Pilkington Optiphon 10/16/9.1
3 & 4	2nd	All Beds	Pilkington Optiphon 10/16/9.1
3 & 4	3rd	All Beds	Existing glazing to remain
3 & 4	4th	All Beds	Existing glazing to remain
3 & 4	5th	All Beds	Existing glazing to remain
3 & 4	6th	All Beds	Pilkington Optiphon 6/16/6.8
3 & 4	7th	All Beds	Pilkington Optiphon 6/16/6.8
5	1st	Bed 2	Pilkington Optiphon 10/16/9.1/100/10
5	2nd	Bed 2	Pilkington Optiphon 10/16/9.1/100/10
5	3rd	Bed 2	Pilkington Optiphon 10/16/9.1/100/10
5	4th	Bed 2	Pilkington Optiphon 10/16/9.1/100/10
5	5th	Bed 2	Pilkington Optiphon 8/16/9.1
5	6th	Bed 2	Existing glazing to remain
5	1st	Bed 1	Pilkington Optiphon 10/16/9.1/100/10
5	2nd	Bed 1	Pilkington Optiphon 10/16/9.1/100/10
5	3rd	Bed 1	Pilkington Optiphon 10/16/9.1
5	4th	Bed 1	Pilkington Optiphon 6/16/6.8
5	5th	Bed 1	Pilkington Optiphon 6/16/6.8
5	6th	Bed 1	Existing glazing to remain

*Further details of the different types of glazing are shown in section 8.2 Table 7

8.1 Calculation Methodology

In order to calculate the glazing, all measurements have had a façade correction of 3dB applied in order to adjust the measurement so that it is comparable to a free-field sound pressure level.

Distance attenuation calculations based on the various measurement positions have also been used in order to predict the noise level on each floor of each façade. The following formulas were used:

- **Line source** $SPL = L_1 - 10\log(r_2/r_1)$
- **Point source** $SPL = L_1 - 20\log(r_2/r_1)$

Values for r were calculated using Pythagoras' Theorem on the distance across from the source and the height of the windows from the pavement.

Building Envelope Insulation software by BRE has been used for the sound insulation analysis of the glazing.

The calculations and predicted levels for internal noise are based on the existing external façade being assumed to be 200mm solid brick construction. The wall was modelled using INSUL prediction software by Marshall Day Acoustics.

Calculations were made on samples of different rooms for each floor. This included Flat 4 Bed 1; Flat 5 Bed 2 and Lounge/Dining/Kitchen; Flat 1 Lounge/Dining/Kitchen, Bed 1, and Bed 2; and Flat 2 Lounge/Dining/Kitchen and Bed 1.

For the purposes of calculations all room dimensions and window sizes are based on a combination of onsite measurements and measurements from the pdf scale drawings provided by Smith + McHugh Architecture Ltd.

The calculations assume each room has a reverberation time of 0.5 seconds.

The predictions also have been calculated assuming that all windows are tightly closed.

8.2 Building Elements

Table 7 shows the expected performance of the glazing.

Table 7: Table showing suggested Glazing

Element	Description[#]	$R_w/D_{n,e,w}$ (dB)	Octave Centre Frequencies (Hz) SRI / $D_{n,e}$ (dB)					
			125	250	500	1k	2k	4k
Existing Glazing	4mm Single Glazing (BRE calculator)	-	20	22	28	32	33	-
Existing Glazing	4mm/12mm/4mm Double Glazing (BRE Calculator)	-	24	20	25	34	37	-
Existing Glazing	6mm/50mm/6mm Double Glazing (Building Bulletin 51)	-	24	29	34	41	45	53
Recommended Glazing	6mm/16mm Argon/6.8mm Pilkington Optiphon™*	38	22	27	35	42	41	48
Recommended Glazing	6mm/16mm Argon/8.8mm Pilkington Optiphon™*	41	24	26	40	48	46	54
Recommended glazing	10mm/16mm Argon/9.1mm Pilkington Optiphon™*	45	29	33	44	46	49	57
Recommended glazing	10mm/16mm argon/9.1mm Pilkington Optiphon™*/ 100mm Air Gap / 10mm Secondary Glaze (Insul model)	51	39	44	49	50	52	60

**The selected units or products described have been used as a guide to form part of the specification. Other similar units or products can be used provided they can achieve the given minimum acoustic performance.*

8.3 Expected Performance

Table 8 shows a sample of some of the calculations carried out for the development and calculations are not shown for every individual room in the building.

$L_{Aeq,16hr}$ figures are shown for the daytime and L_{AFmax} figures are shown for the night time. Calculations were also made for night time $L_{Aeq,8hr}$ which all met the requirements of the guidelines but are not shown in the table.

Some of the L_{AFmax} figures are higher than the 45 dB(A) specified by the WHO guidelines (shown in Table 2) but this may be considered acceptable as it only occurs on a few occasions and WHO Community Noise Guidelines specifically states that "For a good sleep, it is believed that indoor sound pressure levels should not exceed 45 dB L_{AFmax} more than 10–15 times per night (Vallet & Vernet 1991)."

Also given the development is a Grade II listed building, there may be some additional allowances made with reference to Section 7.7.2, Note 7 of BS 8233:2014 which states that "Where the development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

Taking into account the above two statements, a relaxation of 5 dB has been applied to the target figures which brings the daytime $L_{Aeq,16}$ in the Lounge/Dining/Kitchen areas to 40 dB and the night time L_{AFmax} in bedrooms to 50 dB.

If required, further sound attenuation can be achieved with the use of extra glazing in addition to the glazing already specified.

Table 8: Expected internal performance before and after recommended glazing

Façade	Floor	Room	Existing Glazing Calculations			Target (dB) with 5 dB relaxation	Recommended Glazing Calculations	
			Glazing Type (mm)	Daytime $L_{Aeq,16hr}$ (dB)	Night time L_{AFmax} (dB)		Glazing Type (mm)	Night time L_{AFmax} (dB)
Front	1st	Lounge/Dining/Kitchen	6/50/6	35	-	40	Existing glazing to remain	-
Front	2nd	Lounge/Dining/Kitchen	6/50/6	32	-	40	Existing glazing to remain	-
Front	3rd	Lounge/Dining/Kitchen	6/50/6	31	-	40	Existing glazing to remain	-
Front	4th	Lounge/Dining/Kitchen	6/50/6	30	-	40	Existing glazing to remain	-
Front	5th	Lounge/Dining/Kitchen	6/50/6	29	-	40	Existing glazing to remain	-
Front	6th	Lounge/Dining/Kitchen	4/12/4	35	-	40	Existing glazing to remain	-
Front	7th	Lounge/Dining/Kitchen	4/12/4	33	-	40	Existing glazing to remain	-
Front	1st	Flat 4 Bed 1	6/50/6	-	54	50	Optiphon 10/16/9.1	50
Front	2nd	Flat 4 Bed 1	6/50/6	-	53	50	Optiphon 10/19/9.1	49
Front	3rd	Flat 4 Bed 1	6/50/6	-	50	50	Existing glazing to remain	-
Front	4th	Flat 4 Bed 1	6/50/6	-	48	50	Existing glazing to remain	-
Front	5th	Flat 4 Bed 1	6/50/6	-	46	50	Existing glazing to remain	-
Front	6th	Flat 4 Bed 1	4/12/4	-	52	50	Optiphon 6/16/6.8	48
Front	7th	Flat 4 Bed 1	4/12/4	-	53	50	Optiphon 6/16/6.8	48
Front	1st	Flat 5 Bed 2	6/50/6	-	57	50	Pilkington Optiphon 10/16/9.1/100/10	50
Front	2nd	Flat 5 Bed 2	6/50/6	-	56	50	Pilkington Optiphon 10/16/9.1/100/10	49
Front	3rd	Flat 5 Bed 2	6/50/6	-	54	50	Pilkington Optiphon 10/16/9.1/100/10	48
Front	4th	Flat 5 Bed 2	6/50/6	-	53	50	Pilkington Optiphon 10/16/9.1/100/10	47
Front	5th	Flat 5 Bed 2	6/50/6	-	51	50	Pilkington Optiphon 8/16/9.1	50
Front	6th	Flat 5 Bed 2	4/12/4	-	49	50	Existing glazing to remain	-
Side	1st	Flat 1 Bed 1	6/50/6 and 4mm	-	58	50	Pilkington Optiphon 10/16/9.1/100/10	51

Façade	Floor	Room	Existing Glazing Calculations			Target (dB) with 5 dB relaxation	Recommended Glazing Calculations	
			Glazing Type (mm)	Daytime $L_{Aeq,16hr}$ (dB)	Night time L_{AFmax} (dB)		Glazing Type (mm)	Night time L_{AFmax} (dB)
Side	2nd	Flat 1 Bed 1	6/50/6 and 4mm	-	56	50	Pilkington Optiphon 10/16/9.1/100/10	49
Side	3rd	Flat 1 Bed 1	6/50/6 and 4mm	-	54	50	Pilkington Optiphon 10/16/9.1	48
Side	4th	Flat 1 Bed 1	6/50/6 and 4mm	-	53	50	Pilkington Optiphon 6/16/8.8	50
Side	5th	Flat 1 Bed 1	6/50/6 and 4mm	-	52	50	Pilkington Optiphon 6/16/8.8	50
Side	6th	Flat 1 Bed 1	4/12/4	-	50	50	Existing glazing to remain	-
Side	7th	Flat 1 Bed 1	4/12/4	-	48	50	Existing glazing to remain	-
Side	1st	Lounge/Dining/Kitchen	6/50/6	32	-	40	Existing glazing to remain	-
Side	2nd	Lounge/Dining/Kitchen	6/50/6	30	-	40	Existing glazing to remain	-
Side	3rd	Lounge/Dining/Kitchen	6/50/6	29	-	40	Existing glazing to remain	-
Side	4th	Lounge/Dining/Kitchen	6/50/6	28	-	40	Existing glazing to remain	-
Side	5th	Lounge/Dining/Kitchen	6/50/6	24	-	40	Existing glazing to remain	-
Side	6th	Lounge/Dining/Kitchen	4/12/4	31	-	40	Existing glazing to remain	-
Side	7th	Lounge/Dining/Kitchen	4/12/4 and 4mm	32	-	40	Existing glazing to remain	-
rear	1st	Flat 1 Bed 2	4mm	-	55	50	Pilkington Optiphon 6/16/6.8	50
rear	2nd	Flat 1 Bed 2	4mm	-	53	50	Pilkington Optiphon 6/16/6.8	48
rear	3rd	Flat 1 Bed 2	4mm	-	51	50	Pilkington Optiphon 6/16/6.8	46
rear	4th	Flat 1 Bed 2	4mm	-	50	50	Existing glazing to remain	-
rear	5th	Flat 1 Bed 2	4mm	-	47	50	Existing glazing to remain	-
rear	6th	Flat 1 Bed 2	4mm	-	48	50	Existing glazing to remain	-
rear	7th	Flat 1 Bed 2	4mm	-	47	50	Existing glazing to remain	-

