Environmental Noise Impact Assessment

The British Museum, Great Russell Street, London, WC1B 3DG

14th July 2023

ENVIRONMENTAL AND
SUSTAINABILITY CONSULTANTS

encon associates

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1 Introduction

1.1 Overview

Encon Associates Ltd have been commissioned to prepare an environmental noise impact assessment for the refurbishment of 39 Russell and the Science Block at The British Museum, Great Russell Street London.

The following report has been produced for planning purposes and is to be submitted to The London Borough of Camden.

This report details existing background sound levels at the noise sensitive receptors considered as the worst affected, as well as noise emissions associated with the operations that are taking place on-site.

Due to the necessary technical nature of the report, a glossary of terms can be found in Appendix A to assist the reader.

2 Site Description & Background Information

2.1 Site & Surrounding Area

39 Russell Square and The Science Block at The British Museum are being refurbished as part of enabling work for the SWEC (South-West Energy Centre) programme. The immediate surrounding area comprises public building, offices and local transport networks. Immediately to the north of the redevelopment site is 38 Russell Square with Montague Place on the other side. To the east of the redevelopment site is Montague Street, which facilitates regular traffic flow. To the south of the site are properties off Montague Street including offices occupied by University College London and Grange Blooms Hotel. A new East Road building with a ground floor storey and above ground is to be erected between the highlighted offices and the main building of The British Museum to the south of the site. The British Museum is open from 10:00 and 17:00 from Saturday to Thursday and 10:00 and 20:30 on Friday. The British Museum Estate is located immediately to the west of the redevelopment site.

