

Acoustic Consultancy Report

04196/3/3/8

Acoustic Report

Report Prepared For

Warrant Investments Plc
64/65 St Mary's Butts
26 July 2023

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i) Executive Summary

A residential redevelopment has reached completion at 64 – 65 St Marys Butts, in Reading.

An internal noise validation survey has been undertaken to determine whether the noise levels within the new development meet the guidance given by BS8233:2014 and the Local Authority.

The measured results are shown in section 6 and discussed in section 7 of this report.

ii) Document History

Issue	Date	Issue Details	Issued By	Checked By
1	25 th April 2023	Initial Issue	RM	VB
2	13 th July 2023	Revised Issue	RM	MB
3	14 th July 2023	Additional measurement data added	RM	-
4	25 th July 2023	Revised Issue	RM	MB
5	26 th July 2023	Minor amendments	RM	MB

1 Introduction

A residential redevelopment has reached completion at 64 – 65 St Marys Butts, in Reading.

An internal noise validation survey has been undertaken to determine whether the noise levels within the new development meet the guidance given by BS8233:2014 and the Local Authority.

2 Noise Monitoring

2.1 Site description

The site layout together with the measurement position is shown in the drawings contained within Appendix A.

2.2 Measurements

Internal ambient noise measurements were carried out in Flat 1 living room, Flat 2 bedroom 1 and Flat 3 bedroom 1. The noise monitoring in Flats 1 and 2 were carried out from the 13th to the 17th of April 2023 and noise monitoring in Flat 3 took place from the 21st to the 24th of April 2023.

Further internal ambient noise measurements were carried out from the 6th to the 10th July 2023 in the bedrooms of flats 2 and 3. Windows were left open over the measurement period in both bedrooms as the rooms are to be naturally ventilated.

An audio recorder was also left in the bedroom of flat 3 between the 6th to the 10th July 2023. This was in order to determine what the dominate noise source was during the night time period. The dominate noise source was plant noise from neighbouring properties. Low levels of pedestrian noise and music could also be heard however, this would be expected within the bedrooms while the windows are open at night due to the location of the flats and local soundscape.

Warrant Investments Plc has confirmed that the existing plant serving the restaurant below operates between the hours of 12:00 – 23:00 and the plant serving the adjacent Coconut bar operates between the hours of 11:00 - 22:45. Therefore the plant noise heard during the night time periods was from existing plant operating for other properties in the area.

The measurement periods were considered to sufficient to establish the ambient noise levels within habitable spaces over a typical weekday and weekend while the restaurant below and adjacent coconut bar where in normal operation.

The weather conditions monitored during the survey are shown in the following table.

Table 1: Weather Conditions between 13/04/2023 – 17/04/2023

Weather	13/04/2023	14/04/2023	15/04/2023	16/04/2023	17/04/2023
Average Wind Speed	3.5m/s	2.6m/s	4m/s	4m/s	2.2m/s
Wind Direction	East	West	South	North-east	South-west
Cloud Cover	60%	100%	60%	100%	60%
Max. Temperature	12°C	11°C	14°C	13°C	16°C
Min. Temperature	4°C	3°C	4°C	5°C	6°C
Precipitation	None	None	None	None	None

Table 2: Weather Conditions between 21/04/2023 – 24/04/2023

Weather	21/04/2023	22/04/2023	23/04/2023
Average Wind Speed	4m/s	2.6m/s	4m/s
Wind Direction	South-west	South	North-west
Cloud Cover	60%	40%	40%
Max. Temperature	9°C	11°C	12°C
Min. Temperature	6°C	1°C	3°C
Precipitation	None	None	None

Table 3: Weather Conditions between 06/07/2023 – 10/07/2023

Weather	06/07/2023	07/07/2023	08/07/2023	09/07/2023	10/07/2023
Average Wind Speed	5m/s	4.4m/s	3m/s	2.4m/s	2.4m/s
Wind Direction	North	North	North	North	North
Cloud Cover	20%	10%	60%	80%	80%
Max. Temperature	22°C	28°C	16°C	23°C	22°C
Min. Temperature	19°C	11°C	16°C	13°C	12°C
Precipitation	None	None	None	None	None

3 Indoor Ambient Design Criteria with Windows Closed

3.1 BS8233:2014

Guidance is provided in BS8233:2014, this is shown in the following table:

Table 4: BS8233 Indoor ambient noise levels for dwellings, dB L_{Aeq,T}

Activity	Location	Time period	
		07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 L _{Aeq,16 hour}	-
Dining	Dining Room/area	40 L _{Aeq, 16 hour}	-
Sleeping (daytime resting)	Bedroom	35 L _{Aeq, 16 hour}	30 L _{Aeq, 8 hour}

The levels provided in the above table assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern an appropriate alternative period may be used.

The measured levels are considered to follow normal diurnal fluctuations.

If relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.

BS8233:2014 also states that where 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.

The measured façade noise levels are above WHO guidelines, therefore internal noise levels will still be considered reasonable up to 5 dB above the criteria shown in table 3.

3.2 World Health Organisation (WHO) Guidelines for Community Noise (1999)

The WHO's 'Guidelines for Community Noise' gives the following relevant noise criteria:

Table 5: Guideline values for community noise, from Guidelines for Community Noise (WHO, 1999)

Specific Environment	L _{Aeq, T} dB	Time Base (hours)	L _{Amax, fast} dB
Outdoor living area (serious annoyance, daytime and evening)	55	16	-
Outdoor living area (moderate annoyance, daytime and evening)	50	16	-
Dwelling, indoors	35	16	-
Inside bedrooms	30	8	45
Outside bedrooms	45	8	60

A secondary criterion of 45dB L_{Amax} is also considered in relation noise. WHO only considers it appropriate to provide a criterion for the internal L_{Amax} level during the night-time period as it is a useful parameter to assess sleep disturbance. It is recommended that internal noise levels should not exceed 45dB L_{Amax} during the night and the document states that:

'For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{Amax} more than 10 – 15 times per night'

4 Indoor Ambient Design Criteria with Windows Open

4.1 World Health Organisation (WHO) Guidelines for Community Noise (1999)

The WHO's 'Guidelines for Community Noise' gives the following relevant noise criteria:

Table 6: Guideline values for community noise, from Guidelines for Community Noise (WHO, 1999)

Specific Environment	L _{Aeq, T} dB	Time Base (hours)	L _{Amax, fast} dB
Outdoor living area (serious annoyance, daytime and evening)	55	16	-
Outdoor living area (moderate annoyance, daytime and evening)	50	16	-

Dwelling, indoors	35	16	-
Inside bedrooms	30	8	45
Outside bedrooms	45	8	60
Outdoors in parkland and conservation areas*	-	-	-

* Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low

The WHO's 'Guidelines for Community Noise' also gives the following general guidance on the expected sound insulation performance of a façade with a partly open window, it states that:

"At night, sound pressure levels at the outside facades of the living spaces should not exceed 45 dB L_{Aeq} and 60 dB L_{Amax} , so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15 dB."

