REPORT

CLEAR ACOUSTIC DESIGN

WALDEGRAVE MEWS, TEDDINGTON

BS8233 Environmental Noise Assessment

BS6472-1 Vibration assessment

Date of issue: 22/06/2021

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Revision: 0

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1.0 Introduction

Clear Acoustic Design have been requested to carry out a noise and vibration assessment to support a planning application at 189 Waldegrave Road, Teddington.

The planning application involves the provision of 18 new residential dwellings at the rear of the existing premises (herby referred to as Waldegrave Mews), and the refurbishment of the existing premises at 189 Waldegrave Road to provide 2 residential dwellings on the first floor.

The assessments carried out are in line with BS8233:2014 and BS6472-1:2008. These are the main design standards used to assess the suitability of a residential development site in terms of environmental noise levels and ground borne vibration.

This report has been compiled by Patrick Shuttleworth and issued by Stefan Hannan of Clear Acoustic Design. Both hold full corporate membership of the Institute of Acoustics (MIOA), and 10 / 15 years of consulting experience respectively.

2.0 Performance Requirements

2.1 BS 8233:2014

BS 8233:2014 provides a range of internal noise level targets for many building types, including residential buildings. This British Standard is commonly used by planning authorities to place design targets on new residential developments near major sources of noise, such as transportation networks. The guideline internal noise levels for residential buildings, taken from BS 8233:2014 are shown in the Table below.

Activity	Location	Day (0700-2300)	Night (2300-0700)
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 $L_{Aeq,\ 8hour}$

Table 2.1 BS8233:2014 internal noise level criteria

The 2014 version of this British Standard does not give guideline values for L_{Amax} noise levels in bedrooms at night. Maximum noise levels have the potential to cause excessive night awakenings and it is recommended that this be considered in the assessment.

The World Health Organisation provides a guideline value of 45 dB L_{Amax} and states that this should not normally be exceeded more than 10-15 times in one night. The WHO also recommend that the vast majority of sleep awakenings occur for L_{Amax} levels above 55 dB. These recommendations have therefore been used to carry out an assessment of maximum noise levels in bedrooms at night.

2.2 BS 6472-1:2008

BS 6472-1:2008 is a guide relating to the evaluation of human exposure to vibration in buildings. This is the common design standard referenced in planning conditions where ground borne vibration is thought to be a risk to the future occupants of a proposed development.

BS 6472-1:2008 describes a measure called the vibration dose value, which is used to estimate the probability of adverse comment which might be expected by the future occupants due to vibration. The ranges of vibration dose values (VDV's) which may result in adverse comment are provided in Table 2.2.

Place and time	Low probability of adverse comment $ms^{-1.75}$	Adverse comment possible $ms^{-1.75}$	Adverse comment probable $ms^{-1.75}$
Residential buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Table 2.2 BS 6472-1:2008 VDV criteria

3.0 Site Description

The proposed development site is shown below in Figure 3.1. The main sources of noise affecting the proposed development are the railway line directly to the west of the site, and Waldegrave Road directly to the east. The proposed new dwellings are located at the rear of the existing premises, and they are therefore significantly screened from noise from Waldegrave Road. In between train passes, noise levels in Waldegrave Mews were perceived to be low.

The proposed development will also see a refurbishment of the existing premises at 189 Waldegrave Road. Road traffic noise levels on the front façade of the existing building are seen to be moderate, with a consistent flow of vehicles during the day, and a significant drop in to the night time period.