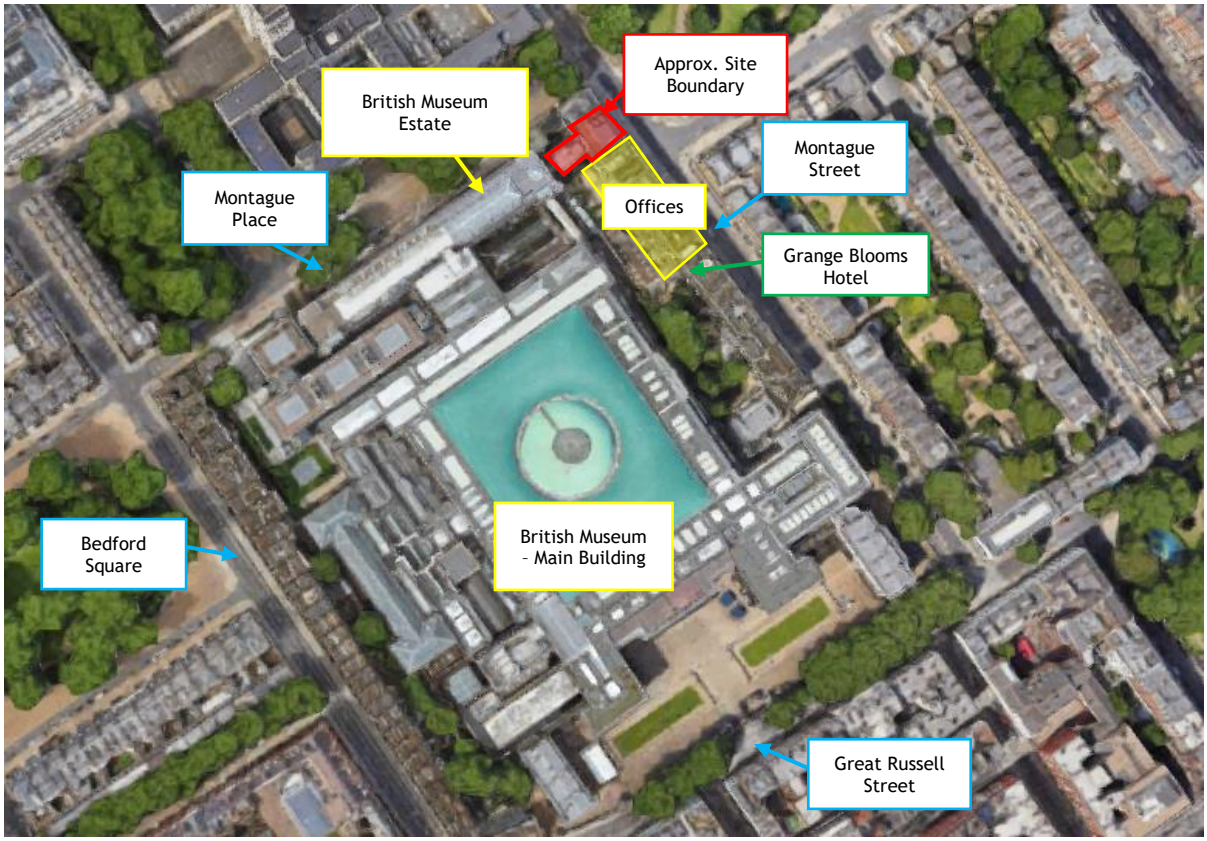


Figure 1.0 – Site and Surrounding Area

2.2 Background

As part of the enabling work for SWEC, 39 Russell Square and the adjoining Science Block are to be refurbished. 39 Russell Square is to be repurposed for office use whilst the Science Block is to be modified for workshop use with all existing building services being removed. 1no. local Mechanical Ventilation with Heat Recovery (MVHR) unit is to be located in the basement to serve the WC and showers with external intake and exhaust louvres terminating on the façade locally in the basement. 2no. local MVHR units are to be located on the ground floor to serve the lock smith and carpenters workshops. External intake and exhaust louvres will terminate at roof level. Additionally, two new identical condensers are to be installed in the lightwell. Consequently, a noise impact assessment was required to determine the likelihood of adverse impact and to maintain an acceptable acoustic environment for those in the vicinity.

The most exposed noise sensitive receptors are considered to be 41 Russell Square and 38 Russell Square. The acoustic environment at the worst-affected noise sensitive is dominated by building services plant associated with properties adjacent to The British Museum as well as noise from local road traffic.

3 Legislation, Policy and Guidance

This report is based on the following policy, guidance and legislation.

3.1 National Planning Policy Framework (NPPF)

The latest revision of the National Planning Policy Framework (July 2021)states that planning system should contribute to, and enhance the natural and local environment by (amongst others) "preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, water or noise pollution or land stability."

NPPF advises that planning policies and decisions should ensure:

"…new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development." [In doing so they should] "mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life" and "identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."

"…new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed."

3.2 The London Plan

Policy D14 Noise of The London Plan stipulates the following:

In order to reduce, manage and mitigate noise to improve health and quality of life, residential and other non-aviation development should manage noise by:

1) Avoiding significant adverse noise impacts on health and quality of life

2) Reflecting the Agent Change principle as set out in Policy D13 Agent of Change

3) Mitigating and minimising the existing and potential adverse impacts of noise on, from, within, as a result of, or in the vicinity of new development without placing unreasonable restrictions on existing noise-generating uses

4) Improving and enhancing the acoustic environment and promoting appropriate soundscapes (including Quiet Areas and spaces of relative tranquility)

5) Separating new noise-sensitive development from major noise sources (such as road, rail, air transport and some types of industrial use) through the use of distance, screening, layout, orientation, uses and materials – in preference to sole reliance on sound insulation

6) Where it is not possible to achieve separation of noise-sensitive development and noise sources without undue impact on other sustainable development objectives, then any potential adverse effects should be controlled and mitigated through applying good acoustic design principles

7) Promoting new technologies and improved practices to reduce noise at source and on the transmission path from source to receiver.

Boroughs and others with relevant responsibilities should identify and nominate new Quiet Areas and protect existing Quiet Areas in line with the procedure in Defra's Noise Action Plan for Agglomerations.

3.3 The London Borough of Camden

The London Borough of Camden stipulates that a noise impact assessment should include background noise levels measured over a 24-hour period. The noise impact assessment should also outline proposed noise levels (including the cumulative noise levels of all proposed units), any proposed measures to reduce noise from the proposed development and the system manufacturers specification of any proposed equipment to be installed, altered or replaced.

Appendix 3: 'Noise Thresholds' of the Camden Local Plan states the following:

The significance of noise impact various dependent on the different noise sources, receptors and times of operation presented for consideration within a planning application. Therefore, Camden's thresholds for noise and vibration evaluate noise impact in terms of various 'effect levels' described in the National Planning Policy Guidance:

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

Three basic design criteria have been set for proposed developments, these being aimed at guiding applicants as to the degree of detailed consideration needed to be given to noise in any planning application. The design criteria outlined below are defined corresponding noise tables. The values will vary depending on the context, type of noise and sensitivity of receptor:

- Green – Where noise is considered to be at an acceptable level.
- Amber – Where noise is observed to have an adverse effect level, but which may be considered acceptable when assessed in the context of other merits of the development.
- Red – Where noise is observed to have a significant adverse effect.

For Industrial and Commercial noise sources a relevant guidance document should be referenced when determining values for LOAEL and SOAEL. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10dB below background (15dB if tonal components are present) should be considered as the design criterion.

Emergency equipment such as generators which are only to be used for short periods of time will be required to meet the noise criteria of no more than 10dB above the background level (L90 15 minutes). During standby periods, emergency equipment will be required to meet the usual criteria for plant and machinery.

3.4 BS4142: 2014 + A1: 2019 'Methods for rating and assessing industrial and commercial sound

British Standard 4142: 2014 + A1:2019 describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials and/or commercial premises; and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as the from fork-lift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The methods described in the standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The standard presents methods to measure and determine ambient, background and residual sound levels, and the rating levels of industrial/commercial sound. BS4142:2014+A1+2019 requires consideration of the level of uncertainty in the data and associated calculations.