4.2 BS8233:2014

The criteria offered in BS8233 for residential buildings are largely based on the recommendations made in the Guidelines for Community Noise.

Using the general guidance from above, on the expected sound insulation performance of a façade with a partly open window, the criteria shown in the table below have been adapted from the criteria offered in table 4 of BS8233 in order to obtain acceptable external noise levels.

The noise levels shown should be treated as overall noise levels, i.e., the combination of all existing noise levels at the site, and noise levels from any proposed plant or activity.

Table 7: External ambient noise levels for dwellings, based on BS8233, dB re 2×10^{-5} Pa

Activity	Location	Time period	
		07:00 to 23:00	23:00 to 07:00
Resting	Living Room	50 $L_{Aeq, 16 \text{ hour}}$	-
Dining	Dining Room/area	55 $L_{Aeq, 16 \text{ hour}}$	-
Sleeping (daytime resting)	Bedroom	50 $L_{Aeq, 16 \text{ hour}}$	45 $L_{Aeq, 8 \text{ hour}}$

In addition to the above criteria, BS8233 goes on to say:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 $L_{Aeq, T}$, with an upper guideline value of 55 dB $L_{Aeq, T}$ which would be acceptable in noisier environments."

The above criteria are in line with the recommendations made in WHO's 'Guidelines for Community Noise'.

5 Design Criteria for external plant

5.1 BS4142:2014

BS4142:2014 states that the significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs.

Table 8: BS4142 assessment based upon rating level

Difference between background noise and rating levels	Assessment
+ 10 dB	Indication of a significant adverse impact
+ 5 dB	Indication of an adverse impact
0 dB	Indication of low impact

Certain acoustic features can increase the significance of impact. The specific sound level should be corrected if a tone, impulse or other acoustic feature is expected to be present.

Table 9: Corrections for acoustic features, subjective method

Acoustic Feature	Correction, dB		
	Just Perceptible	Clearly Perceptible	Highly Perceptible
Tonality	2	4	6
Impulsivity	3	6	9
Other Characteristics	3		
Intermittency	3		

Typically the acoustic feature correction would not be expected to exceed 10dB. Where the level of uncertainty could affect the conclusion, take reasonably practicable steps to reduce the level of uncertainty.

6 Internal Ambient Noise Survey Results

6.1 Internal Ambient Noise Levels While Windows Are Closed

The glazing installed on both facades of the property is composed of 6.4mm Laminated, 18mm warm edge spacer, 4mm annealed planitherm from HomeGaurd Windows. The noise reduction performance for the installed glazing is R_w35dB .

All rooms were unfurnished, and carpets were yet to be installed at the time of the noise surveys. This would give the rooms higher reverberation times than what would be expected once the rooms are occupied. Reverberation time measurements were carried out in the three measurement locations and the ambient noise data recorded has been corrected to a reverberation time 0.5 seconds, which is expected for rooms for residential purpose. As a result, the measured ambient levels provided in Table 5 have been corrected by 2-3dB.

Works were being carried out during the day on the 13th from 17:00 to 20:30 and on the 14th from 09:30 to 18:45. The measured noise data during this time has been omitted from the results.

The measurement periods were considered sufficient to establish the ambient noise levels within habitable spaces over a typical weekday and weekend while the restaurant below and adjacent coconut bar were in normal operation.

The corrected ambient noise levels and measured night-time L_{AFmax} along with the noise criteria for comparison are shown in the table below. The statistical broad-band sound pressure levels are shown within Appendix B.

Warrant Investments Plc has confirmed that the existing plant serving the restaurant below operates between the hours of 12:00 – 23:00 and the plant serving the adjacent Coconut bar operates between the hours of 11:00 - 22:45. Due to the acoustic characteristics of the existing mechanical plant a 4dB feature correction for tonality has been applied to the noise levels measured during the daytime period within bedrooms only.

BS8233:2014 states that where 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.

Due to the location of the proposed development, the development is considered desirable and has therefore received a 5dB relaxation for the internal noise criteria as per the guidance given in BS8233 and WHO guidelines. This is shown in the table below.

Table 10: Internal noise levels, dB re 2×10^{-5} Pa

Location	Date	Time period	Criteria dB	Result dB
MP1 - Flat 2 Bedroom 1	13/04/2023 – 14/04/2023	20:30 - 23:00	40 $L_{Aeq,16hr}$	29 + 4 = 33
		23:00 – 07:00	35 $L_{Aeq,8hr}$	28
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	37
MP1 - Flat 2 Bedroom 1	14/04/2023 – 15/04/2023	07:00 - 09:30 and 18:45 – 23:00	40 $L_{Aeq,16hr}$	30 + 4 = 34
		23:00 – 07:00	35 $L_{Aeq,8hr}$	28
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	39
MP1 - Flat 2 Bedroom 1	15/04/2023 – 16/04/2023	07:00 - 23:00	40 $L_{Aeq,16hr}$	30 + 4 = 34
		23:00 – 07:00	35 $L_{Aeq,8hr}$	28
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	36
MP1 - Flat 2 Bedroom 1	16/01/2023 – 17/01/2023	07:00 - 23:00	40 $L_{Aeq,16hr}$	29 + 4 = 33
		23:00 – 07:00	35 $L_{Aeq,8hr}$	28
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	34
MP2 - Flat 1 Living room	13/04/2023	20:30 - 23:00	40 $L_{Aeq,16hr}$	29
MP2 - Flat 1 Living room	14/04/2023	07:00 - 09:30 and 18:45 – 23:00	40 $L_{Aeq,16hr}$	30
MP2 - Flat 1 Living room	15/04/2023	07:00 - 23:00	40 $L_{Aeq,16hr}$	31
MP2 - Flat 1 Living room	16/04/2023	07:00 - 23:00	40 $L_{Aeq,16hr}$	29
MP3 - Flat 3 Bedroom 1	21/04/2023 – 24/04/2023	11:30 – 23:00	40 $L_{Aeq,12hr}$	36 + 4 = 40
		23:00 – 07:00	35 $L_{Aeq,8hr}$	30