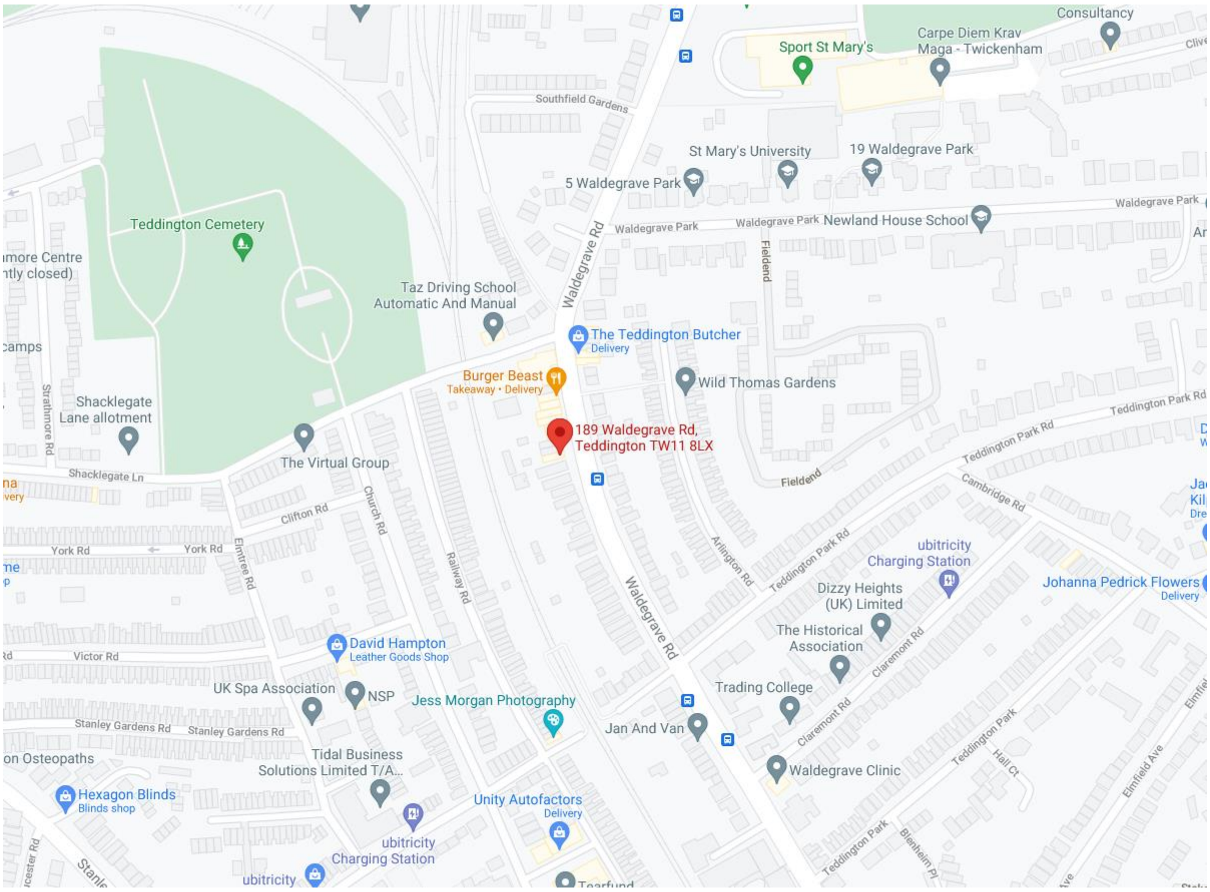

Figure 3.1 Map of site

4.0 Noise & Vibration Survey

Long term noise and ground vibration levels were measured, using 15-minute samples for noise, in a fixed position. The survey was carried out from 28/05/21 to 21/06/21. The vibration meter utilized a VDV transducer in order to directly output vibration dose values. These measurements have been conducted in order to inform the acoustic design of the proposed dwellings which will form Waldegrave Mews.

Short term attended noise measurements were also conducted on Waldegrave Road, in order to inform the sound insulation requirements for the refurbishment of 189 Waldegrave Road.

For the long term noise measurements, the sound level meter was placed on a tripod at a height of approximately 3 metres, in a position that reflects the approximate façade location of the proposed new residential facades.

The vibration monitor was placed on solid concrete ground adjacent to the sound level meter. The transducers had weight applied on top of them using a bag of soil to ensure a solid connection at all times with the ground Although exact underground conditions are unknown this location is seen to provide a good representation of ground borne vibration levels at the location of the proposed buildings.

The short term attended noise measurements have been undertaken on the pavement at the front of 189 Waldegrave Road, with the microphone at a height of approximately 1.5 metres. The attended noise measurements were conducted over a 3 hour period.

The locations of the fixed noise and vibration monitors, and of the short term noise monitoring position are provided in Figure 4.1.

Figure 4.1 Noise and vibration monitoring locations

4.1 Measurement Equipment

The following equipment was used for the survey.

Equipment	Serial Number	Last Calibration Date
NTi XL2 sound level meter – Class 1	A2A-16925-E0	28/11/2019
NTi Microphone Capsule - MC230A	A17732	28/11/2019
NTi Preamplifier - MA220	8657	28/11/2019
Cirrus Class 1 Calibrator – CR:515	91539	18/12/2019
Vibrock V901-2	1025	11/10/2018

Table 4.1 Measuring equipment used for survey

4.2 Fixed Long Term Noise Monitoring (N1) - Results

The results of the long term noise monitoring are provided in graphical form in Figure 4.2 and in Table 4.2. This noise data has been obtained from a fixed position as indicated in Figure 4.1.

L_{Aeq} and L_{Amax} noise levels for each 15-minute sample are shown using two different lines. L_{Amax} noise levels are only used in the assessment for the night time period (2300-0700).

Calculations of noise ingress have been carried out using the octave-band values measured during the survey. A façade specification has also been provided in the following sections.