The determination of noise amounting to a nuisance is beyond the scope of BS4142. The standard stipulates that it not intended to be applied to the rating and assessment of sound from the passage of vehicles of vehicles on public roads and railway systems, recreational activities, music and entertainment, shooting grounds, construction and demolition, domestic animals, public address systems and other sources not specified within the document.

The Reference Time Interval, T, is defined in the standard as the "specified interval over which the specific sound level is determined", which is 1 hour during the daytime (07:00 to 23:00 hours) and 15 minutes during the night (23:00 to 07:00 hours).

Ambient sound is defined as "totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far". It comprises the residual sound and the specific sound when present.

Residual sound is defined as "ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound".

The background sound level is the $L_{A90,\ T}$ of the residual sound level, and is the underlying level of sound. Measurements of background sound level should be undertaken at the assessment location where possible or at a comparable location.

The measurement time interval should be sufficient to obtain a representative value (normally not less than 15 minutes) and the monitoring duration should reflect the range of background sound levels across the assessment period. The background sound level used for the assessment should be representative of the period being assessed.

The specific sound level is the $L_{Aeq,T}$ of the sound source being assessed over the reference time interval, Tr. BS 4142: 2014 + A1: 2019 advises that Tr should be 1 hour during the day and 15 minutes at night.

The rating level is the specific sound level plus any adjustment for the characteristics that are present with the sound including tonality, impulsivity, intermittency or other acoustic characteristics. The standard describes subjective and objective methods to establish the appropriate adjustment. The characteristics and coinciding adjustments are defined as:

- Tonality: A rating penalty of + 2dB is applicable for a tone which I “just perceptible”, +4 dB where a tone is “clearly perceptible”, and +6 dB where a tone is “highly perceptible”.

- Impulsivity: A rating penalty of +3 dB is applicable for impulsivity which is “just perceptible”, +6 dB where it is “clearly perceptible”, and +9 dB where it is “highly perceptible”.

- Intermittency: When the specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on-time if the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3dB can be applied.”

- Other Sound Characteristics: Where the specific sound features that are neither tonal nor impulsive but are otherwise readily distinctive against the residual acoustic environment, a 3 dB penalty can be applied.

The level of impact is assessed by comparing the rating level with the background sound level. Typically, the greater the difference between the rating level and background sound level the greater the magnitude of impact, depending on context. A difference of +5 dB is likely to indicate an adverse impact and a difference of +10 dB is likely is likely to indicate a significant adverse impact, depending on context.

4 Environmental Noise Survey

To characterise the acoustic environment of the area, a 24-hour noise survey was carried out from the 20th - 21st February 2023.

4.1 Measurement Methodology

Unattended monitoring was carried out at one measurement position (MP1). The sound level meter was positioned on the balcony/decking space of number 39 Russell Square. The microphone was mounted onto a tripod 1.5m above the deck in free-field conditions (more than 3.5m from any reflective surfaces apart from the ground). This measurement position was chosen to obtain background sound levels that are representative of the most exposed noise sensitive receptors during the daytime and night-time periods and was an accessible and secure location to install noise monitoring equipment to be left unattended. This location is considered to be representative due to its similar proximity to local road networks such as Montague Street and Russell Square. The measurement position is shown in Figure 2.0.