9.0 Conclusions

When installing the specified glazing as discussed in the recommendations section, the recommended internal noise levels described in BS 8233:2014 can be achieved for $L_{Aeq,16\ hour}$ and $L_{Aeq,8\ hour}$ internal noise levels in all bedrooms and lounge/dining/kitchens from the external sources. L_{AFmax} figures are shown to meet the requirements of World Health Organisation Guidelines: 1999.

10.0 References

BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

World Health Organisation Guidelines: 1999

BS 7445-1: 2003 Description and measurement of environmental noise – Part 1: Guide to quantities and procedures

The Little Red Book of Acoustics – R. Watson & O Downey

Building Envelope Insulation software by BRE

INSUL software by Marshall Day Acoustics

www.google.co.uk/maps

Appendix

Figure 1: Aerial view of development showing monitoring positions

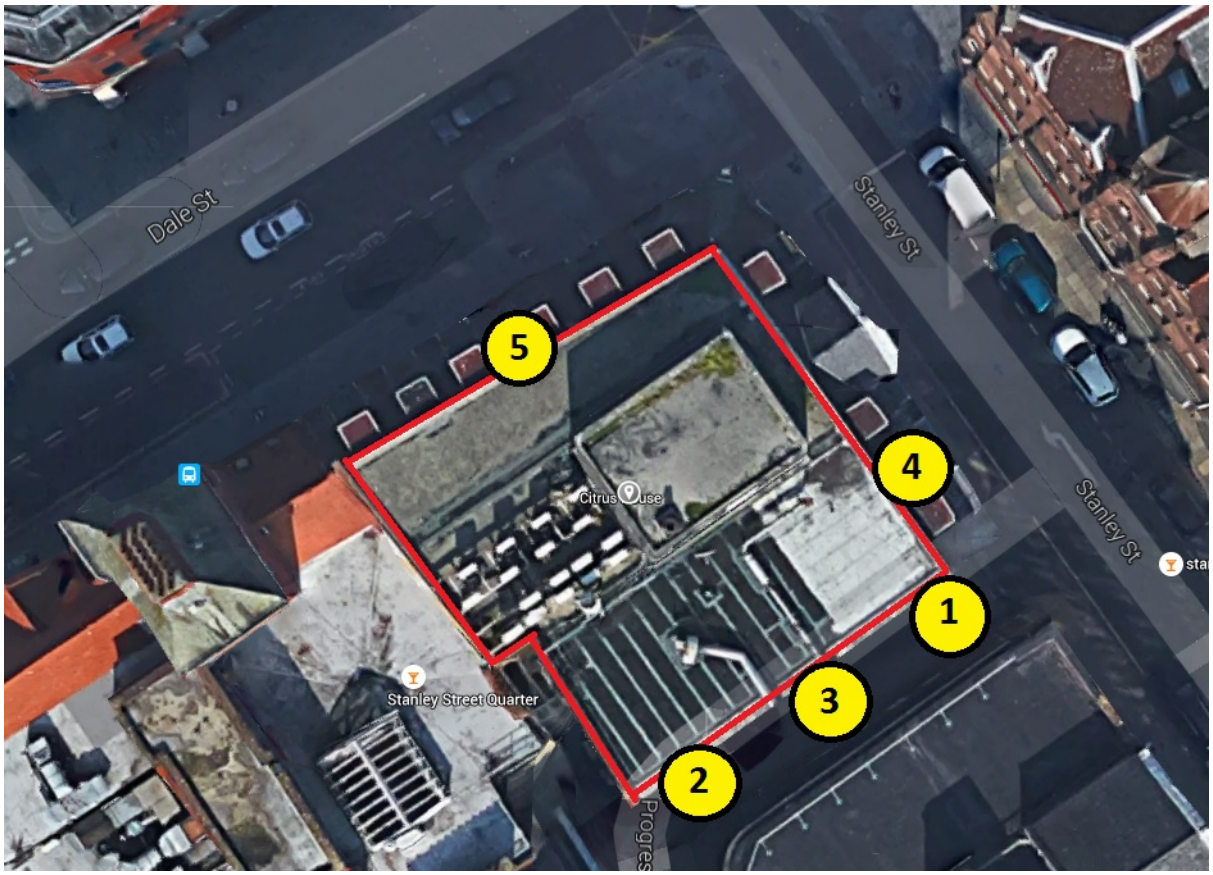


Figure 2: Position 1 - 3rd Floor, rear façade, near to Stanley Street

Figure 3: Position 2 - 3rd Floor, rear façade, away from Stanley Street

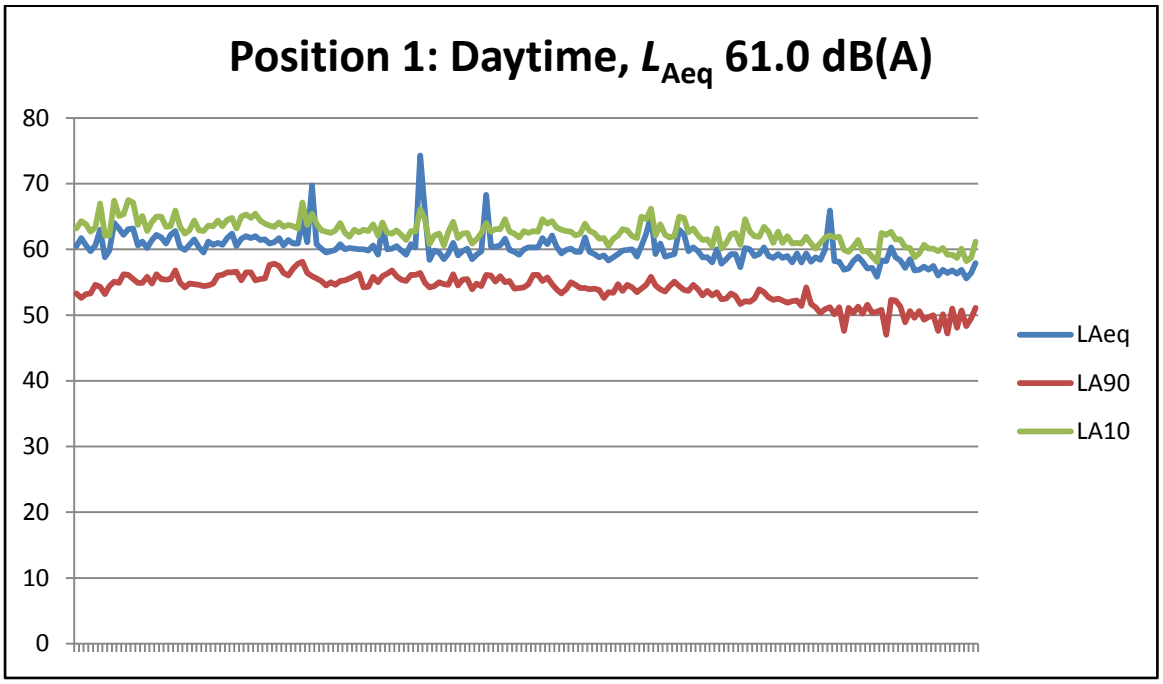
Figure 4: Position 3 - 7th Floor, centre of rear facade

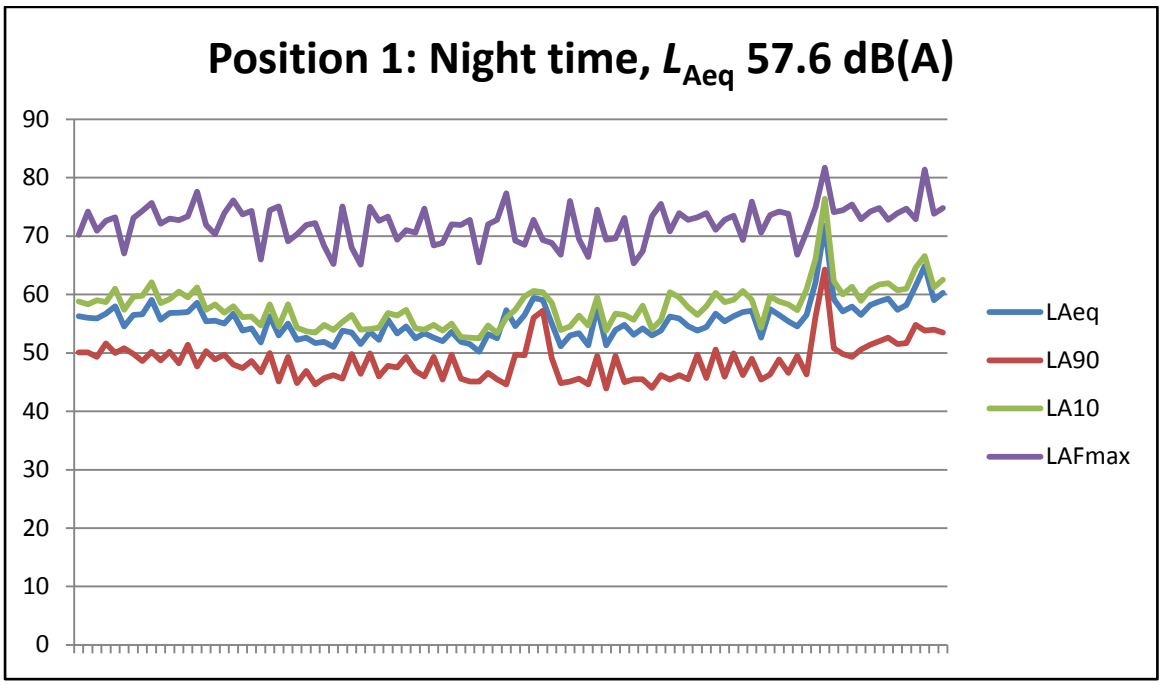
Figure 5: Position 4 - 3rd Floor, side façade on Stanley Street