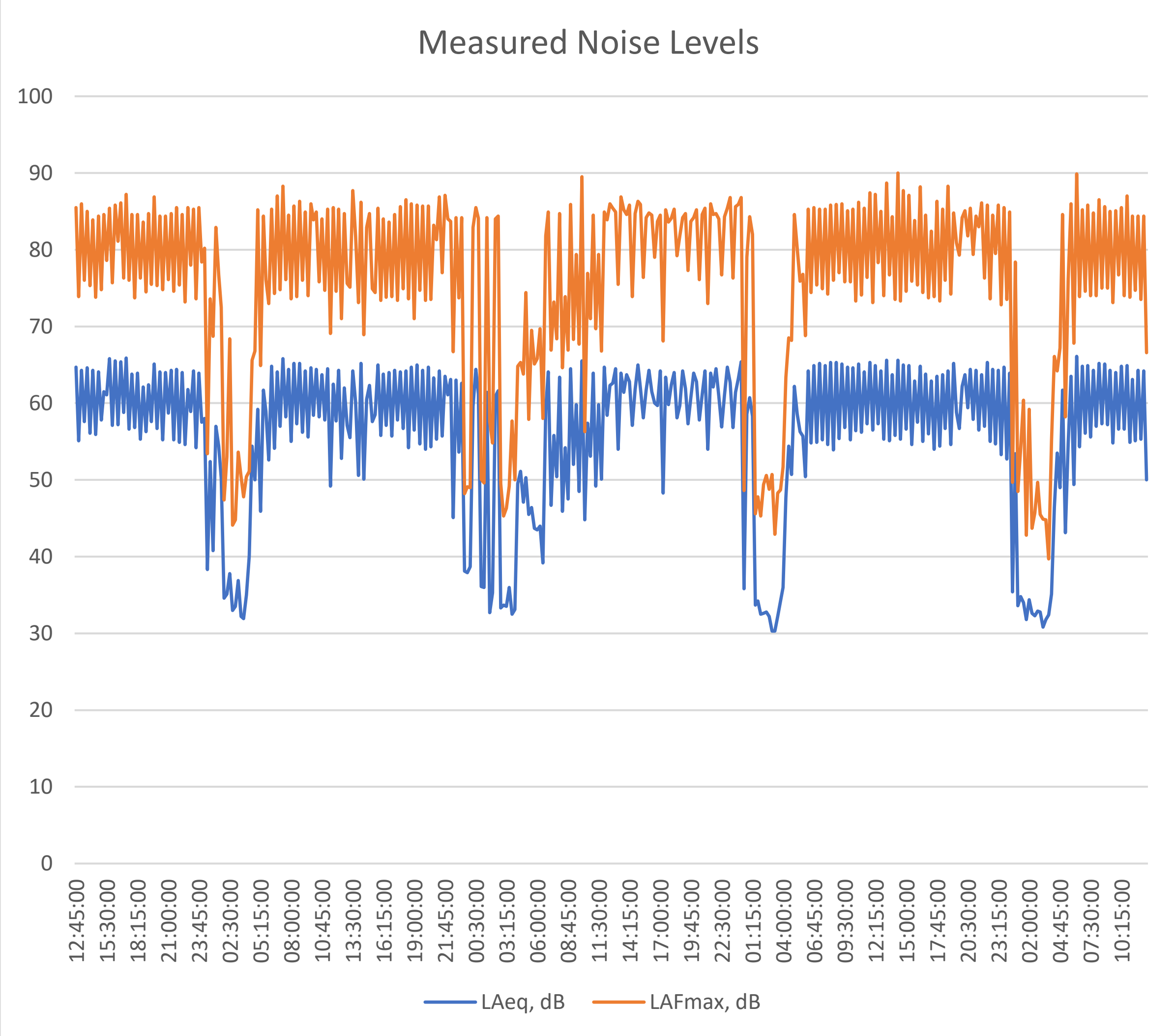

Figure 4.2 Graph showing fixed long term noise monitoring results

Date	Time Period	dB L_{Aeq}	dB L_{Amax} (11th highest)	dB L_{Amax} (highest)
28/05/21	Day (0700-2300)	62	--	--
	Night (2300-0700)	58	77	87
29/05/21	Day (0700-2300)	62	--	--
	Night (2300-0700)	56	70	86
30/05/21	Day (0700-2300)	61	--	--
	Night (2300-0700)	59	80	87
31/05/21	Day (0700-2300)	62	--	--
	Night (2300-0700)	58	74	90
01/06/21	Day (0700-2300)	62	--	--

Table 4.2 Table showing fixed long term noise monitoring results

4.3 Attended Short Term Noise Monitoring (N2) - Results

Table 4.3 below provides the results of the attended noise monitoring on Waldegrave Road, the location of which is indicated in Figure 4.1. The attended measurements were undertaken over a 3 hour period during day time hours, representative of a worst case of road traffic noise.

Date	Time Period	L_{Aeq}, dB	$L_{A10\ 3\ HOUR}$, dB	L_{Amax}, dB
01/06/21	12:30 – 15:30	64	67	73

Table 4.3 Table showing attended noise monitoring results, Waldegrave Road

In order to convert the measured 3 hour noise levels to a format which can be used in assessment, the method provided within the Control of Road Traffic Noise (CRTN) document from the department of transport has been utilised. The corrected value is provided in Table 4.4. below, and is specified as $L_{A10\ 18\ HOUR}$, dB.

It is necessary to provide an additional correction to obtain an $L_{Aeq\ 16\ HOUR}$ value, which will form the basis of noise break-in calculations. BS8233 states that $L_{Aeq\ 16\ HOUR}$ is approximately equal to $L_{A10\ 18\ HOUR}$ minus 2 dB.

The average change between day and night time levels has also been derived from the long term monitoring position, and has been applied to give an indicative 8 hour average for the night time period. These values are also tabulated below.

Time Period	Measured ($L_{A10\ 3\ HOUR}$, dB)	Corrected $L_{A10\ 18\ HOUR}$, dB	Corrected $L_{Aeq\ 16\ HOUR}$	Indicative $L_{Aeq\ 8\ HOUR}$
DAY	67	66	65	--
NIGHT	--	--	--	61

Table 4.4 Assessment noise levels – Front of 189 Waldegrave Road

4.4 Ground Vibration Levels (V) - Results

Vibration Dose Values (VDV) have been measured in 3-axis, X, Y, and Z, with the vertical Z-axis usually providing the highest levels of ground vibration. Table 4.5 presents the highest value measured from all of the 3-axis.

Date	Time Period	Highest VDV, $ms^{-1.75}$
28/05/21	Day 16-hour – 0700-2300	0.062
	Night 8-hour – 2300-0700	0.055
29/05/21	Day 16-hour – 0700-2300	0.075
	Night 8-hour – 2300-0700	0.050
30/05/21	Day 16-hour – 0700-2300	0.048
	Night 8-hour – 2300-0700	0.038
31/05/21	Day 16-hour – 0700-2300	0.048
	Night 8-hour – 2300-0700	0.034
01/06/21	Day 16-hour – 0700-2300	0.056

Table 4.5 VDV vibration levels measured on site

5.0 Assessment to BS8233:2014

The requirements of BS8233:2014 have been outlined previously, see section 2.1.

In order to make an assessment a series of noise break-in calculations need to be undertaken to predict the internal noise levels within the proposed development. Noise ingress is calculated through each element of the facade, and then logarithmically summed together to give an overall noise level in the room. These calculations can be found in Appendix A.