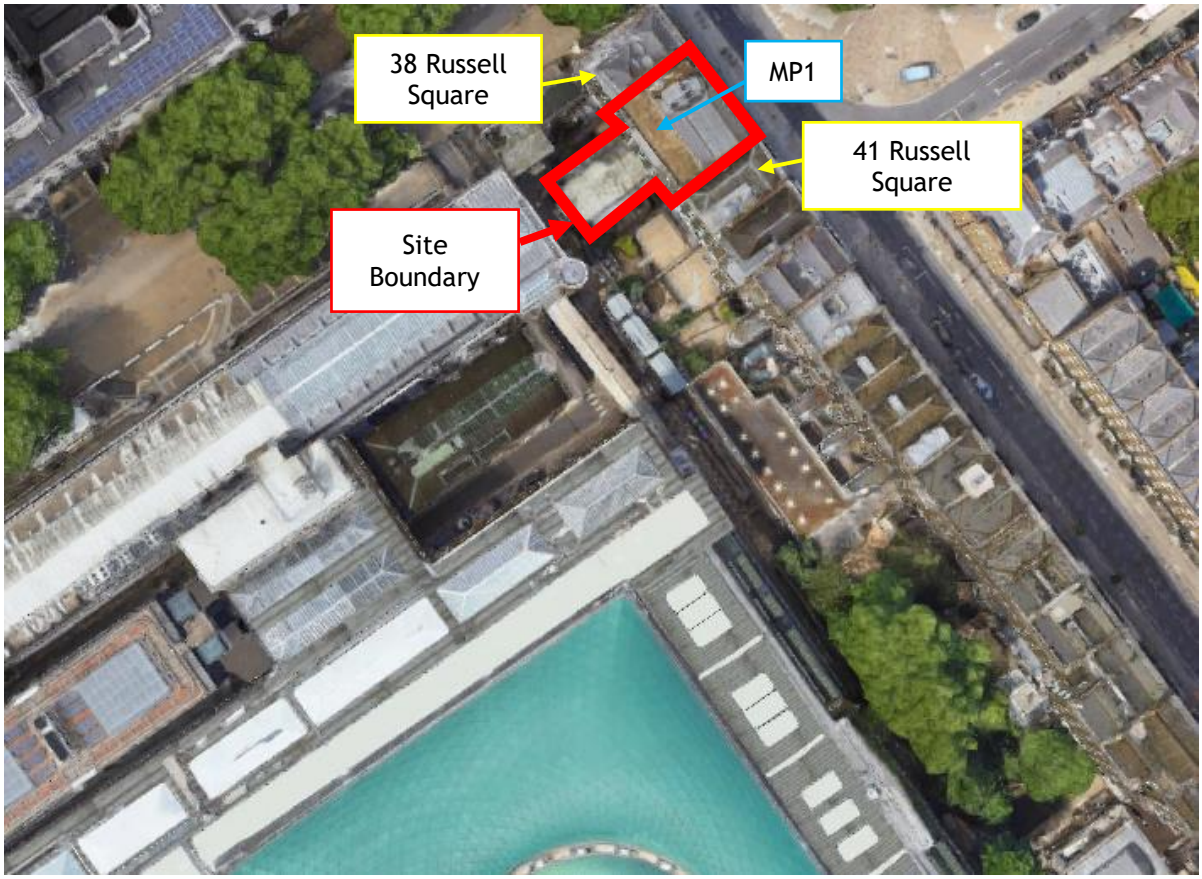


Figure 2.0 – Measurement Positions

4.2 Instrumentation

Equipment	Serial No.	Laboratory Calibration
Cirrus Optimus Green+ Class 1 Sound Level Meter	G303154	19/08/2021
Cirrus CR:515 Class 1 Acoustic Calibrator	96656	30/08/2022

Table 1.0 – Instrumentation

All sound level meters were field calibrated immediately before and after the measurement period and no significant drift (≤0.5 dB) occurred. Laboratory calibration by a third-party is carried out on all sound level meters every twenty-four months with all calibrators being calibrated every twelve months. All microphones were fitted with a protective windshield. Calibration certificates can be seen in Appendix E.

4.3 Weather Conditions

Localised meteorological conditions were recorded throughout the survey period during the measurement of the background sound levels from 20th – 21st February 2023. The conditions were in accordance with those laid out in BS 7445-2:1991 and provided no significant uncertainty to the measured data. A summary of the meteorological conditions can be found in Appendix C.

4.4 Survey Results

Time History Graphs showing the results of the automated survey can be found in Appendix B. These graphs display the 15-minute L_{A90}, L_{A10}, L_{Aeq}, and L_{AFmax} sound levels at each monitoring location throughout the survey period.

4.4.1 Background Measurement Results

The table below shows the L_{A90} measurements at MP1 during daytime hours.

Measurement Position 1			
Daytime (07:00 - 23:00)	**Typical $L_{A90,\ 15\ min}$ (mode)**	**Min. $L_{A90,\ 15\ min}$**	**Max. $L_{A90,\ 15\ min}$**
Monday – Tuesday 20 - 21/02/23	46	45	54

Table 2.0 – Operational Hours Daytime Background Measurements - MP1

The background measurements at MP1 for the night-time period are shown below.

Measurement Position 1			
Night-time (23:00 - 07:00)	**Typical $L_{A90,\ 15\ min}$ (mode)**	**Min. $L_{A90,\ 15\ min}$**	**Max. $L_{A90,\ 15min}$**
Monday – Tuesday 20 - 21/02/23	45	44	46

Table 3.0 – Operational Hours Night-time Background Measurements - MP1

It is understood that the MVHR units will only run between the hours of 09:00 – 18:00 i.e., when the workshops are occupied. The table below shows the L_{A90} measurements at MP1 during workshops operation hours.

Measurement Position 1			
Workshop Occupation Hours (09:00 - 18:00)	**Typical $L_{A90,\ 15\ min}$ (mode)**	**Min. $L_{A90,\ 15\ min}$**	**Max. $L_{A90,\ 15min}$**
Monday – Tuesday 20 - 21/02/23	48	47	54

Table 4.0 – Operational Hours Night-time Background Measurements - MP1

The tables above demonstrate the range of background sound levels at the noise sensitive receptors. Considering that the background sound levels have not been influenced by on-site activity, the $L_{A90,\ 15min}$ sound levels measured at the noise sensitive receptors during the same periods that activities were taking place are to be used for the assessment.

5 Plant Noise Emission Criteria

Based on the requirements of the local authority and the results of the environmental noise survey, we propose the following plant noise emission criteria to be achieved at the most-exposed noise sensitive window. Considering that the MVHR units are only likely to run during hours where the workshops are occupied between 09:00 and 18:00, limits for noise emissions for plant running within these hours have been set according to the statistically most-repeated figure during this time period, as show in the table below.