Location	Date	Time period	Criteria dB	Result dB
		23:00 – 07:00	50 L _{AF} Max, 8hr	41
MP3 - Flat 3 Bedroom 1	22/04/2023 – 23/04/2023	07:00 - 23:00	40 L _{Aeq} ,16hr	35 + 4 = 39
		23:00 – 07:00	35 L _{Aeq} ,8hr	26
		23:00 – 07:00	50 L _{AF} Max, 8hr	45
MP3 - Flat 3 Bedroom 1	23/04/2023 - 24/04/2023	07:00 - 23:00	40 L _{Aeq} ,16hr	32 + 4 = 36
		23:00 – 07:00	35 L _{Aeq} ,8hr	22
		23:00 – 07:00	50 L _{AF} Max, 8hr	35

6.2 Internal Ambient Noise Windows Open

The measured internal ambient noise levels in both bedrooms while windows were open are shown in the table below along with the noise criteria for comparison.

Both bedrooms were fully furnished when the measurements were carried out.

The measurement periods were considered sufficient to establish the ambient noise levels within habitable spaces over a typical weekday and weekend while the restaurant below at 64 St Mary's Butts (T/A Biryani Mama) and adjacent Restaurant, 62/63 St Mary's Butts (T/A Coconut) were in normal operation and trading.

A 5dB increase in noise criteria while windows are opened has been agreed with the Local Authority. This increase has been applied to the criteria shown in the table below.

Table 11: Internal noise levels windows open, dB re 2x10⁻⁵ Pa

Location	Date	Time period	Criteria dB	Result dB
MP1 - Flat 2 Bedroom 1	06/07/2023 – 07/07/2023	16:00 - 23:00	40 L _{Aeq} ,16hr	44
		23:00 – 07:00	35 L _{Aeq} ,8hr	35
		23:00 – 07:00	50 L _{AF} Max, 8hr	44
MP1 - Flat 2 Bedroom 1	07/07/2023 – 08/07/2023	07:00 - 09:30 and 18:45 – 23:00	40 L _{Aeq} ,16hr	41
		23:00 – 07:00	35 L _{Aeq} ,8hr	35
		23:00 – 07:00	50 L _{AF} Max, 8hr	44
MP1 - Flat 2 Bedroom 1	08/07/2023 – 09/07/2023	07:00 - 23:00	40 L _{Aeq} ,16hr	45
		23:00 – 07:00	35 L _{Aeq} ,8hr	34
		23:00 – 07:00	50 L _{AF} Max, 8hr	42

Location	Date	Time period	Criteria dB	Result dB
MP3 - Flat 3 Bedroom 1	06/07/2023 – 07/07/2023	16:00 – 23:00	40 $L_{Aeq,16hr}$	43
		23:00 – 07:00	35 $L_{Aeq,8hr}$	39
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	44
MP3 - Flat 3 Bedroom 1	07/07/2023 – 08/07/2023	07:00 - 23:00	40 $L_{Aeq,16hr}$	44
		23:00 – 07:00	35 $L_{Aeq,8hr}$	40
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	45
MP3 - Flat 3 Bedroom 1	08/07/2023 - 09/07/2023	07:00 - 23:00	40 $L_{Aeq,16hr}$	50
		23:00 – 07:00	35 $L_{Aeq,8hr}$	38
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	43
MP3 - Flat 3 Bedroom 1	09/07/2023 - 10/07/2023	07:00 - 23:00	40 $L_{Aeq,16hr}$	42
		23:00 – 07:00	35 $L_{Aeq,8hr}$	36
		23:00 – 07:00	50 $L_{AFMax, 8hr}$	39

7 Notes and Comments

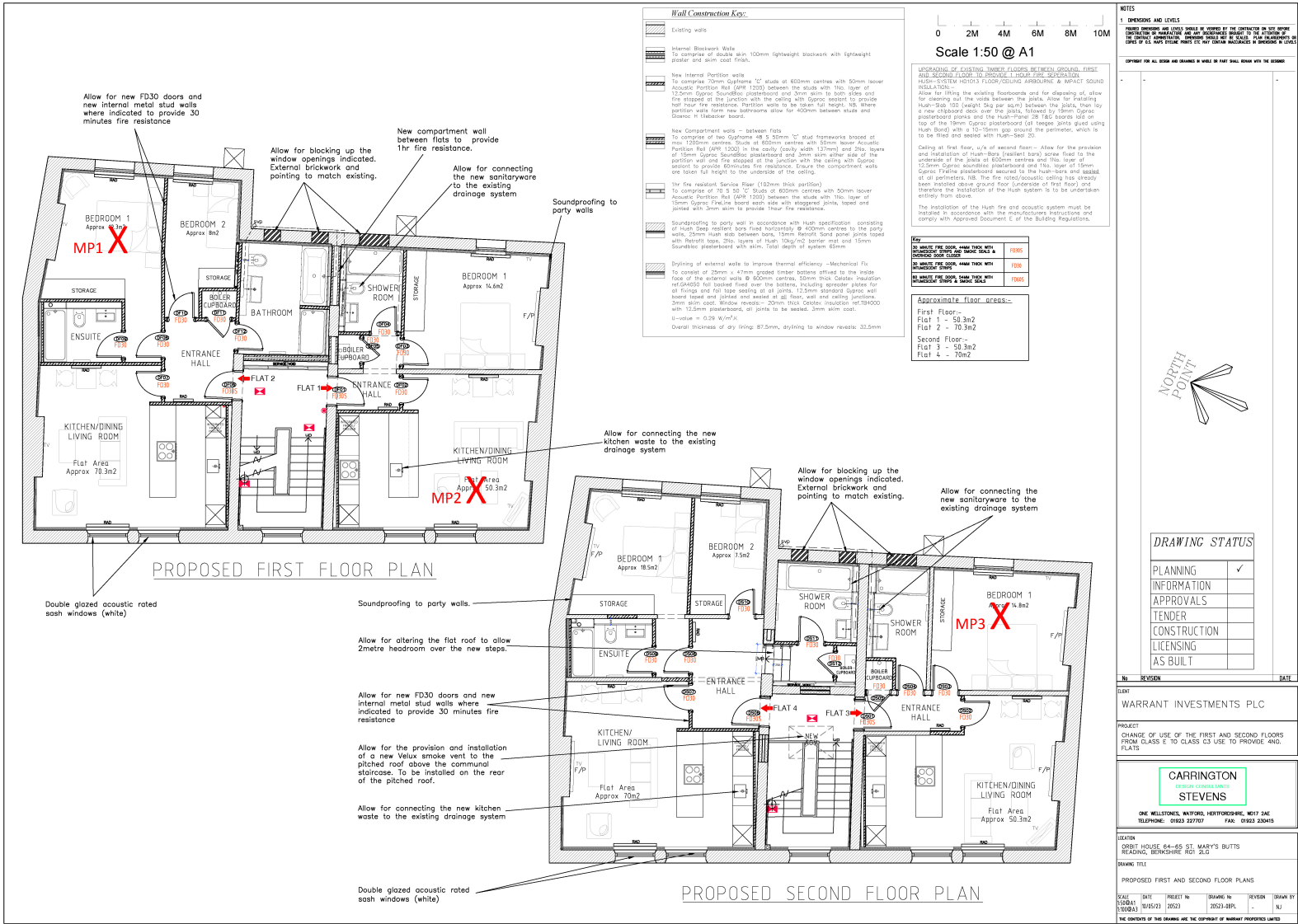
The internal ambient noise measurement results taken with windows open shows the following:

- The night-time design criteria has been met in the bedroom of flat 2.
- The results indicate that the L_{AFmax} meets the night-time noise criteria in the bedrooms of flat 2 and flat 3.
- The daytime results in both bedrooms of flat 2 and 3 meet the daytime noise criteria.
- The night-time results in the bedroom of flat 3 exceed the design criteria.

As the design criteria has been exceeded whilst the windows are open at night, the client has confirmed that the design will now incorporate internal mechanical services for ventilation instead of relying on openable windows. Bedroom windows will therefore no longer be used for ventilation as part of the design but will be openable if desired by the occupant.

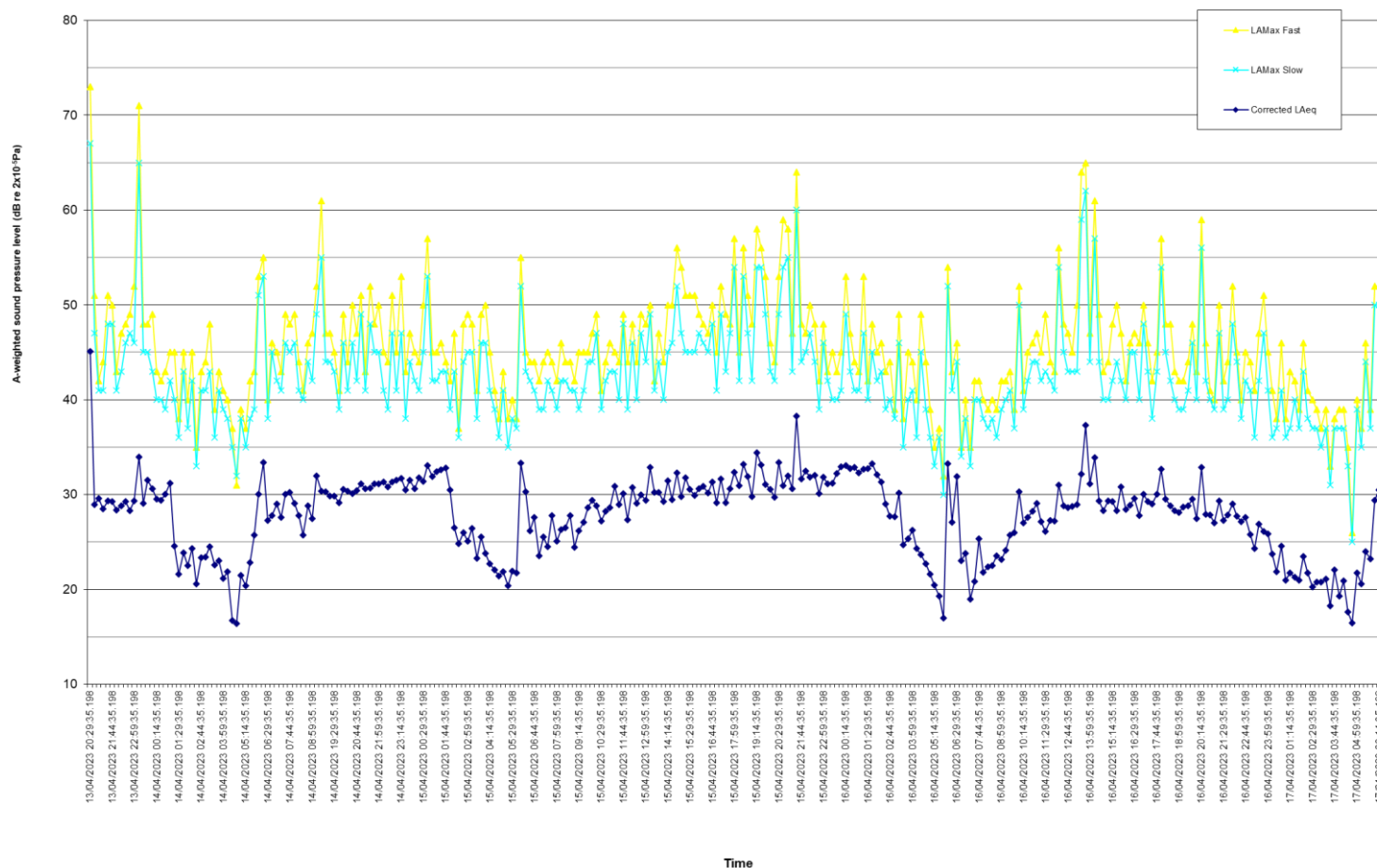
The noise measurement results with the windows closed show that the design criteria can be achieved with the installation of mechanical services in each of the bedrooms.