Calculations have been based on a typical room and window dimensions. Small differences to these room dimensions will have a negligible impact on the result of calculations.

The internal noise levels have been shown to be compliant with BS8233:2014 when utilising the façade specifications in the following sub sections. The calculations assume that windows do not need to be opened for sustained periods to control overheating. Short term purge ventilation via opening windows for a short time is allowable and noise ingress does not need to be considered in this scenario.

5.1 Façade Specification

The acoustic performance of the façade elements used in the noise break-in calculations are provided in the following sub sections. These octave band sound reduction values will therefore need to be met when finalising the design of the façade and choosing specific products.

The R_w values have been provided for guidance only. The octave band values take precedence as the R_w does not accurately account for weaknesses in certain frequency bands.

Any constructions and products can be specified and installed that achieve the level of acoustic performance stated. The constructions used in our calculations are also provided, but for guidance only. Manufacturers noise data should always be obtained and confirmed.

Note that for facades affected by the railway line, the façade specification provided will mitigate the 11^{th} highest L_{Amax} level to below 45 dBA as required by the World Health Organisation. In order to ensure that passing trains do not cause an adverse noise impact to future occupants, the specification is also based on ensuring that the highest L_{Amax} events are mitigated to within 55 dBA. This upper limit is specified by the WHO as being linked to the vast majority of sleep awakenings and as such this is seen to be a robust approach.

5.1.1 Waldegrave Mews, Line of Sight to Railway

The necessary sound insulation performance for Waldegrave Mews is provided in Table 5.1 below. Note that this specification is applicable to the facades with line of sight to the railway line. Figure 5.1 provides an overview of the applicable locations.

Performance values have been provided for the external wall / roof, windows and trickle ventilators. A range of construction types can meet the requirements for the external wall and roof - The sound insulation performance of the proposed constructions should be verified against the values in Table 5.1 during the detailed design stage.

Element	Type	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	R/Dne$_w$
External Wall / Roof	R, dB	43	47	55	55	55	55	55
Glazing	R, dB	28	30	39	44	48	56	42
Trickle Ventilator – Open	Dne, dB	33	39	44	49	50	53	47

Table 5.1 Façade acoustic performance – Waldegrave Mews, Line of Sight to Railway

The example windows and trickle vents which have been used in the calculations are provided in Table 5.2 below. Other products / systems may meet the necessary sound insulation.

Element	Description
Windows	Saint Gobain Double Glazed Unit – 8.4/12/10 Stadip Silence
Trickle Ventilator (Open)	Renson AK40

Table 5.2 Example Products / Systems – Waldegrave Mews, Line of Sight to Railway

5.1.2 Front Façades, 189 Waldegrave Road

The necessary sound insulation performance for the front façades of 189 Waldegrave Road is provided in Table 5.3 below. Figure 5.1 provides an overview of the applicable locations.

Performance values have been provided for the windows and trickle ventilators. The existing external wall is understood to be masonry and as such will not be a limiting factor in noise breaking in to the building.

Element	Type	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	R/Dne$_w$
Glazing	R, dB	22	23	33	41	44	46	36
Trickle Ventilator – Open	Dne, dB	47	39	35	41	56	62	41

Table 5.3 Façade acoustic performance – Front Facades, 189 Waldegrave Road

The example products / constructions which have been used in the calculations are provided in Table 5.4 below. Other products / systems may meet the necessary sound insulation.

Element	Description
Windows	Saint Gobain Double Glazed Unit - 4/12/6.8 Phon
Trickle Ventilator (Open)	Renson Invisivent Evo Ak Ultra

Table 5.4 Example Products / Systems – Front Facades, 189 Waldegrave Road

5.1.3 Screened Areas

Within the proposed Waldegrave Mews, some facades will be screened from the railway and will be subject to lower noise levels. Note that this is dependent on the actual screening provided by the elevations of the proposed buildings. This should therefore be confirmed during the detailed design stage.

Noise levels at the rear of 189 Waldegrave Road will also be lower than those at the front due to screening of road traffic noise, although noise from the railway line will be higher at the rear. The necessary sound insulation performance for these areas is provided in Table 5.5 below. Figure 5.1 provides an overview of the applicable locations.

Performance values have been provided for the windows and trickle ventilators. For Waldegrave Mews, the same façade / roof specifications should be applied in all areas and hence the values in Table 5.1 should be applied to the external wall in these areas.

Element	Type	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	R/Dne_w
Glazing	R, dB	25	25	31	34	34	36	33
Trickle Ventilator – Open	Dne, dB	37	35	30	33	38	49	34

Table 5.5 Façade acoustic performance – Screened Areas

The example products / constructions which have been used in the calculations are provided in Table 5.6 below. Other products / systems may meet the necessary sound insulation.

Element	Description
Windows	Saint Gobain Double Glazed Unit – 10/12/6
Trickle Ventilator (Open)	Renson Invisivent Evo Ak Ultra

Table 5.6 Example Products / Systems – Screened Areas

5.2 Application of Specifications

Figure 5.1 below indicates the application of the 3 façade specifications.

Figure 5.1 Application of Specifications

6.0 Assessment to BS6472-1:2008

The VDV values collected during the survey have been assessed below in line with BS6472-1. The worst case transfer function values have been rounded to a single decimal place. The outcome of the assessment is provided below.