Plant Noise Emission Criteria (dBA)
Workshop Occupation Hours (09:00 - 18:00)
38

Table 5.0 – Plant Noise Emission Criteria – Workshop Occupation Hours

It is understood that no. 2 Mitsubishi condenser units in the lightwell will run at any time subject to indoor temperatures. Subsequently, noise emission limits from the condenser units have been set according to the he statistically most-repeated L_{A90} measurement during the daytime and night-time periods, as shown in the table below.

Plant Noise Emission Criteria (dBA)	
Daytime (07:00 - 23:00)	**Night-time (23:00 - 07:00)**
36	35

Table 6.0 – Plant Noise Emission Criteria – Daytime and Night-time

6 Noise Impact Assessment

The models and layout of the LMHR units for the ground floor have been established, thus enabling for a noise impact assessment to be carried out. Noise emissions from the items have been calculated at the worst-affected noise sensitive receptor by using manufacturer noise data. The manufacturer noise data for the model of LMHR unit is shown below.

Plant Description	Sound Power Level dB at Octave Band Centre Frequency								dB SWL
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Discharge (Ground Floor MVHR)	88	81	85	71	72	72	66	64	91
Induct Discharge (Basement MVHR)	83	84	78	81	72	72	70	71	88

Table 7.0 – MVHR Noise Data

It is understood that the exhaust for the MVHR unit in the basement is to be located on the east side of the science block but its exhaust will terminate on the south-west corner of the building. The exhaust duct is 11m long and has two bends. The following table predicts the sound pressure level at 41 Russell Square taken into account attenuation via the ductwork.

MVHR - Basement	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level	83	84	78	81	72	72	70	71	88
Main Duct Attenuation	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	69.9	70.9	64.9	67.9	58.9	58.9	56.9	57.9	68
Distance Correction (1m to 13m)	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	
Sound Pressure Level at Receptor (13m)	47.6	48.6	42.6	45.6	36.6	36.6	34.6	35.6	46

Table 8.0 – MVHR Basement - Noise Emissions Calculations (41 Russell Square)

The following table predicts the noise emissions from the MVHR unit servicing the basement at the 38 Russell Square. The exhaust is completely screened from the receptor resulting in a reduction of 10dB (BS 5228:2009).

MVHR - Basement	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level	83	84	78	81	72	72	70	71	88
Main Duct Attenuation	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Screening Attenuation	-10	-10	-10	-10	-10	-10	-10	-10	
Sound Pressure Level at 1m from Plant	59.9	60.9	54.9	57.9	48.9	48.9	46.9	47.9	58
Distance Correction (1m to 19m)	-25.6	-25.6	-25.6	-25.6	-25.6	-25.6	-25.6	-25.6	
Sound Pressure Level at Receptor (19m)	34.3	35.3	29.3	32.3	23.3	23.3	21.3	22.3	40

Table 9.0 – MVHR Basement - Noise Emissions Calculations (38 Russell Square)

It is understood that the exhausts for the MVHR units are located on the roof of the science block. The following table predicts the sound pressure level for one of the units (MVHR GF1) at 41 Russell Square taking into account attenuation via the ductwork.

MVHR - GF1	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level	88	81	85	71	72	72	66	64	91
Main Duct Attenuation	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	74.6	67.6	71.6	57.6	58.6	58.6	52.6	50.6	66
Distance Correction (1m to 13m)	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	
Sound Pressure Level at Receptor (13m)	52.3	45.3	49.3	35.3	36.3	36.3	30.3	28.3	44

Table 10.0 – MVHR GF1 Noise Emissions Calculations (41 Russell Square)

Table 11 shows the predicted sound pressure level for MVHR GF1 at 38 Russell Square.

MVHR - GF1	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level	88	81	85	71	72	72	66	64	91
Main Duct Attenuation	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	74.6	67.6	71.6	57.6	58.6	58.6	52.6	50.6	66
Distance Correction (1m to 8m)	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	
Sound Pressure Level at Receptor (8m)	56.5	49.5	53.5	39.5	40.5	40.5	34.5	32.5	48

Table 11.0 – MVHR GF1 Noise Emissions Calculations (38 Russell Square)

The following tables predict the sound pressure levels for MVHR GF2 at 41 and 38 Russell Square respectively, considering attenuation via the ductwork.

MVHR - GF2	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level	88	81	85	71	72	72	66	64	91
Main Duct Attenuation	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	75.1	68.1	72.1	58.1	59.1	59.1	53.1	51.1	67
Distance Correction (1m to 13m)	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	
Sound Pressure Level at Receptor (13m)	52.8	45.8	49.8	35.8	36.8	36.8	30.8	28.8	45

Table 12.0 – MVHR GF2 Noise Emissions Calculations (41 Russell Square)

MVHR - GF2	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level	88	81	85	71	72	72	66	64	91
Main Duct Attenuation	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	75.1	68.1	72.1	58.1	59.1	59.1	53.1	51.1	67
Distance Correction (1m to 8m)	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	
Sound Pressure Level at Receptor (13m)	57.0	50.0	54.0	40.0	41.0	41.0	35.0	33.0	49

Table 13.0 – MVHR GF2 Noise Emissions Calculations (38 Russell Square)

Two identical Mitsubishi Condensers are to be installed in the lightwell. The table below shows the noise data for the Mitsubishi MXZ-3F354VF3. It is understood that the condenser unit will only operate on the cooling cycle.