Figure 6: Position 5 - 5th Floor, front façade on Dale Street

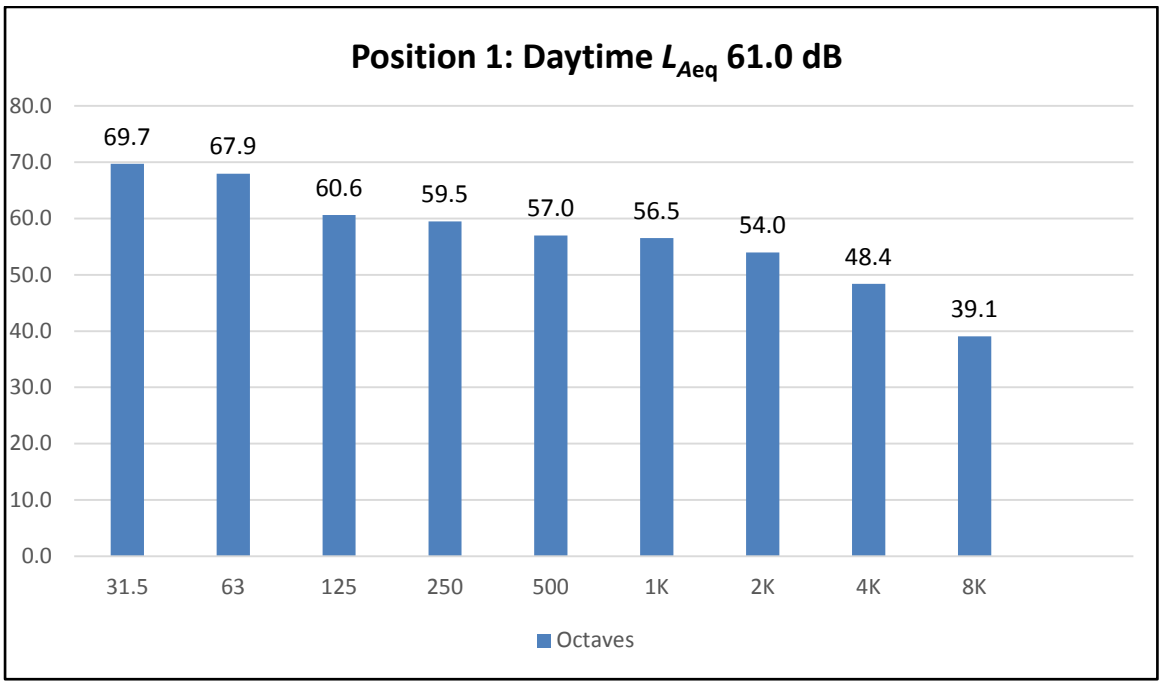
Measurement Results

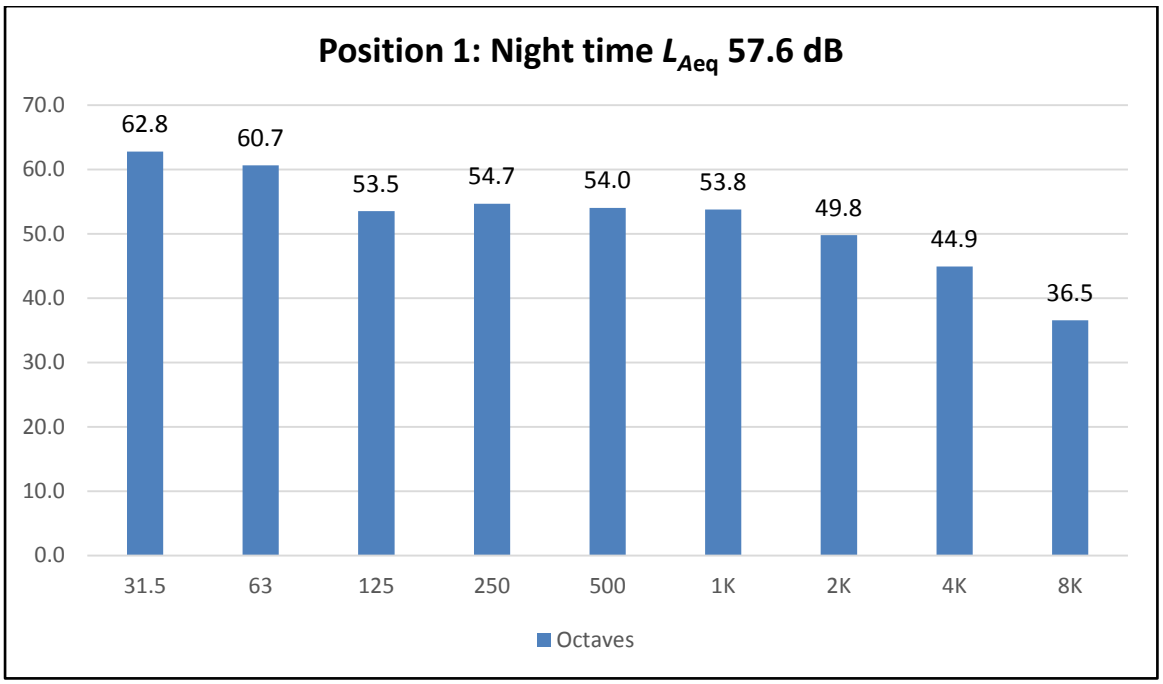
Position 1

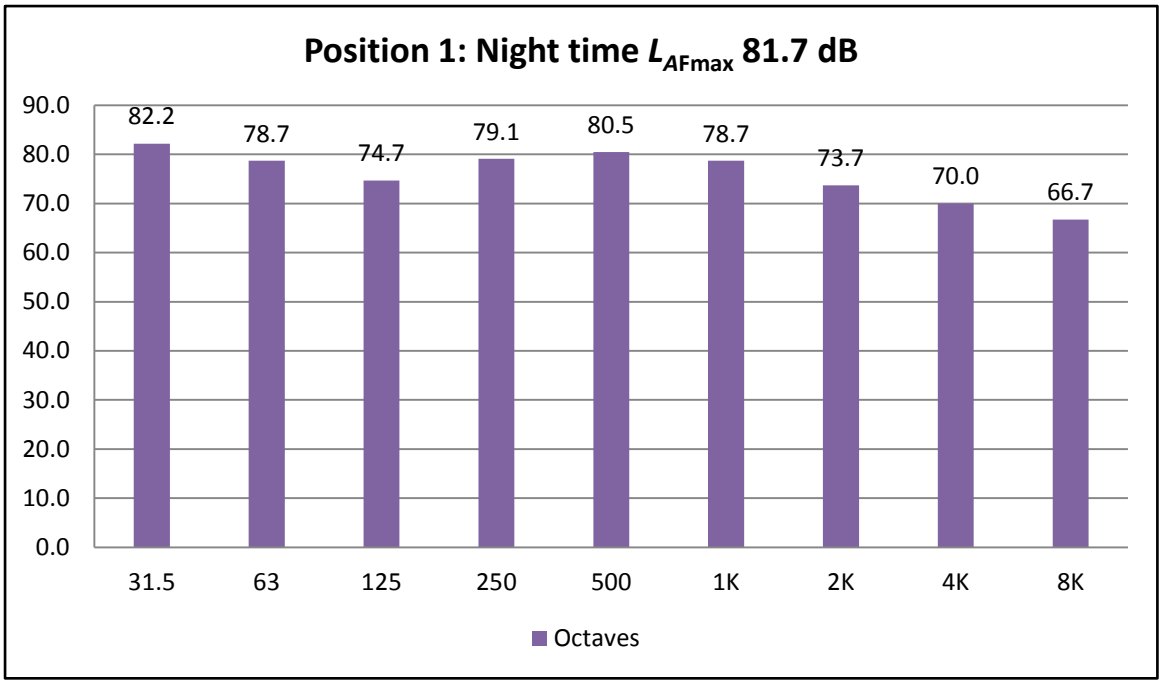




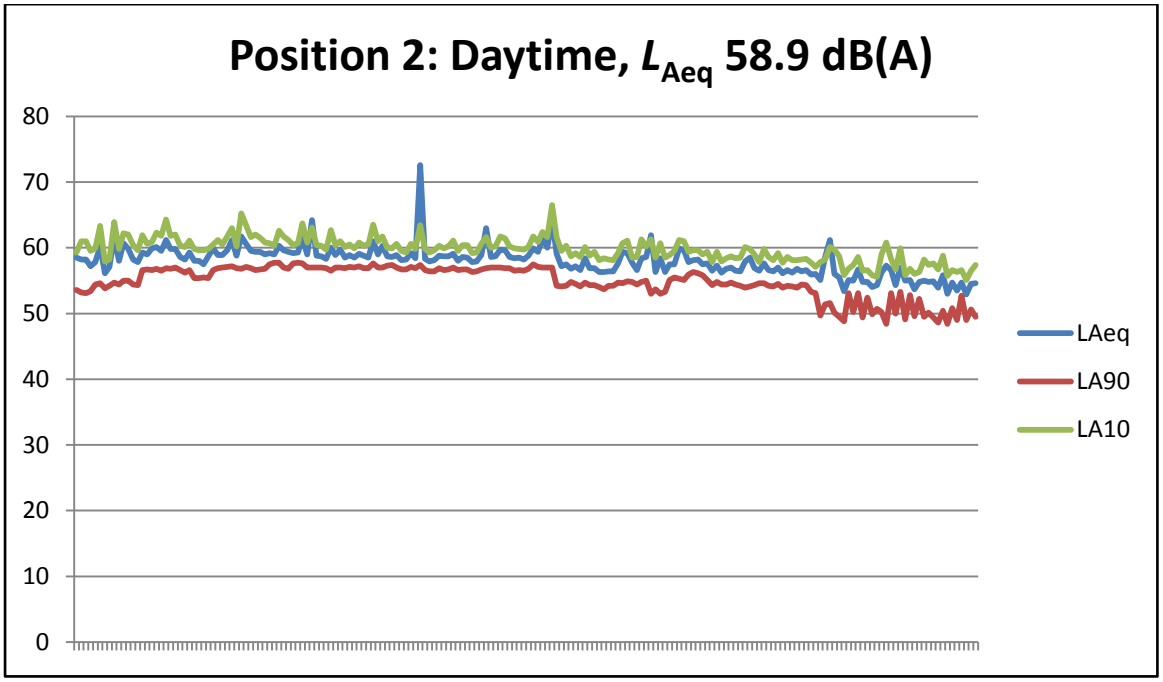
Un- weighted 1:1 Octave Results