Date	Time Period	Highest VDV, $ms^{-1.75}$	Worst case transfer function for upper floors – x4	BS 6472-1 VDV Range for low probability of adverse comment
28/05/21	Day 16-hour – 0700-2300	0.062	0.3	0.2 - 0.4
	Night 8-hour – 2300-0700	0.055	0.2	0.1 – 0.2
29/05/21	Day 16-hour – 0700-2300	0.075	0.3	0.2 - 0.4
	Night 8-hour – 2300-0700	0.050	0.2	0.1 – 0.2
30/05/21	Day 16-hour – 0700-2300	0.048	0.2	0.2 - 0.4
	Night 8-hour – 2300-0700	0.038	0.2	0.1 – 0.2
31/05/21	Day 16-hour – 0700-2300	0.048	0.2	0.2 - 0.4
	Night 8-hour – 2300-0700	0.034	0.1	0.1 – 0.2
01/06/21	Day 16-hour – 0700-2300	0.056	0.2	0.2 - 0.4

Table 6.1 Assessment to BS6472-1

Table 6.1 shows highest measured values along with a correct value based on a transfer function, as vibration can be amplified on the upper floors of a building. A transfer function of measured VDV x 4 has been applied which is seen allow a robust and worst-case assessment of the risk in the finished building.

It can be seen that during all periods throughout the survey, the corrected VDV is in line with the range that demonstrates a low probability of adverse comment. Therefore, there are seen to be no requirements to provide vibration isolation to prevent adverse comment due to vibration, in line with BS 6472-1:2008.

7.0 Conclusion

A noise & vibration survey and indicative façade specification has been provided to support a planning application for the site at 189 Waldegrave Road, Teddington.

The measured noise levels have been used to carry out a series of noise break-in calculations to assess the development in line with BS8233:2014

The calculations have demonstrated that the recommended internal noise level requirements, when background ventilating, can be achieved with basic façade elements, without specialist high-performance systems being required.

Providing that the façade elements are designed and installed in line with Section 5.0 of this report, the requirements of BS8233:2014 are seen to be fully complied with.

The levels of measured ground vibration demonstrate that there is minimal risk of adverse comment due to vibration, in line with the assessment methodology in BS 6472-1:2008; therefore, no mitigation methods are required.

Appendix A – Noise Break-in Calculations

A.1 Waldegrave Mews

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		58	59	60	56	52	55	**62**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	65 m3							
Reverberation Time in room	1.0 s	1.0	1.0	1.0	1.0	1.0	1.0	
A = Total absorption is Sabines		10.5	10.5	10.5	10.5	10.5	10.5	
10*log(S/A)		6.2	6.2	6.2	6.2	6.2	6.2	
Facade Details								
Total Façade Area	**44.0 m2**							
External Wall	38.0 m2	43	47	55	55	55	55	
External Wall		-44	-48	-56	-56	-56	-56	
Noise ingress through element		**23.6**	**20.6**	**13.6**	**9.6**	**5.6**	**8.6**	17.4
Double - 8.4/12/10 - SGG Stadip Silence	6.0 m2	28	30	39	44	48	56	
Glazing		-37	-39	-48	-53	-57	-65	
Noise ingress through element		**30.6**	**29.6**	**21.6**	**12.6**	**4.6**	**-0.4**	23.9
Trickle Vent - n=1 = one trickle vent	n = 1	33	39	44	49	50	53	
Renson AK40		33	39	44	49	50	53	
Trickle Vent		-39	-46	-51	-55	-56	-59	
Noise ingress through element		**28.0**	**22.7**	**18.5**	**10.0**	**4.8**	**4.8**	19.7
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**33.0**	**30.8**	**23.8**	**15.8**	**10.2**	**10.9**	**26**

Figure A1 – Daytime L_{Aeq} – Living Room

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		55	57	58	54	50	46	**59**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	43	47	55	55	55	55	
External Wall		-43	-47	-55	-55	-55	-55	
Noise ingress through element		**20.9**	**18.9**	**11.9**	**7.9**	**3.9**	**-0.1**	15.0
Double - 8.4/12/10 - SGG Stadip Silence	3.0 m2	28	30	39	44	48	56	
Glazing		-38	-40	-49	-54	-58	-66	
Noise ingress through element		**26.7**	**26.7**	**18.7**	**9.7**	**1.7**	**-10.3**	20.9
Trickle Vent - n=1 = one trickle vent	n = 1	33	39	44	49	50	53	
Renson AK40		33	39	44	49	50	53	
Trickle Vent		-37	-44	-49	-53	-54	-57	
Noise ingress through element		**27.1**	**22.8**	**18.6**	**10.1**	**4.9**	**-2.1**	19.5
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**30.4**	**28.7**	**22.1**	**14.3**	**9.0**	**4.3**	**24**

Figure A2 – Night time L_{Aeq} – Bedroom

BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		76	72	67	66	63	59	71
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	43	47	55	55	55	55	
External Wall		-43	-47	-55	-55	-55	-55	
Noise ingress through element		**41.9**	**33.9**	**20.9**	**19.9**	**16.9**	**12.9**	29.8
Double - 8.4/12/10 - SGG Stadip Silence	3.0 m2	28	30	39	44	48	56	
Glazing		-38	-40	-49	-54	-58	-66	
Noise ingress through element		**47.7**	**41.7**	**27.7**	**21.7**	**14.7**	**2.7**	36.0
Trickle Vent - n=1 = one trickle vent	n = 1	33	39	44	49	50	53	
Renson AK40		33	39	44	49	50	53	
Trickle Vent		-37	-44	-49	-53	-54	-57	
Noise ingress through element		**48.1**	**37.8**	**27.6**	**22.1**	**17.9**	**10.9**	34.7
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**51.4**	**43.7**	**31.1**	**26.1**	**21.5**	**15.4**	**39**