Mitsubishi MXZ-3F54VF3 Sound Pressure Level (dBA) @1m	
Heating	**Cooling**
50	46

Table 14.0 – Mitsubishi Condenser Noise Data

The following table predicts the noise emissions from the two condensers at 41 Russell Square when running simultaneously on the cooling setting, thus representing the worst case. The top of the plant is likely to be just visible from the closest first-floor window, therefore 5dB of screening attenuation has been applied (BS 5228:2009).

Item of Plant	dB_A @1m	Distance to Receptor	Propagation	Screening	dB_A @ Receptor
Mitsubishi MXZ-3F354VF3	46	5	Unit to be mounted on a reflective surface (+3dB)	-5	30.0
Mitsubishi MXZ-3F354VF3	46	4.5	Unit to be mounted on a reflective surface (+3dB)	-5	30.9
Cumulative A-weighted Sound Pressure Level					33.5

Table 15.0 – Mitsubishi Condenser Noise Emissions (41 Russell Square)

Table 16 predicts the noise emissions from the condenser units at 38 Russell Square. There is no line of sight between the units and the receptor, therefore 10dB of screening attenuation has been applied (BS 5228:2009).

Item of Plant	dB_A @1m	Distance to Receptor	Propagation	Screening	dB_A @ Receptor
Mitsubishi MXZ-3F354VF3	46	15	Unit to be mounted on a reflective surface (+3dB)	-10	15.5
Mitsubishi MXZ-3F354VF3	46	15.5	Unit to be mounted on a reflective surface (+3dB)	-10	15.2
Cumulative A-weighted Sound Pressure Level					18.3

Table 16.0 – Mitsubishi Condenser Noise Emissions (38 Russell Square)

This section demonstrates that the plant noise limits are likely to be exceeded at the most exposed noise sensitive receptors when the MVHR units are running. Subsequently, mitigation measures are required to ensure that The London Borough of Camden criteria can be achieved.

6.2 Mitigation Measures

In order to control plant noise emissions to comply with the requirements of The London Borough of Camden, we recommend an appropriate attenuator being installed between the fan and the outlet of the MVHR units. The follow table recommends attenuation values for an in-line silencer which should reduce plant noise emissions to below appropriate limits.

Description	Insertion Loss (dB) at Octave Band Centre Frequency							
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz
Sound Attenuator – ELTA MODEL CP01 – M31 -120	6	9	14	23	32	32	18	15

Table 17.0 – Recommended Sound Attenuator Attenuation Values

The table below predicts the plant noise emissions at 41 Russell Square if a silencer with the insertion loss performance stated above was to be implemented for all MVHR units in the science block.

Description	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level – Basement MVHR	83	84	78	81	72	72	70	71	88
Attenuator Insertion Loss	-6	-9	-14	-23	-32	-32	-18	-15	
Main Duct Attenuation	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	63.9	61.9	50.9	44.9	26.9	26.9	38.9	42.9	50
Distance Correction (1m to 13m)	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	
Sound Pressure Level at Receptor	**41.6**	**39.6**	**28.6**	**22.6**	**4.6**	**4.6**	**16.6**	**20.6**	**23**
Induct Sound Power Level – MVHR GF1	88	81	85	71	72	72	66	64	91
Attenuator Insertion Loss	-6	-9	-14	-23	-32	-32	-18	-15	
Main Duct Attenuation	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	68.6	58.6	57.6	34.6	26.6	26.6	34.6	35.6	51

Distance Correction (1m to 13m)	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	
Sound Pressure Level at Receptor	**46.3**	**36.3**	**35.3**	**12.3**	**4.3**	**4.3**	**12.3**	**13.3**	**24**
Induct Sound Power Level – MVHR GF1	88	81	85	71	72	72	66	64	91
Attenuator Insertion Loss	-6	-9	-14	-23	-32	-32	-18	-15	
Main Duct Attenuation	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	69.1	59.1	58.1	35.1	27.1	27.1	35.1	36.1	51
Distance Correction (1m to 13m)	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	
Sound Pressure Level at Receptor	**46.8**	**36.8**	**35.8**	**12.8**	**4.8**	**4.8**	**12.8**	**13.8**	**28.9**
Cumulative Sound Pressure Level at Receptor	**50.2**	**42.6**	**39.0**	**23.4**	**9.4**	**9.4**	**19.1**	**22.1**	**33.9**

Table 19.0 – MVHR – Cumulative Sound Pressure Level at 41 Russell Square – Including Mitigation

The following table the plant noise emissions at 38 Russell Square if a silencer with the insertion loss performance stated in table 17 was to be implemented for all MVHR units in the science block.