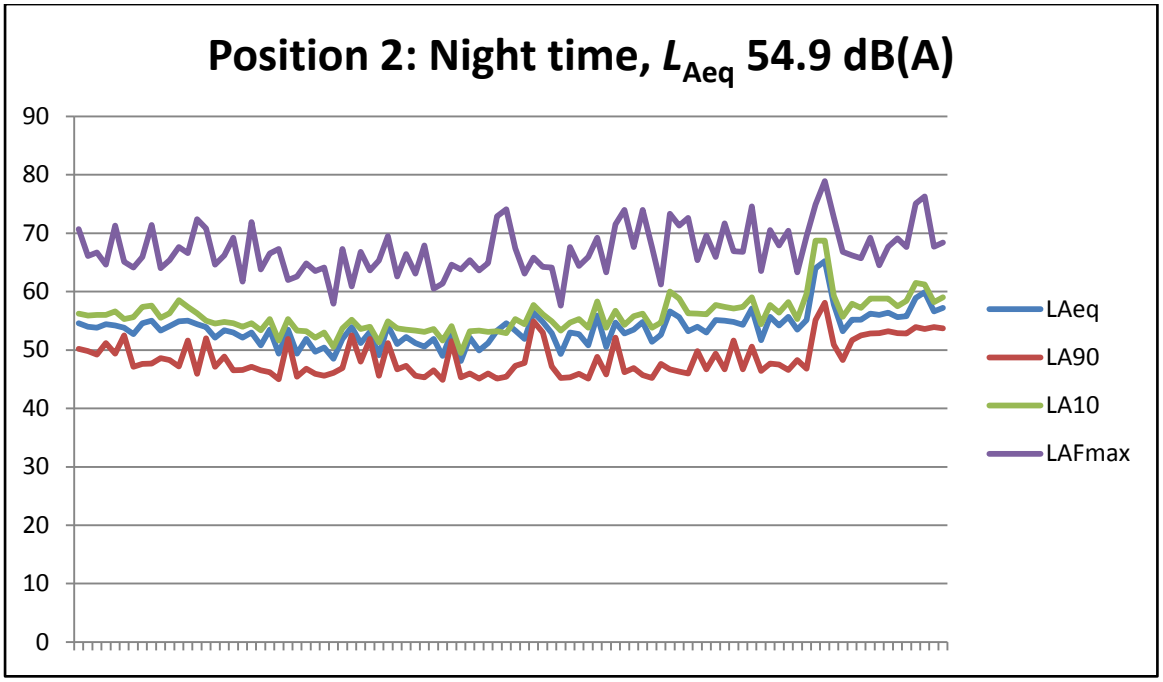




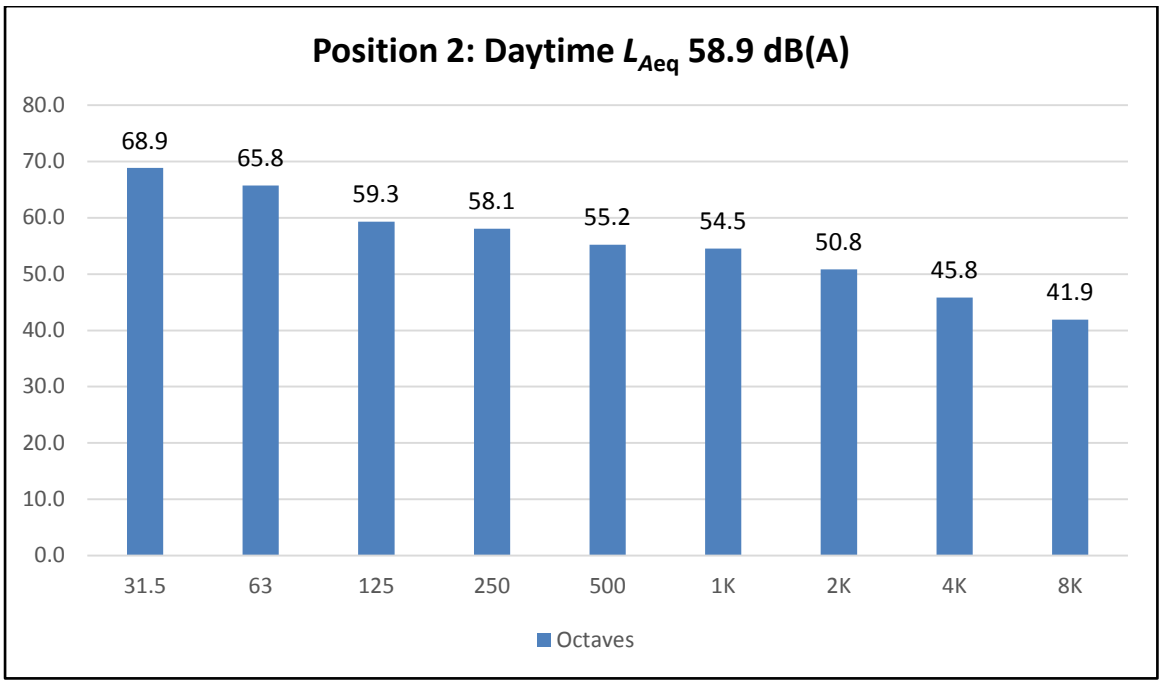

Position 1: Night time L_{AFmax} 81.7 dB
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
82.2
78.7
74.7
79.1
80.5
78.7
73.7
70.0
66.7
31.5
63
125
250
500
1K
2K
4K
8K
Octaves