Figure A3 – Night time L_{Amax} 11th Highest – Bedroom

BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		92	88	83	82	79	75	**87**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	43	47	55	55	55	55	
External Wall		-43	-47	-55	-55	-55	-55	
Noise ingress through element		**57.9**	**49.9**	**36.9**	**35.9**	**32.9**	**28.9**	45.8
Double - 8.4/12/10 - SGG Stadip Silence	3.0 m2	28	30	39	44	48	56	
Glazing		-38	-40	-49	-54	-58	-66	
Noise ingress through element		**63.7**	**57.7**	**43.7**	**37.7**	**30.7**	**18.7**	52.0
Trickle Vent - n=1 = one trickle vent	n = 1	33	39	44	49	50	53	
Renson AK40		33	39	44	49	50	53	
Trickle Vent		-37	-44	-49	-53	-54	-57	
Noise ingress through element		**64.1**	**53.8**	**43.6**	**38.1**	**33.9**	**26.9**	50.7
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**67.4**	**59.7**	**47.1**	**42.1**	**37.5**	**31.3**	**55**

Figure A4 – Night time L_{Amax} Highest – Bedroom

A.2 Front Facades, 189 Waldegrave Road

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		61	60	60	63	55	44	**65**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	65 m3							
Reverberation Time in room	1.0 s	1.0	1.0	1.0	1.0	1.0	1.0	
A = Total absorption is Sabines		10.5	10.5	10.5	10.5	10.5	10.5	
10*log(S/A)		6.2	6.2	6.2	6.2	6.2	6.2	
Facade Details								
Total Façade Area	**44.0 m2**							
External Wall	38.0 m2	37	39	45	52	55	55	
External Wall		-38	-40	-46	-53	-56	-56	
Noise ingress through element		**32.6**	**29.6**	**23.6**	**19.6**	**8.6**	**-2.4**	25.8
Double - 4/12/6.8 Phon	6.0 m2	22	23	33	41	44	46	
Glazing		-31	-32	-42	-50	-53	-55	
Noise ingress through element		**39.6**	**37.6**	**27.6**	**22.6**	**11.6**	**-1.4**	31.7
Trickle Vent - n=1 = one trickle vent	n = 1	47	39	35	41	56	62	
Renson Invisivent Evo AK Ultra		47	39	35	41	56	62	
Trickle Vent		-54	-45	-41	-47	-62	-68	
Noise ingress through element		**16.7**	**24.2**	**27.9**	**24.9**	**1.9**	**-15.0**	28.1
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**40.4**	**38.4**	**31.5**	**27.7**	**13.8**	**3.7**	**34**

Figure A5 – Daytime L_{Aeq} – Living Room

BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		57	56	56	59	51	40	**61**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	37	39	45	52	55	55	
External Wall		-37	-39	-45	-52	-55	-55	
Noise ingress through element		**28.9**	**25.9**	**19.9**	**15.9**	**4.9**	**-6.1**	22.1
Double - 4/12/6.8 Phon	3.0 m2	22	23	33	41	44	46	
Glazing		-32	-33	-43	-51	-54	-56	
Noise ingress through element		**34.7**	**32.7**	**22.7**	**17.7**	**6.7**	**-6.3**	26.8
Trickle Vent - n=1 = one trickle vent	n = 1	47	39	35	41	56	62	
Renson Invisivent Evo AK Ultra		47	39	35	41	56	62	
Trickle Vent		-52	-43	-39	-45	-60	-66	
Noise ingress through element		**14.8**	**22.3**	**26.0**	**23.0**	**0.0**	**-16.9**	26.2
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**35.7**	**33.8**	**28.3**	**24.7**	**9.9**	**1.8**	**30**

Figure A6 – Night time L_{Aeq} – Bedroom

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		70	68	69	71	64	49	**73**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	37	39	45	52	55	55	
External Wall		-37	-39	-45	-52	-55	-55	
Noise ingress through element		**41.9**	**37.9**	**32.9**	**27.9**	**17.9**	**2.9**	34.6
Double - 4/12/6.8 Phon	3.0 m2	22	23	33	41	44	46	
Glazing		-32	-33	-43	-51	-54	-56	
Noise ingress through element		**47.7**	**44.7**	**35.7**	**29.7**	**19.7**	**2.7**	39.2
Trickle Vent - n=1 = one trickle vent	n = 1	47	39	35	41	56	62	
Renson Invisivent Evo AK Ultra		47	39	35	41	56	62	
Trickle Vent		-52	-43	-39	-45	-60	-66	
Noise ingress through element		**27.8**	**34.3**	**39.0**	**35.0**	**13.0**	**-7.9**	38.7
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**48.7**	**45.8**	**41.3**	**36.7**	**22.4**	**7.0**	**43**

Figure A7 – Night time L_{Amax} 11th Highest – Bedroom

A.3 Screened Areas

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		56	57	58	54	50	53	**60**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	65 m3							
Reverberation Time in room	1.0 s	1.0	1.0	1.0	1.0	1.0	1.0	
A = Total absorption is Sabines		10.5	10.5	10.5	10.5	10.5	10.5	
10*log(S/A)		6.2	6.2	6.2	6.2	6.2	6.2	
Facade Details								
Total Façade Area	**44.0 m2**							
External Wall	38.0 m2	43	47	55	55	55	55	
External Wall		-44	-48	-56	-56	-56	-56	
Noise ingress through element		**21.6**	**18.6**	**11.6**	**7.6**	**3.6**	**6.6**	15.4
Double - 10/12/6	6.0 m2	25	25	31	34	34	36	
Glazing		-34	-34	-40	-43	-43	-45	
Noise ingress through element		**31.6**	**32.6**	**27.6**	**20.6**	**16.6**	**17.6**	29.1
Trickle Vent - n=1 = one trickle vent	n = 1	37	35	30	33	38	49	
Renson Invisivent Evo AK Basic		37	35	30	33	38	49	
Trickle Vent		-44	-41	-37	-39	-44	-55	
Noise ingress through element		**21.5**	**24.8**	**30.5**	**23.9**	**15.1**	**7.2**	29.4
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**32.4**	**33.4**	**32.3**	**25.6**	**19.1**	**18.3**	**32**