Appendix A: Site Plan



Appendix B: Measurement Data

MP1 Flat 2 Bedroom 1 Windows Closed:

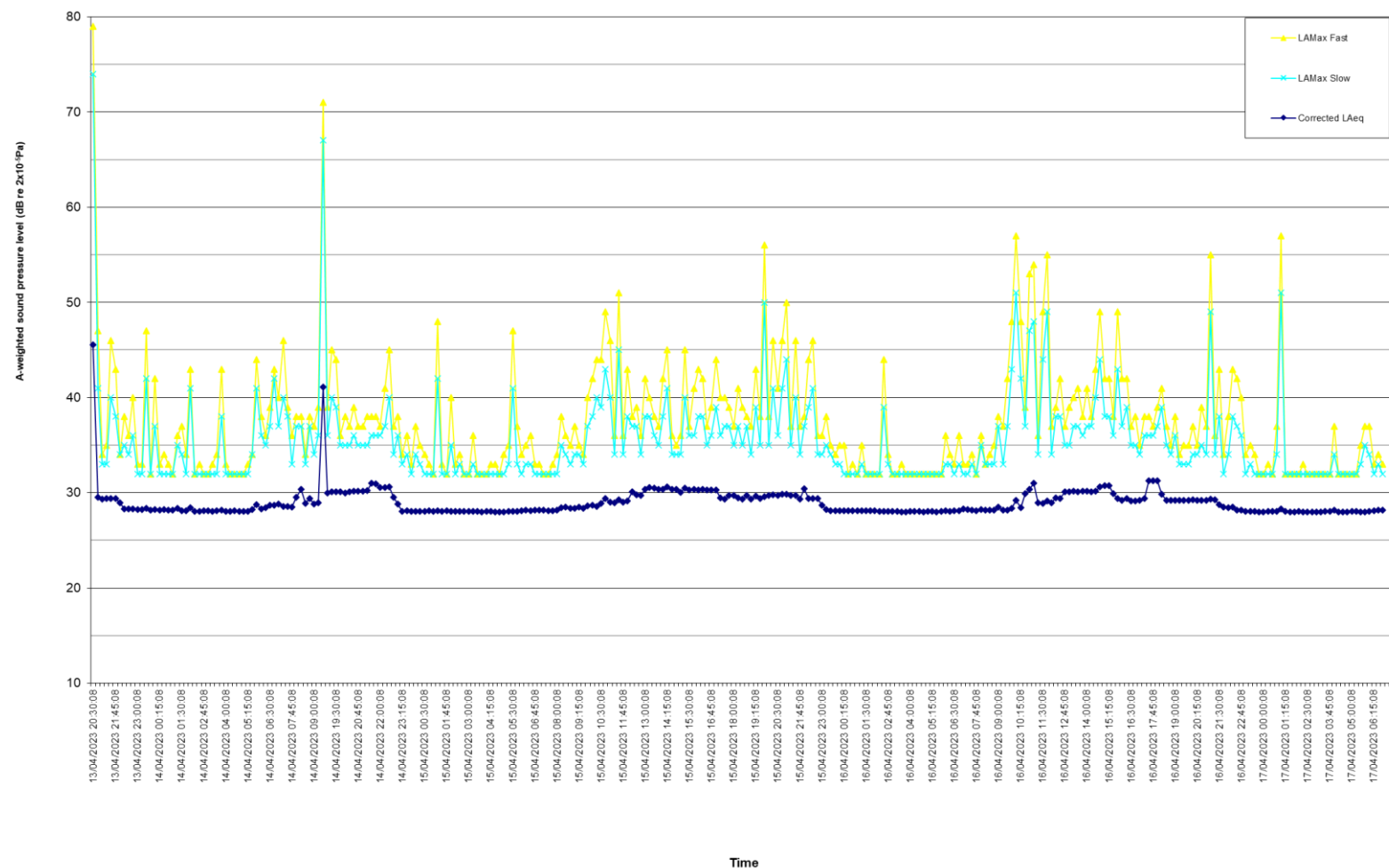


Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 959 Sound Level Meter S/N: 11207 (next cal due 11/05/23) Start gain 1.83 End gain 1.73.
- Svantek pre-amplifier SV12L S/N: 49860 with GRAS microphone capsule 40AE S/N: 215511

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 10890 (next cal due 18/01/24) complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

MP2 Flat 1 Living Room Windows Closed:

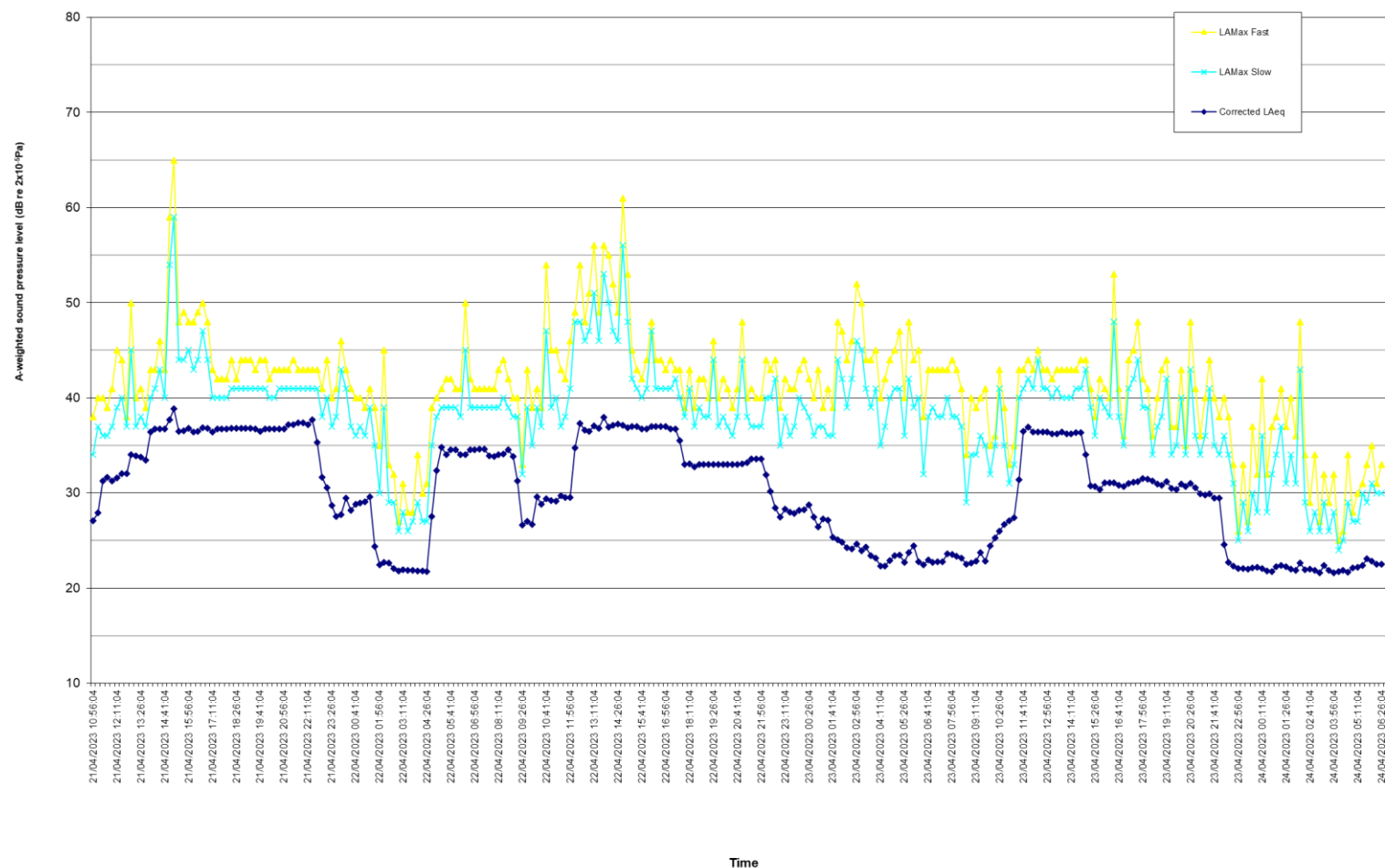


Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 959 Sound Level Meter S/N: 27152 (next cal due 05/07/24) Start gain -0.70 End gain -0.68.
- Svantek pre-amplifier SV12L S/N: 25151 with GRAS microphone capsule 40AE S/N: 158102

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 10890 (next cal due 18/01/24) complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

MP3 Flat 3 Bedroom Windows Closed:

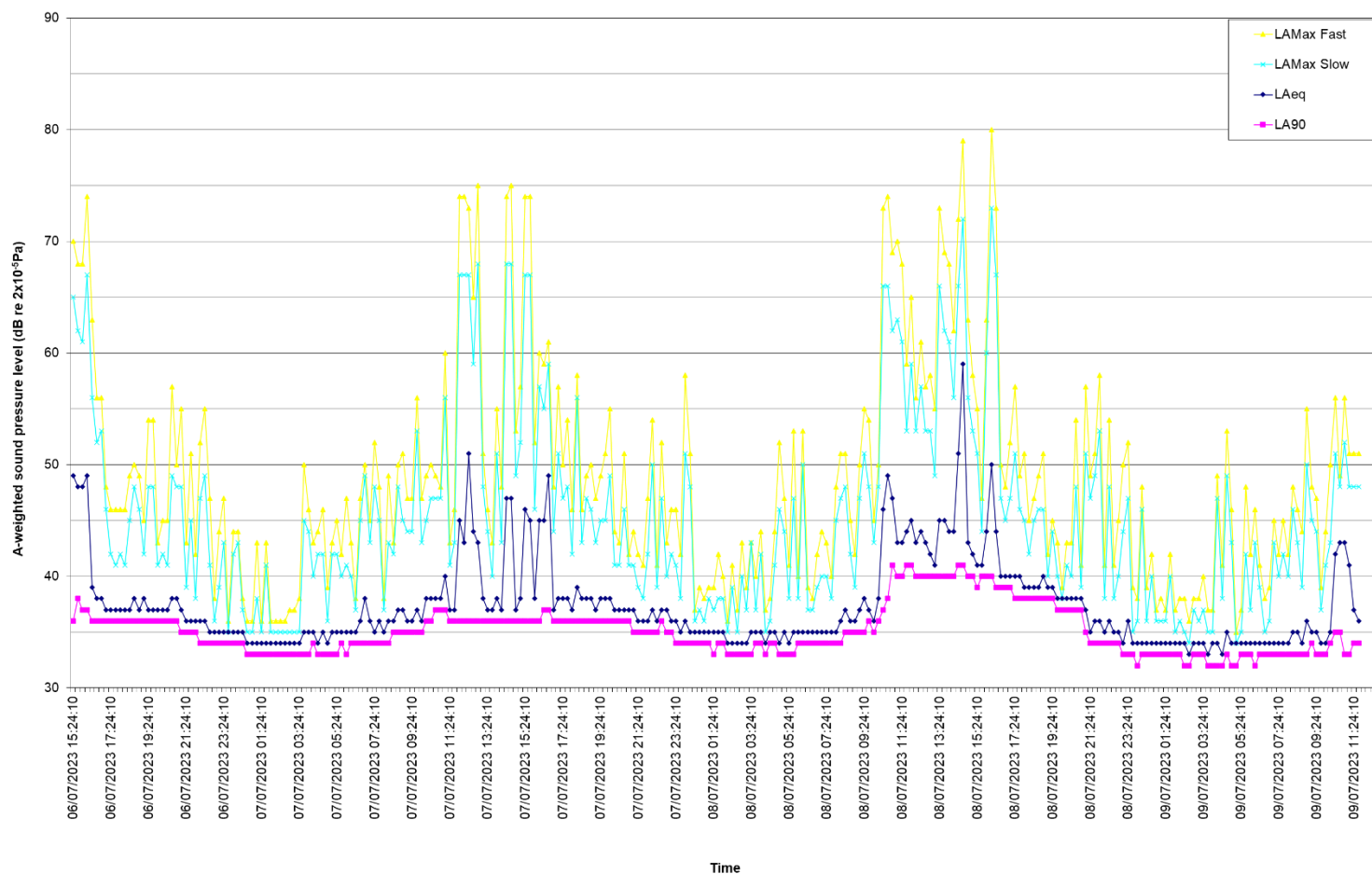


Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 959 Sound Level Meter S/N: 11207 (next cal due 11/05/23) Start gain 1.79 End gain 1.62.
- Svantek pre-amplifier SV12L S/N: 49860 with GRAS microphone capsule 40AE S/N: 215511