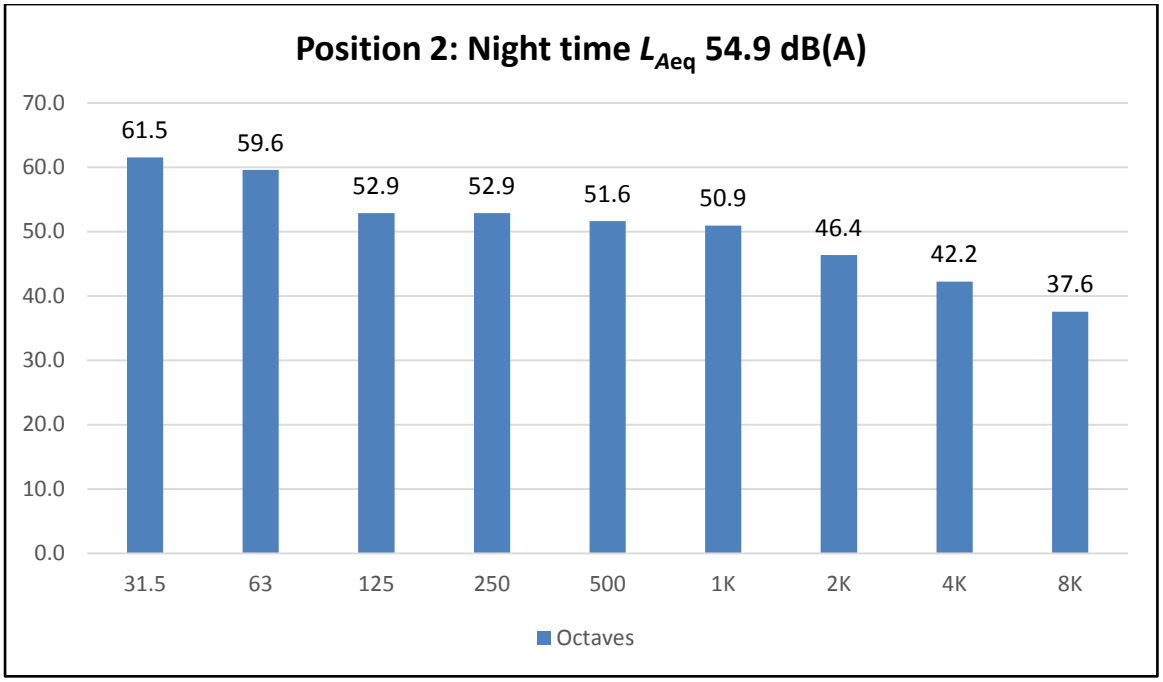
Position 2

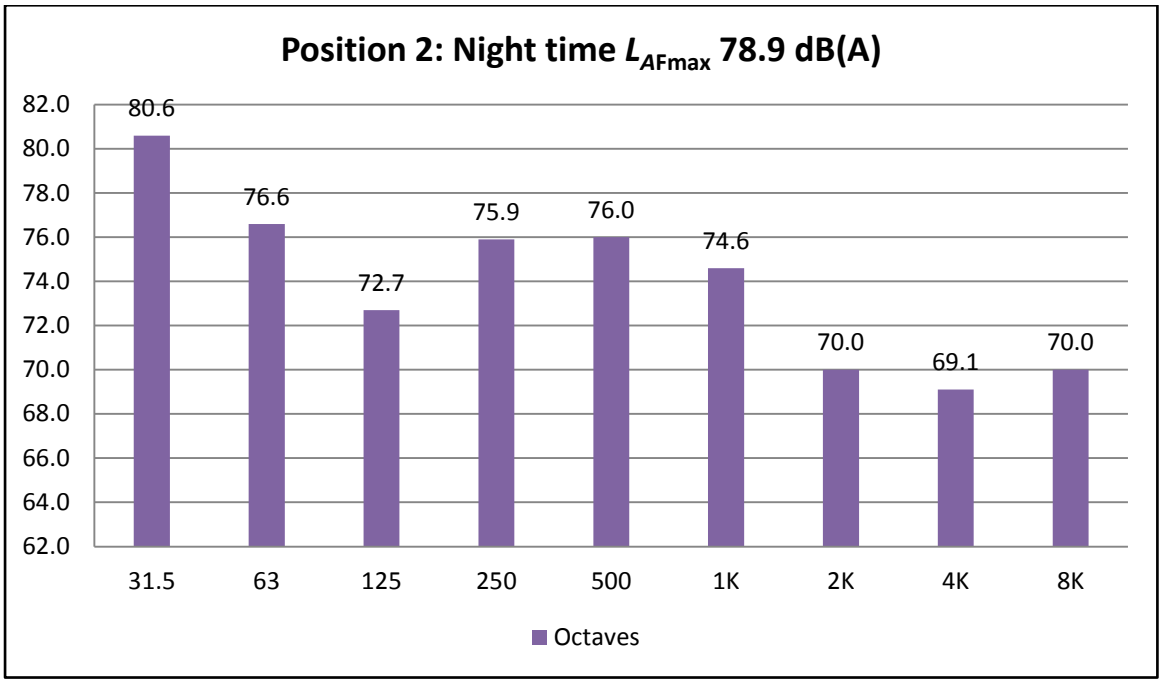

Position 2: Daytime, L_{Aeq} 58.9 dB(A)
80
70
60
50
40
30
20
10
0
LAeq
LA90
LA10



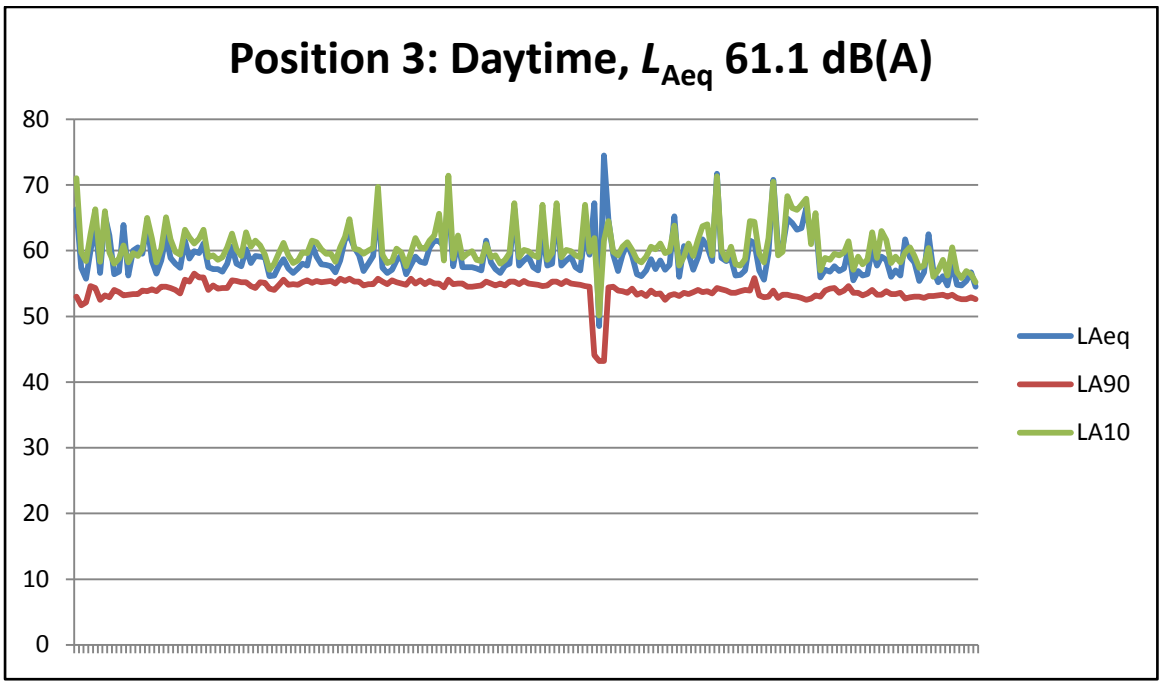
Un- weighted 1:1 Octave Results

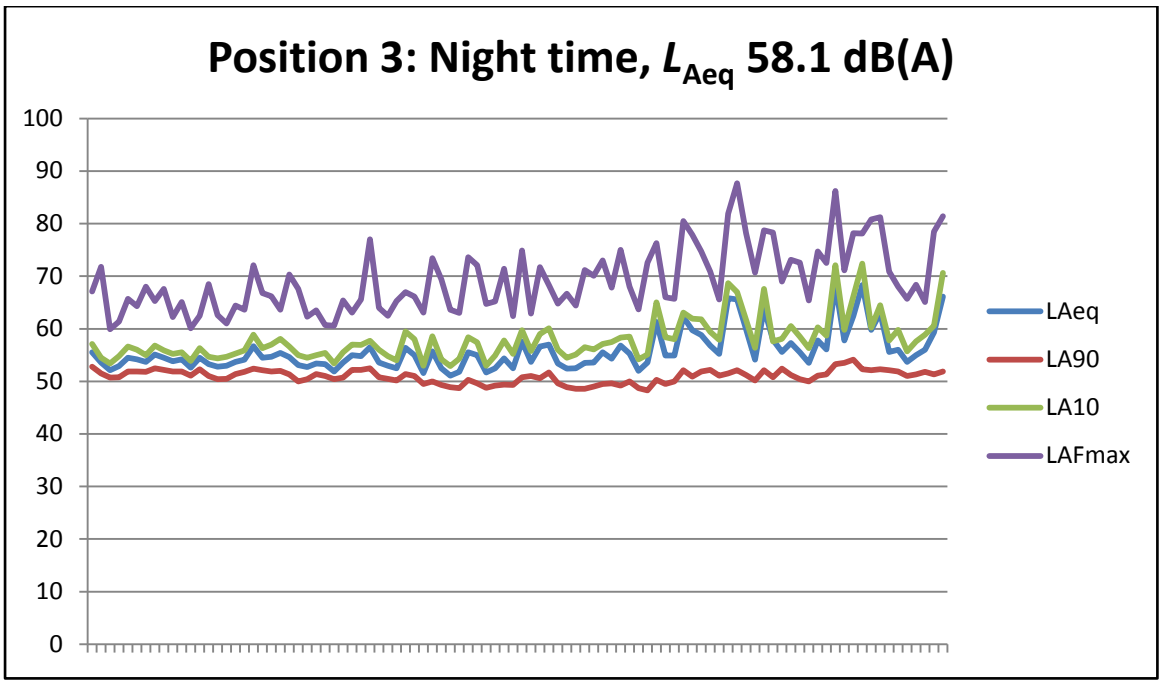



Position 2: Night time L_{Aeq} 54.9 dB(A)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
61.5
59.6
52.9
52.9
51.6
50.9
46.4
42.2
37.6
31.5
63
125
250
500
1K
2K
4K
8K
Octaves

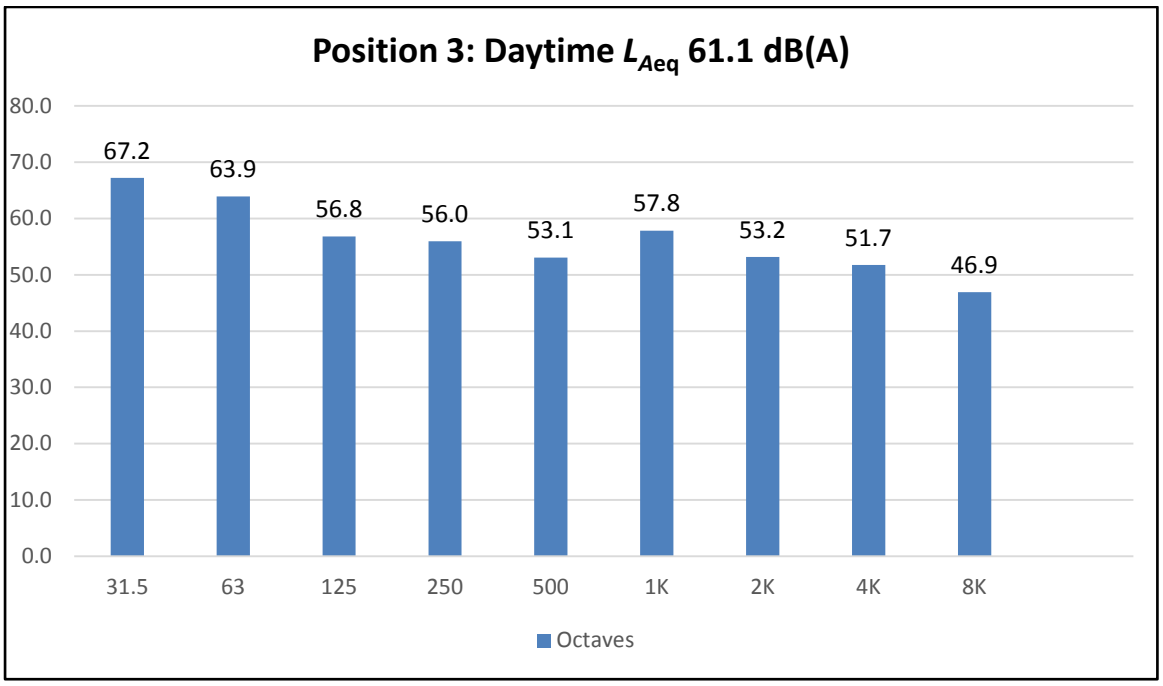

Position 2: Night time L_{AFmax} 78.9 dB(A)
82.0
80.0
78.0
76.0
74.0
72.0
70.0
68.0
66.0
64.0
62.0
80.6
76.6
72.7
75.9
76.0
74.6
70.0
69.1
70.0
31.5
63
125
250
500
1K
2K
4K
8K
Octaves