Figure A8 – Daytime L_{Aeq} – Living Room

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		52	54	55	51	47	43	**56**
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	43	47	55	55	55	55	
External Wall		-43	-47	-55	-55	-55	-55	
Noise ingress through element		**17.9**	**15.9**	**8.9**	**4.9**	**0.9**	**-3.1**	12.0
Double - 10/12/6	3.0 m2	25	25	31	34	34	36	
Glazing		-35	-35	-41	-44	-44	-46	
Noise ingress through element		**26.7**	**28.7**	**23.7**	**16.7**	**12.7**	**6.7**	24.8
Trickle Vent - n=1 = one trickle vent	n = 1	37	35	30	33	38	49	
Renson Invisivent Evo AK Basic		37	35	30	33	38	49	
Trickle Vent		-42	-39	-35	-37	-42	-53	
Noise ingress through element		**19.6**	**23.9**	**29.6**	**23.0**	**14.2**	**-0.7**	28.5
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**27.9**	**30.1**	**30.6**	**24.0**	**16.7**	**8.5**	**30**

Figure A9 – Night time L_{Aeq} – Bedroom

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		73	69	64	63	60	56	68
Additional Safety	3 dB	3.0	3.0	3.0	3.0	3.0	3.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	43	47	55	55	55	55	
External Wall		-43	-47	-55	-55	-55	-55	
Noise ingress through element		**38.9**	**30.9**	**17.9**	**16.9**	**13.9**	**9.9**	26.8
Double - 10/12/6	3.0 m2	25	25	31	34	34	36	
Glazing		-35	-35	-41	-44	-44	-46	
Noise ingress through element		**47.7**	**43.7**	**32.7**	**28.7**	**25.7**	**19.7**	38.4
Trickle Vent - n=1 = one trickle vent	n = 1	37	35	30	33	38	49	
Renson Invisivent Evo AK Basic		37	35	30	33	38	49	
Trickle Vent		-42	-39	-35	-37	-42	-53	
Noise ingress through element		**40.6**	**38.9**	**38.6**	**35.0**	**27.2**	**12.3**	39.4
Screening		0.0	0.0	0.0	0.0	0.0	0.0	

	125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room	**48.9**	**45.1**	**39.6**	**36.0**	**29.6**	**20.8**	**42**

Figure A10 – Night time L_{Amax} 11th Highest – Bedroom

CLEAR ACOUSTIC DESIGN BS8233 Noise Break-in Calculation		125	250	500	1000	2000	4000	dB(A)
Noise Level at Façade		82	78	73	72	69	65	**77**
Additional Safety	5 dB	5.0	5.0	5.0	5.0	5.0	5.0	
Facade Corrections	Lff	0.0	0.0	0.0	0.0	0.0	0.0	
Volume of room	32 m3							
Reverberation Time in room	0.8 s	0.8	0.8	0.8	0.8	0.8	0.8	
A = Total absorption is Sabines		6.4	6.4	6.4	6.4	6.4	6.4	
10*log(S/A)		6.4	6.4	6.4	6.4	6.4	6.4	
Facade Details								
Total Façade Area	**28.0 m2**							
External Wall	25.0 m2	43	47	55	55	55	55	
External Wall		-43	-47	-55	-55	-55	-55	
Noise ingress through element		**49.9**	**41.9**	**28.9**	**27.9**	**24.9**	**20.9**	37.8
Double - 10/12/6	3.0 m2	25	25	31	34	34	36	
Glazing		-35	-35	-41	-44	-44	-46	
Noise ingress through element		**58.7**	**54.7**	**43.7**	**39.7**	**36.7**	**30.7**	49.4
Trickle Vent - n=1 = one trickle vent	n = 1	37	35	30	33	38	49	
Renson Invisivent Evo AK Basic		37	35	30	33	38	49	
Trickle Vent		-42	-39	-35	-37	-42	-53	
Noise ingress through element		**51.6**	**49.9**	**49.6**	**46.0**	**38.2**	**23.3**	50.4
Screening		0.0	0.0	0.0	0.0	0.0	0.0	
		125	250	500	1000	2000	4000	dB(A)
Total Noise Level in Room		**59.9**	**56.1**	**50.6**	**47.0**	**40.6**	**31.8**	**53**

Figure A11 – Night time L_{Amax} Highest – Bedroom

Appendix B - Calibration Certificates

Manufacturer Calibration Certificate

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3. All tests are traceable in accordance with ISO/IEC 17025.

No pattern approval is available for this sound level meter configuration.

Sound Level Meter

Manufacturer	NTi Audio		
Type	XL2	S/N	A2A-16925-E0
Firmware	V4.20		
Reference Level Range	mid		
Microphone Model	M2230		
Preamplifier	MA220	S/N	8657
Microphone Capsule	MC230A	S/N	A17732
Performance class	Class 1		
Customer Inventory Nr.			