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 10893 (next cal due 21/08/23) complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

MP1 Flat 2 Bedroom 1 Windows Open:

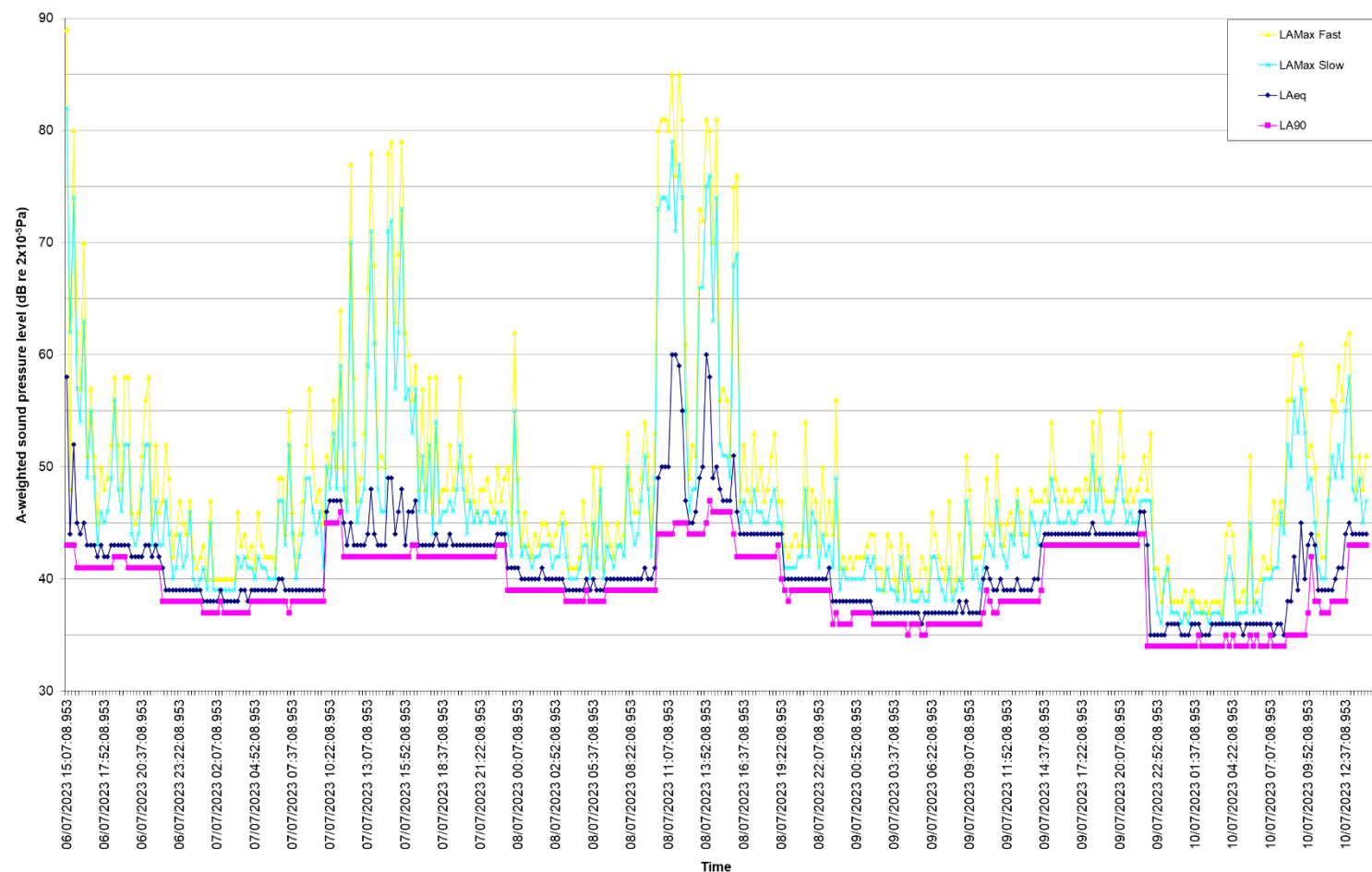


Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 959 Sound Level Meter S/N: 11258 (next cal due 24/02/24) Start gain 0.28 End gain 0.36.
- Svantek pre-amplifier SV12L S/N: 13111 with GRAS microphone capsule 40AE S/N: 241965

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 10890 (next cal due 18/01/24) complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

MP3 Flat 3 Bedroom Windows Open:



Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 979 Sound Level Meter S/N: 27152 (next cal due 05/07/24) Start gain 0.28 End gain 0.36.
- Svantek pre-amplifier SV12L S/N: 25151 with GRAS microphone capsule 40AE S/N: 158102.

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 10890 (next cal due 18/01/24) complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

Appendix C: Glossary

The list below details the major acoustical terms and descriptors, with brief definitions:

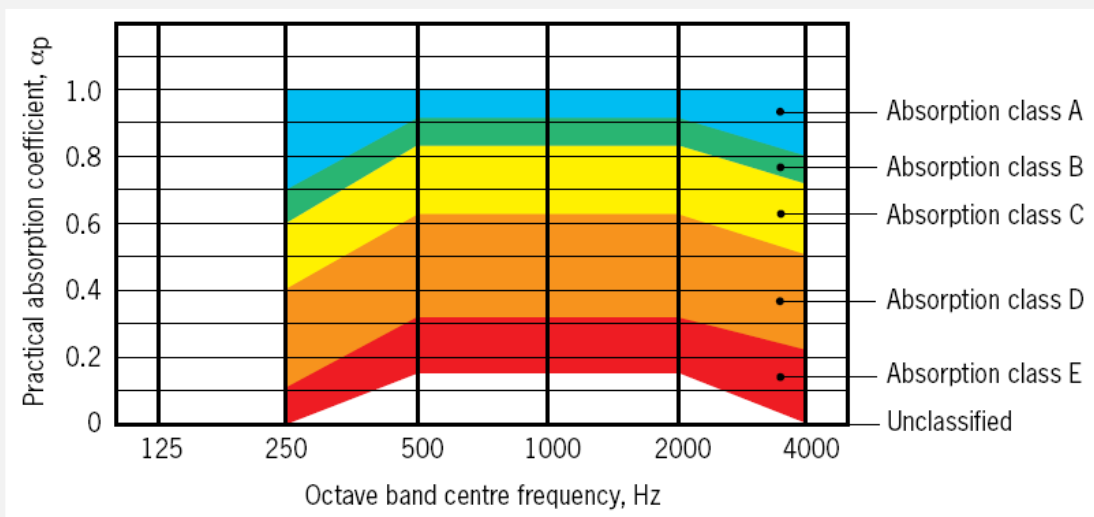
'A' Weighting

Weighting applied to the level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The letter 'A' will follow a descriptor, indicating the value has been 'A' weighted. An 'A' weighted noise level may also be written as dB(A).