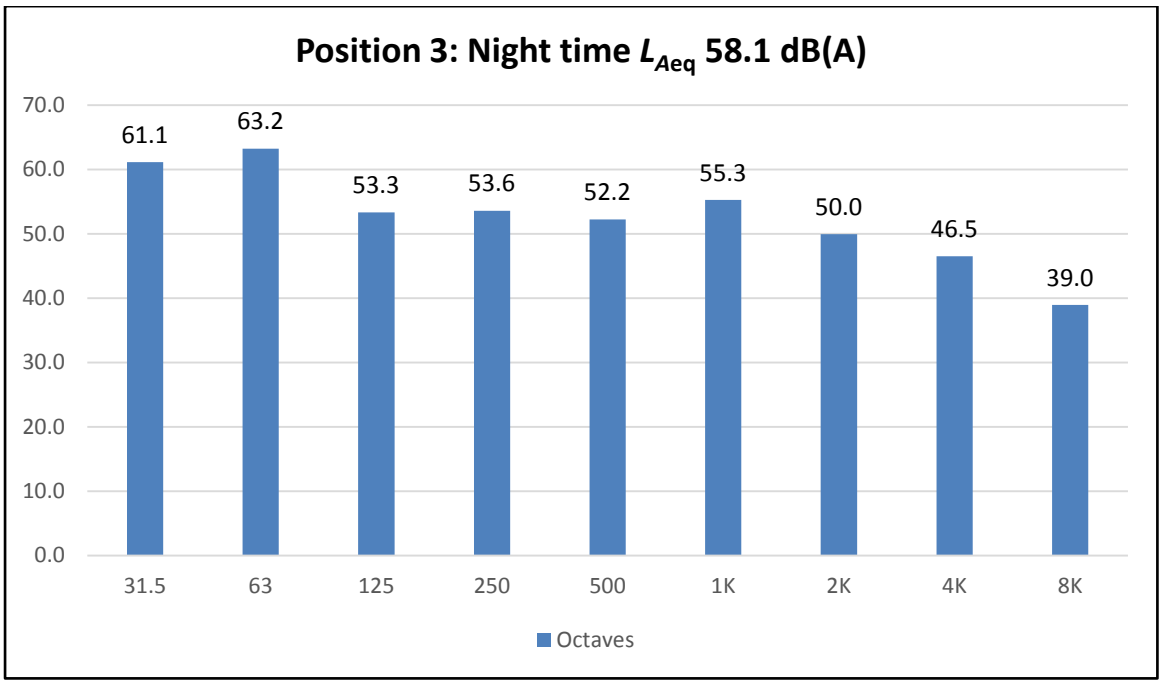
Position 3

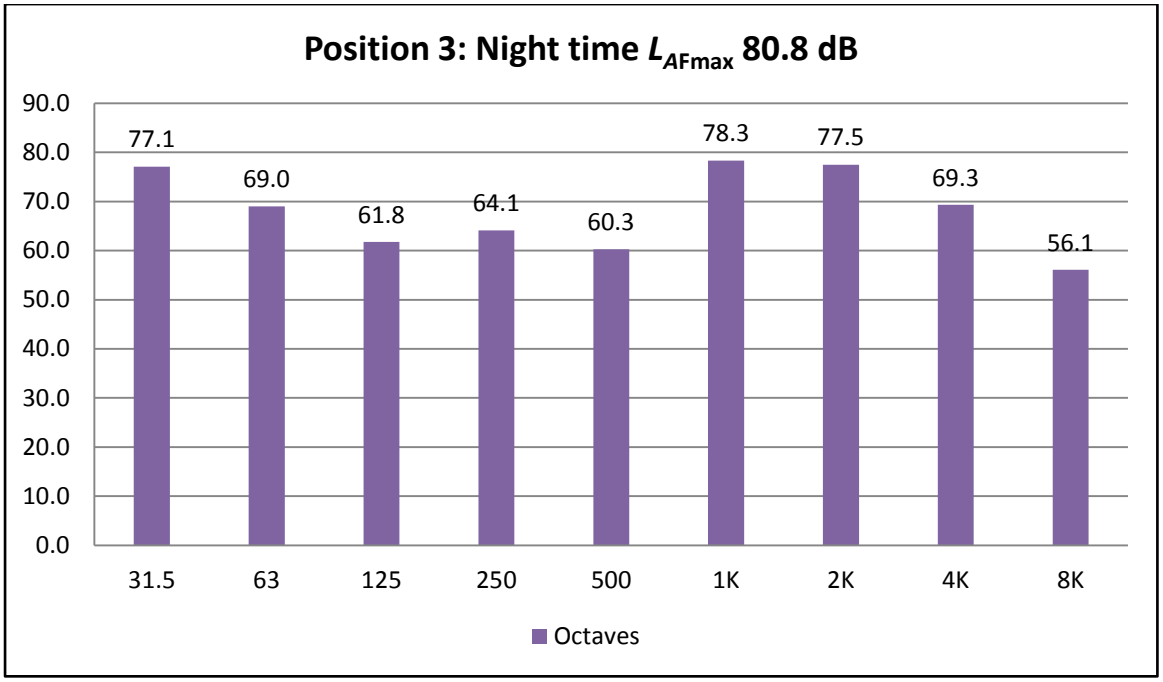

Position 3: Daytime, L_{Aeq} 61.1 dB(A)
80
70
60
50
40
30
20
10
0
LAeq
LA90
LA10


Position 3: Night time, L_{Aeq} 58.1 dB(A)
100
90
80
70
60
50
40
30
20
10
0
LAeq
LA90
LA10
LAFmax