Customer

Issue Date 28 November 2019

Certificate FL-19-217

Results PASSED
(for detailed report see next pages)

Operator Markus Frick

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CLEAR
ACOUSTIC DESIGN

CERTIFICATE OF CALIBRATION

ISSUED BY **Noisemeters**

DATE OF ISSUE **14 January 2020** CERTIFICATE NUMBER **136504**

NoiseMeters

NoiseMeters
Acoustic House
Bridlington Road
Hunmanby
YO14 0PH
United Kingdom
www.noisemeters.com

Page 1 of 2
Approved signatory
J.Johnston
Electronically signed:

Sound Calibrator : IEC 60942:2003

Instrument information

Manufacturer: Cirrus Research plc

Model: CR:515

Serial number: 91539

Class: 1

Notes:

Test summary

Date of calibration: 18 December 2019

The sound calibrator detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC 60942:2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK:224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

The manufacturer's product information indicates that this model of sound calibrator has been formally pattern approved to IEC 60942:2003 Annex A to Class 1. This has been confirmed with the PhysikalischTechnische Bundesanstalt (PTB).

As public evidence was available, from a testing organisation responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the Class 1 requirements of IEC 60942:2003.

Notes:

This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.

CERTIFICATE OF CALIBRATION

Certificate Number: **136504**

Page 2 of 2

Environmental conditions

The following conditions were recorded at the time of the test:

Pressure: 100.60 kPa
Temperature: 23.2 °C
Humidity: 33.6 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Acoustic Calibrator	Bruel and Kjaer	4231	1795641
Distortion Meter	Keithley	2015	1175401
Multimeter	Fluke	8845A	9440017

Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Limits	Uncertainty
Level (dB)	94.00	94.00	94.00	93.98	**93.99**	-0.01	±0.40	0.11 dB
Distortion (%)	< 3.00	1.16	1.16	1.29	**1.20**	1.20	+3.00	0.13 %
Frequency (Hz)	1000.0	1000.0	1000.0	1000.0	**1000.0**	0.0	±10.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

End of results

CERTIFICATE OF CALIBRATION

ISSUED BY: **CALIBRATION MAINTENANCE & REPAIR LTD**

DATE OF ISSUE: 11 October 2018 CERTIFICATE NUMBER: **181553**

0654

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Approved Signatory
Electronically Authorised Document
☐ P K CLARK
☐ R J WADE
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☒ M S PARDOE

CUSTOMER
GRACEY & ASSOCIATES
BARN COURT
SHELTON ROAD
UPPER DEAN
PETERBOROUGH
PE28 0NQ
UNITED KINGDOM

MANUFACTURER	**VIBROCK**
DESCRIPTION	**DIGITAL SEISMOGRAPH**
MODEL	**V901**
SERIAL No.	**1025**
IDENT No.	**NOT KNOWN**
DATE RECEIVED	**9 OCTOBER 2018**
DATE OF CALIBRATION	**11 OCTOBER 2018**
ORDER No.	**G4726**

INSTRUMENT CONDITION

Adjustments Made	No
Repairs Made	No

ENVIRONMENT
The instrument was placed in the Laboratory environment for a minimum period of 4 hours prior to calibration.

The ambient conditions were: 22°C ± 3°C and 45% RH ± 15% RH.

STABILITY
The results contained in this Certificate refer to the measurements made at the time of test and not to the instrument's ability to maintain calibration.

PROCEDURE
Measurements were performed in accordance with the in house Laboratory procedure No.0689

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a coverage probability of approximately 95 %. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

CERTIFICATE OF CALIBRATION

ISSUED BY: **CALIBRATION MAINTENANCE & REPAIR LTD**

UKAS ACCREDITED CALIBRATION LABORATORY No. 0654

CERTIFICATE NUMBER
181553

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INSTRUMENTS USED

EQUIPMENT	SERIAL No	CERTIFICATE No	CAL DUE
Dactron Laser	11633408	M2361	03 Jan 2019
PCB Piezotronics 301A11	1934	M2368	03 Jan 2020
PCB Piezotronics 333B40	53896	M2489	04 Jan 2019

Additional Non Accredited Uncertainties:
Display values are not assigned an uncertainty, as they are an indication only.
Distortion: +/- 1.4 mV

Calculations

Gravity = $9.80665 ms^2$

Displacement = $\frac{Acceleration}{2\pi^2 F^2}$ Velocity = $\frac{Acceleration}{2\pi F}$ 1000mm = 1m 1000000µm = 1m

pk = rms * 1.414 pk-pk = rms * 2.828

Notes:

Measurement Uncertainties

Parameter	Range	Uncertainty
Vibration Meters & Analysers	10Hz to 1kHz	$0.1 ms^2$ to $10 ms^2$ 5.0%

Parameter	Range	Uncertainty

CLEAR ACOUSTIC DESIGN

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Measurement Uncertainties (Continued)

Parameter	Range	Uncertainty	Parameter	Range	Uncertainty

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CERTIFICATE NUMBER

181553

RESULT SHEET 0689 – V901 SEISMOGRAPH

BATTERIES REPLACED **NO**

AS FOUND

1) PPV ACCELERATION
@ 22.3 Hz

Axis	Nominal	Limits	Measured	Units	Error %
L	50.0	±5%	50.7	mm/s	1.40
T	50.0	±5%	51.0	mm/s	2.00
V	50.0	±5%	50.6	mm/s	1.20

2) VDV ACCELERATION
@ 22.3 Hz

Axis	Nominal	Measured	Units	Error %
X	12.9	12.4	$m/s^{-1.75}$	-3.88
Y	12.9	12.3	$m/s^{-1.75}$	-4.65
Z	12.9	12.5	$m/s^{-1.75}$	-3.10

COMMENTS

TEST ENGINEER **R J WADE** **DATE 11 OCTOBER 2018**

Issue No 5

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