Absorption Class

In order to categorise the absorptive effects of different elements (such as ceiling tiles), classes from A to E were derived, as per BS EN ISO 11654:1997. A class 'A' absorber would be very acoustically absorptive, a Class 'E' absorber would be less absorptive and more reflective. A product that is highly reflective may not be classified.

The chart shown below has been extracted from BB93, and demonstrates the characteristics of each class according to BS EN ISO 11654:1997.



Absorption Coefficient (α)

A value usually between 0 and 1 assigned to a material to indicate how acoustically absorptive it is. 0 indicates a material is entirely reflective (and therefore not absorptive), and 1 indicates a material is entirely absorptive (and therefore not reflective). Absorption coefficients are usually given for each octave band between 125Hz and 4kHz, or as an overall 'practical' coefficient.

Airborne Noise

Noise transmitted through air.

Ambient Noise

The total noise level including all 'normally experienced' noise sources.

dB or Decibel

Literally meaning 'a tenth of a bel', the bel being a unit devised by the Bell Laboratory and named after Alexander Graham Bell. A logarithmically based descriptor to compare a level to a reference level. Decibel arithmetic is not linear, due to the logarithmic base. For example:

30 dB + 30 dB $\neq$ 60 dB

30 dB + 30 dB = 33 dB

$D_{nTw} + C_{tr}$

The weighted, normalised difference in airborne noise levels measured in a source room (L1) and a receive room (L2) due to a separating partition.

D Is simply $L1 - L2$.

D_{nT} Is the normalisation of the measured level difference to the expected (in comparison to the measured) reverberation time in the receiving room.

D_{nTw} Is the weighted and normalised level difference. This value is the result of applying a known octave band weighting curve to the measured result.

C_{tr} Is a correction factor applied to the D_{nTw} to account for the known effects of particular types of noise, such as loud stereo music or traffic noise.

Frequency (Hz)

Measured in Hertz (after Heinrich Hertz), and represents the number of cycles per second of a sound or tone.

Impact Noise

Re-radiated noise as a result of impact(s) on a solid medium, such as footfalls on floors. Measured in L'_{nTw} .

Insertion Loss, dB

The amount of sound reduction offered by an attenuator or louvre once placed in the path of a noise level.

$L_{A90, T}$

The 'A' weighted noise level exceeded for 90% of the time period T, described or measured. The '90' can be substituted for any value between 1 and 99 to indicate the noise level exceeded for the corresponding percentage of time described or measured.

$L_{Aeq, T}$

The 'A' weighted 'equivalent' noise level, or the average noise level over the time period T, described or measured.

L_{Amax}

The 'A' weighted maximum measured noise level. Can be measured with a 'slow' (1 sec) or 'fast' (0.125 sec) time weighting.

L_{Amin}

The 'A' weighted minimum measured noise level.

L'_{nTw}

The weighted, normalised impact sound pressure level measured in a receive room below a source room.

L

Is the spatially averaged impact sound pressure level measured in a receive room.

L'_{nT}

Is the normalisation of the measured impact sound pressure level to the expected (in comparison to the measured) reverberation time in the receiving room.

L'_{nTw}

Is the weighted and normalised impact sound pressure level. This value is the result of applying a known octave band weighting curve to the measured result.

NR

Noise Rating (NR) level. A frequency dependent system of noise level curves developed by the International Organisation for Standardisation (ISO). NR is used to categorise and determine the acceptable indoor environment in terms of hearing preservation, speech communication and annoyance in any given application as a single figure level. The US predominantly uses the Noise Criterion (NC) system.

Octave

The interval between a frequency in Hz (f) and either half or double that frequency (0.5f or 2f).

Pa

Pascals, the SI unit to describe pressure, after physicist Blaise Pascal.

Reverberation Time, T_{mf}, RT60, RT30 or RT20

The time taken in seconds for a sound to diminish within a room by 1,000 times its original level, corresponding to a drop in sound pressure of 60 dB. When taking field measurements and where background noise levels are high, the units RT20 or RT30 are used (measuring drops of 20 or 30 dB respectively). Sometimes given as a mid-frequency reverberation time, T_{mf} which is the average of reverberation time values at 500Hz, 1kHz and 2kHz.

R_w

The sound reduction value(s) of a constructional element such as a door, as measured in a laboratory, with a known octave band weighting curve applied to the result.

Sound Power Level

A noise level obtained by calculation from measurement data, given at the face of an item of plant or machinery. Referenced to 10^{-12} W or 1pW.

Sound Pressure Level

A noise level measured or given at a distance from a source or a number of sources. Referenced to 2×10^{-5} Pa.

Speech Intelligibility, Speech Transmission Index (STI)

Speech intelligibility is the measure of how well a speaker's voice can be heard within a given space. Speech intelligibility within a room depends on a number of factors, including reverberation time and background noise.

The Speech Transmission Index or STI has emerged as the favoured method of describing speech intelligibility.

Subjective Effect of Changes in Sound Pressure Level

The table below details the subjective effects of different variations in sound pressures (adapted from Bies and Hansen).

Difference between background noise and rating levels	Increase in ambient noise level in 'real terms'	Change in apparent loudness
+ 10 dB	+ 10 dB	Twice as loud
+ 5 dB	+ 6 dB	Clearly noticeable
0 dB	+ 3 dB	Just perceptible
-10 dB	0 dB	No change

W

Watts, the SI unit to describe power, after engineer James Watt.