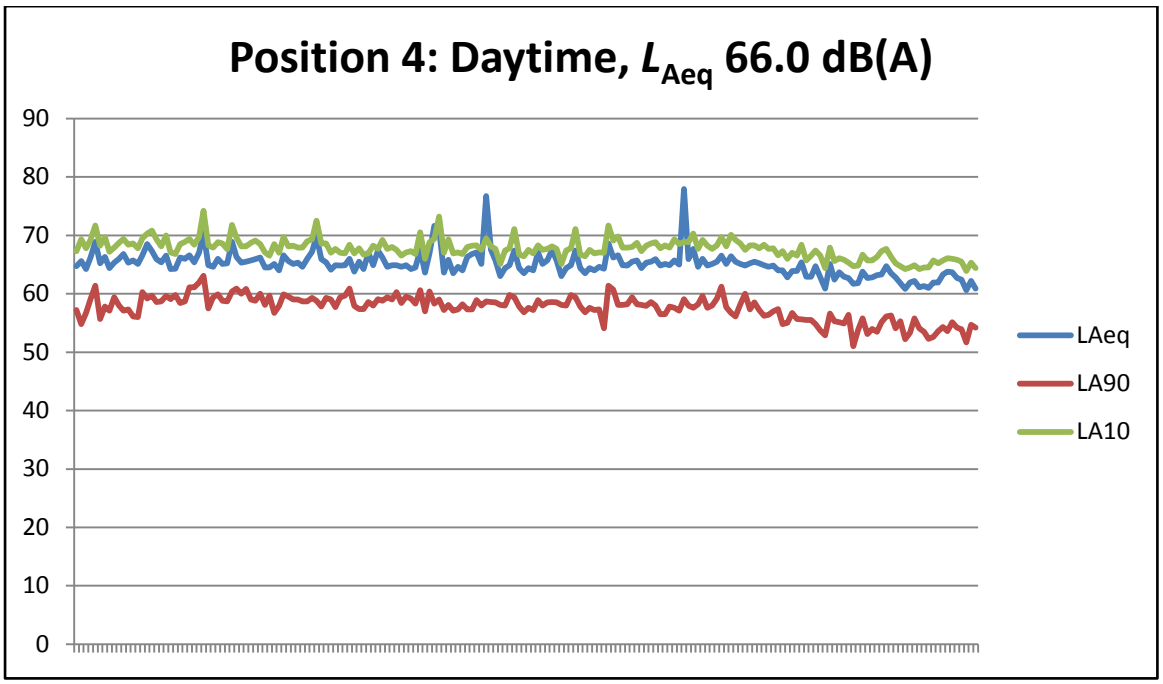
Un- weighted 1:1 Octave Results

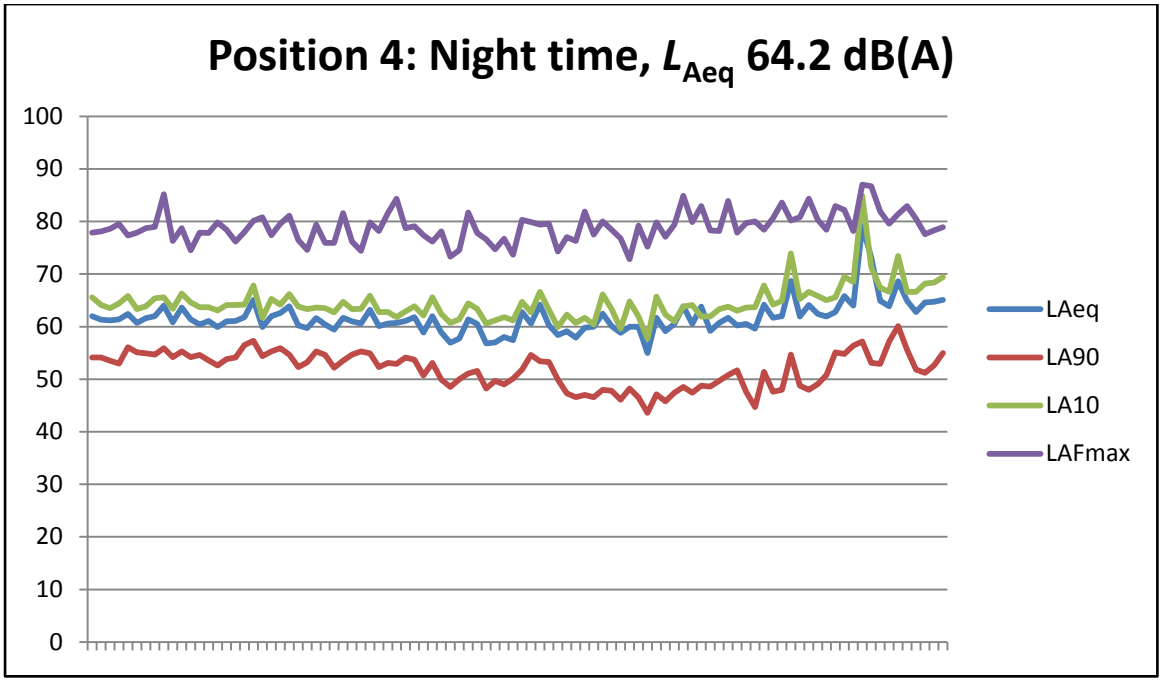




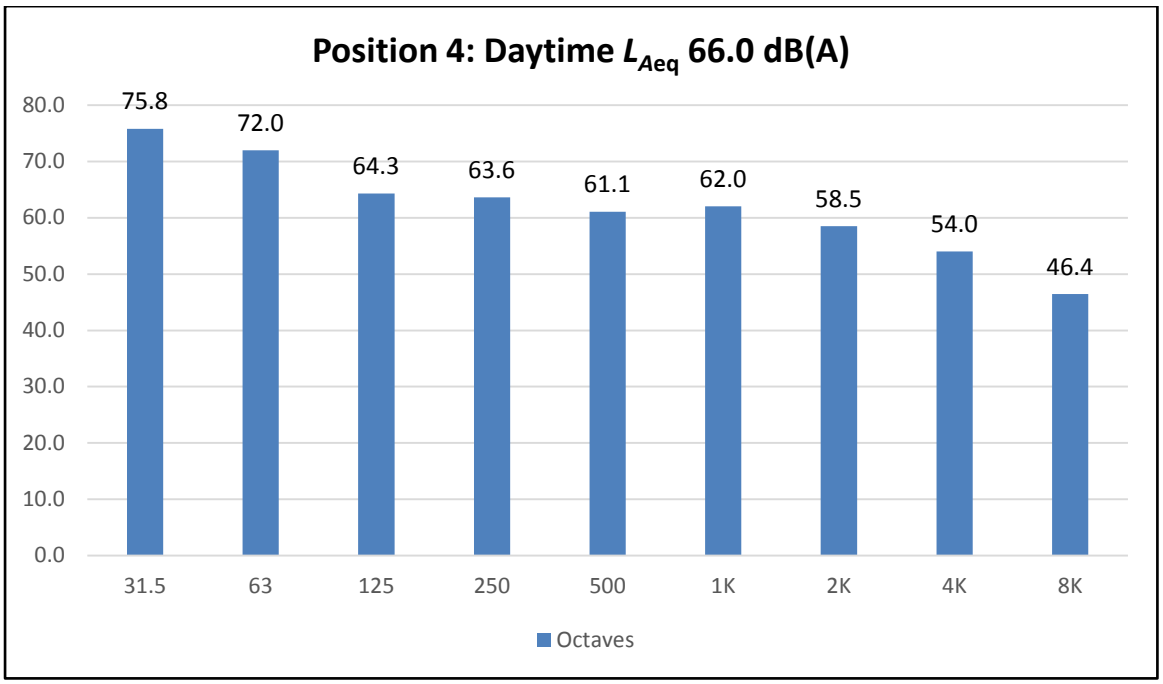

Position 3: Night time L_{AFmax} 80.8 dB
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
77.1
69.0
61.8
64.1
60.3
78.3
77.5
69.3
56.1
31.5
63
125
250
500
1K
2K
4K
8K
Octaves

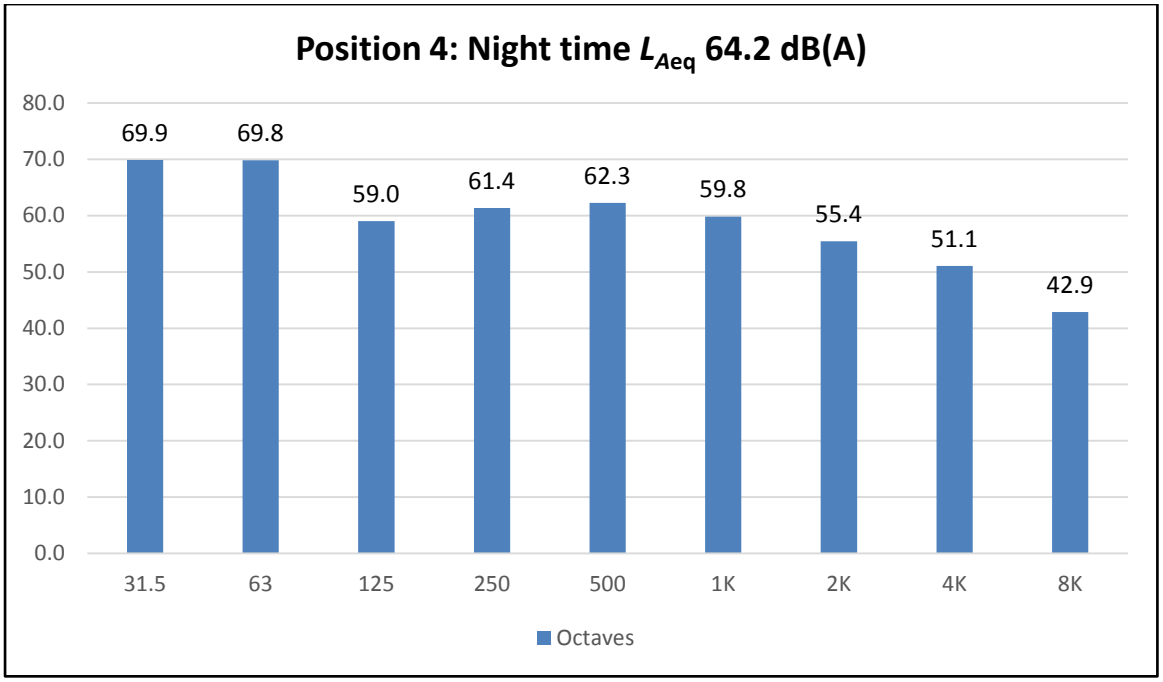
Position 4

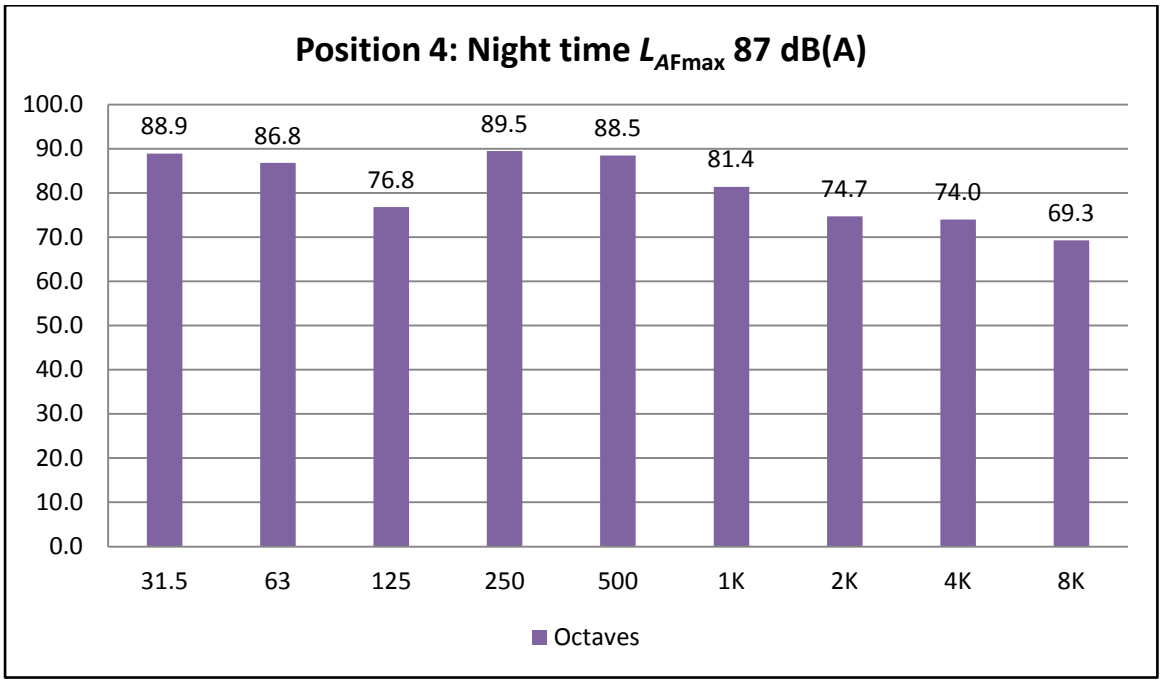

Position 4: Daytime, L_{Aeq} 66.0 dB(A)
90
80
70
60
50
40
30
20
10
0
LAeq
LA90
LA10



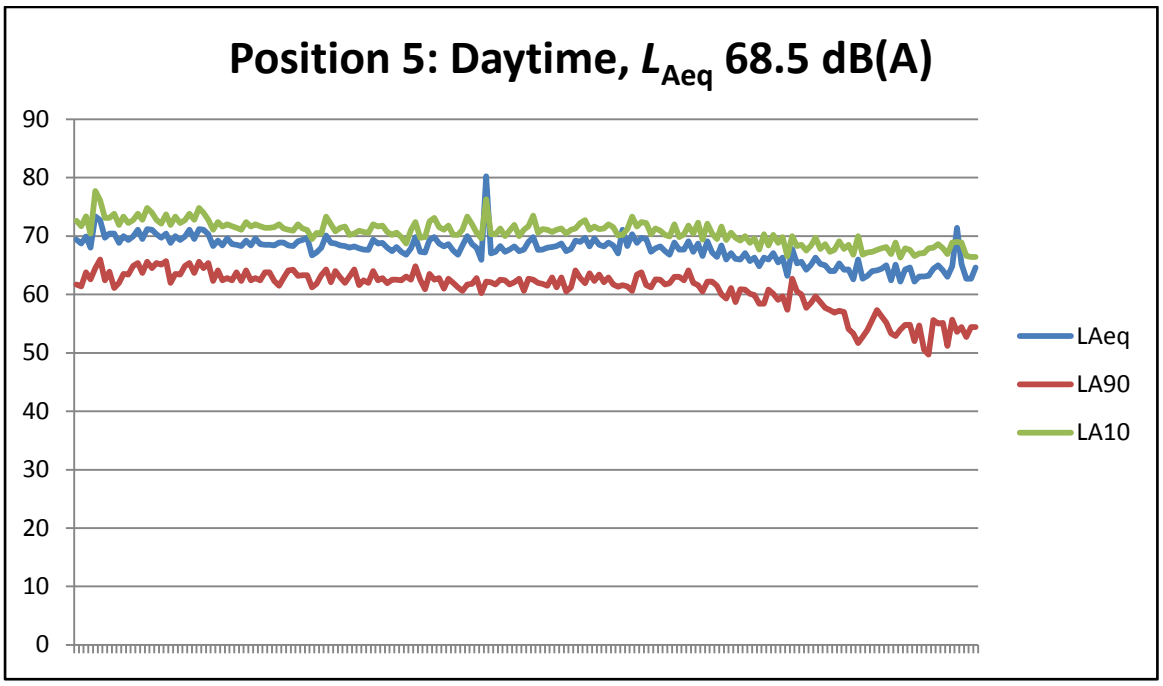
Un- weighted 1:1 Octave Results

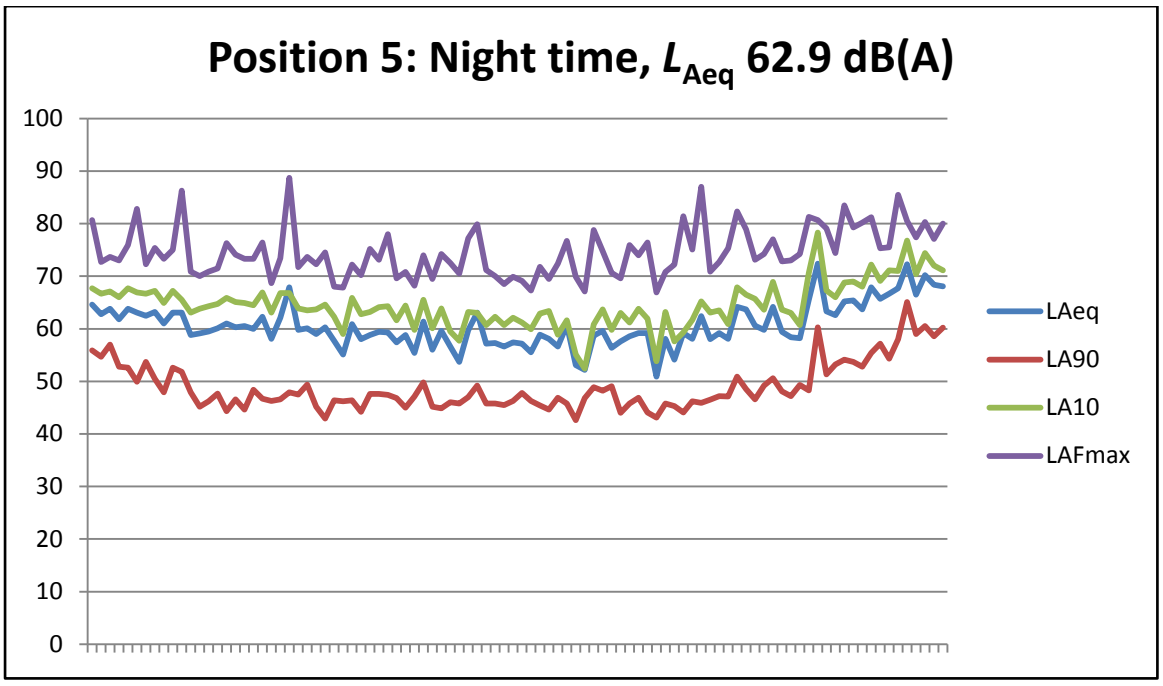



Position 4: Night time L_{Aeq} 64.2 dB(A)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
69.9
69.8
59.0
61.4
62.3
59.8
55.4
51.1
42.9
31.5
63
125
250
500
1K
2K
4K
8K
Octaves


Position 4: Night time L_{AFmax} 87 dB(A)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
88.9
86.8
76.8
89.5
88.5
81.4
74.7
74.0
69.3
31.5
63
125
250
500
1K
2K
4K
8K
Octaves

Position 5





More detailed measured data is available on request.

INSUL Model of Acoustic Properties of 200mm Brick Wall

Sound Insulation Prediction (v7.0.6)

Program copyright Marshall Day Acoustics 2012

- Key No. 2522

Margin of error is generally within Rw +/- 3 dB

Job Name:

Job No.: Page No.: Notes:

Date: 6 Aug 14 Initials:martinhamer

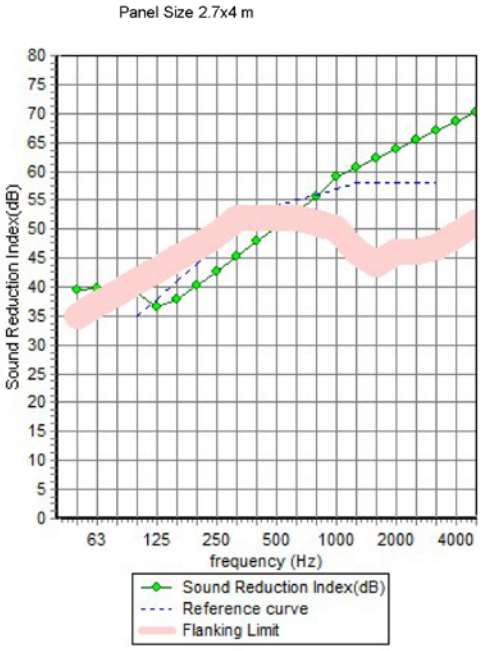
File Name: insul.ixl

Rw 54 dB
C -1 dB
C_{tr} -5 dB

System description

Panel 1 Outer layer: 1 x 200.0 mm Brick- (m=320.0 kg/m2, fc=137 Hz, Damping=0.00) Profile

frequency (Hz)	TL(dB)	TL(dB)
50	39	
63	40	39
80	38	
100	39	
125	37	38
160	38	
200	40	
250	43	42
315	45	
400	48	
500	50	50
630	53	
800	56	
1000	59	58
1250	61	
1600	62	
2000	64	64
2500	65	
3150	67	
4000	69	68
5000	70	



INSUL Model of Pilkington Optiphon 9.1/16/10 with 100mm Air Gap and 10mm Secondary Glaze

Sound Insulation Prediction (v7.0.13)

Program copyright Marshall Day Acoustics 2012

- Key No. 2516

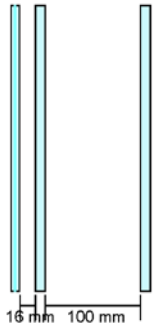
Margin of error is generally within Rw +/- 3 dB

Job Name:

Job No.: Page No.: Notes:

Date: 14 Sep 15 Initials:Ben

File Name: insul 2nd glaze.ixl



Rw	51 dB
C	-1 dB
C_{tr}	-3 dB

System description

First pane: 1 x 9.1 mm Laminated Glass (Pilkington Optiphon) [(4.0 mm +1.14 mm Pilkington Optiphon™ +4.0 mm); m=20.7 kg/m2, fc=1849 Hz, Dampi

Second pane: 1 x 10.0 mm Glass [(); m=24.3 kg/m2, fc=1399 Hz, Damping=0.02]

Third pane: 1 x 10.0 mm Glass [(); m=24.3 kg/m2, fc=1399 Hz, Damping=0.02]

frequency (Hz)	R(dB)	R(dB)
50	28	
63	31	30
80	34	
100	37	
125	39	39
160	41	
200	43	
250	45	44
315	46	
400	48	
500	49	49
630	50	
800	50	
1000	51	50
1250	49	
1600	49	
2000	52	52
2500	55	
3150	58	
4000	61	60
5000	64	

Panel Size 2.7x4 m