Description	Sound Pressure Level dB at Octave Band Centre Frequency								dBA
	63Hz	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	8KHz	
Induct Sound Power Level – Basement MVHR	83	84	78	81	72	72	70	71	88
Attenuator Insertion Loss	-6	-9	-14	-23	-32	-32	-18	-15	
Main Duct Attenuation	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Screening Attenuation	-10	-10	-10	-10	-10	-10	-10	-10	
Sound Pressure Level at 1m from Plant	53.9	51.9	40.9	34.9	16.9	16.9	28.9	32.9	50
Distance Correction (1m to 19m)	-25.6	-25.6	-25.6	-25.6	-25.6	-25.6	-25.6	-25.6	
Sound Pressure Level at Receptor	**28.3**	**26.3**	**15.3**	**9.3**	**-**	**-**	**3.3**	**7.3**	**15**
Induct Sound Power Level – MVHR GF1	88	81	85	71	72	72	66	64	91
Attenuator Insertion Loss	-6	-9	-14	-23	-32	-32	-18	-15	
Main Duct Attenuation	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	68.6	58.6	57.6	34.6	26.6	26.6	34.6	35.6	51
Distance Correction (1m to 8m)	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	
Sound Pressure Level at Receptor	**50.5**	**40.5**	**39.5**	**16.5**	**8.5**	**8.5**	**16.5**	**17.5**	**33**
Induct Sound Power Level – MVHR GF2	88	81	85	71	72	72	66	64	91
Attenuator Insertion Loss	-6	-9	-14	-23	-32	-32	-18	-15	
Main Duct Attenuation	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	
Duct Bend Attenuation	-4	-4	-4	-4	-4	-4	-4	-4	
Directionality	+3	+3	+3	+3	+3	+3	+3	+3	
Distance Correction (0m to 1m)	-11	-11	-11	-11	-11	-11	-11	-11	
Sound Pressure Level at 1m from Plant	69.1	59.1	58.1	35.1	27.1	27.1	35.1	36.1	51

Distance Correction (1m to 8m)	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	-18.1	
Sound Pressure Level at Receptor	**51.0**	**41.0**	**40.0**	**17.0**	**9.0**	**9.0**	**17.0**	**18.0**	**28.9**
Cumulative Sound Pressure Level at Receptor	**53.8**	**43.9**	**42.8**	**20.2**	**11.8**	**11.8**	**19.9**	**21.0**	**35.6**

Table 20.0 – MVHR – Cumulative Sound Pressure Level at 38 Russell Square – Including Mitigation

The above tables indicate that if a silencer with a performance equal to that stated in table 17 was to be fitted, the noise emissions from the MVHR units should fall below the noise criterion of 38dB$_A$ at each of the closest noise sensitive receptors when they are running simultaneously.

7 Conclusions

A sound survey was undertaken to establish the prevailing acoustic climate for the refurbishment of 39 Russell Square and the Science Block at The British Museum, London. Sound measurements were taken at one location to represent the most exposed noise sensitive receptors, 41 Russell Square and 38 Russell Square.

Plant noise emission criteria have been set according to the requirements of The London Borough of Camden.

An environmental noise impact assessment has been carried out to determine the plant noise emissions from building services plant associated with the refurbishment.

The environmental noise impact assessment predicts that noise emissions from the building services plant will exceed the stipulated plant noise emission limits at the closest noise sensitive receptor.

Mitigation measures have been recommended to reduce plant noise emissions to fall in-line with The London Borough of Camden criteria.

The mitigation measures suggested in this report, if sufficiently implemented, are predicted to reduce the plant noise emissions to fall in-line with the requirements of The London Borough of Camden.

This Report has been prepared by:

Encon Associates Limited

10 Chapel Lane

Arnold

Nottingham

NG5 7DR

Tel: 0115 987 55 99

Email: ben@enconassociates.com

Signed for and on behalf of Encon Associates Limited

Ben Phipps BSc (Hons), AMIOA

Acoustic Consultant

Date: 14th July 2023

Appendix A – Acoustic Terminology & Definitions

Sound Pressure	The fluctuations in air pressure, from the steady atmospheric pressure, created by sound, measured in pascals (Pa).
Sound Pressure Level (SPL)	The sound pressure measured on a decibel scale relative to a standard reference pressure of 20μPa (20x10-6 Pascals).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
Frequency (Hz)	The pitch of the sound, measured in Herts (Hz)
Integrating Sound Level Meter	An instrument used for measuring sound levels with the capacity to perform calculations to derive other parameters.
Calibration	A check of the function of a sound level meter by comparing the meter reading with a known sound pressure level. This is performed in the field before and after measurement and by a laboratory every year calibrators and every two years for Sound Level Meters.
A-Weighting, dB(A)	A frequency waiting devised to attempt to take the fact that human response to sound is not equally sensitive at all frequencies into account.
Z-Weighting	A zero frequency weighting (often referred to as unweighted).
Attenuation	Noise reduction, measured in decibels.
Ambient Sound Level $L_{Aeq.T}$	The total encompassing sound in a given situation, at a given time. Usually composed of sounds from many sources, near and far.
Residual Sound Level $L_{Aeq.T}$	The ambient sound remaining when the specific sound source is suppressed to a degree it does not contribute to the ambient sound.
Specific Sound Level $L_{Aeq.T}$	The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr
Rating Level $L_{Ar,\ tr}$	The specific sound level plus any adjustment for the characteristic features of the sound
Background Sound Level $L_{A90.T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.
Frequency Analysis	Analysis of a sound into its frequency components. Commonly 1/1 or 1/3 octave bands
Frequency Spectrum	A graph resulting from frequency analysis and showing different levels of the signal in the various frequency bands.
Octave-bands	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
Noise Index	A method of evaluating or rating a noise, usually by assigning a single number to it, based on some combination of its physical parameters (sound pressure level, frequency, duration) and other factors such as time of day, tonal characteristics and impulsive characteristics.
Leq, T	Otherwise referred to as the 'continuous equivalent noise level' of a period of time (T). This is the steady noise level which contains the same amount of energy as the time varying sound level that was recorded.
Lmax,T	The maximum RMS sound pressure level that occurs within a specified time period. It is used often to describe occasional loud noise events that may have little influence on the Leq but will have an effect on the overall acoustic environment. The time weighting (Fast or Slow) is usually specified.

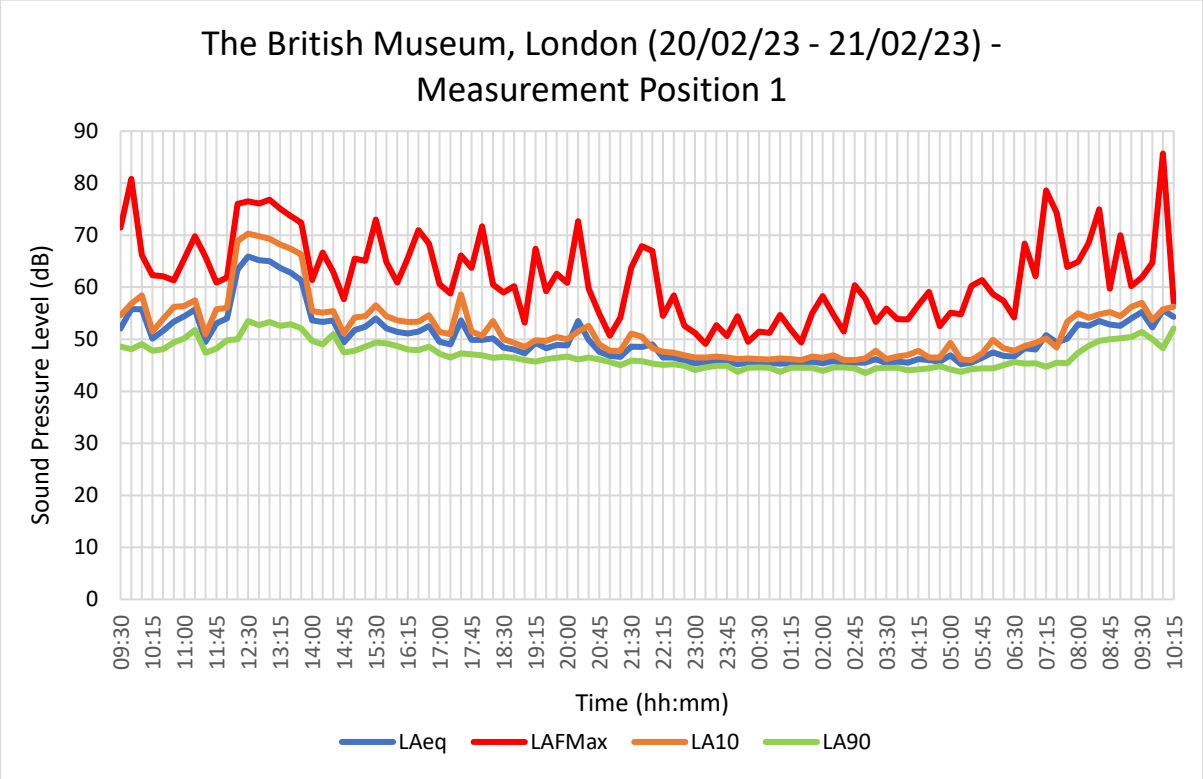
L90, T	The noise level exceeded for 90% of the specified time period (T). It is often used to characterise the background noise.
L10, T	The noise level exceeded for 10% of the specified time period (T). It is often used to characterise road traffic noise.
Free-Field	A situation where the radiation from a sound source is completely unaffected by the presence of reflective surfaces. In terms of environmental noise measurement, it is usually taken to mean at least 3.5m away from 3.5m away from reflective surfaces with the exception of the ground.
Façade Noise Level	A noise level measured within 3m of a building façade, which contains a contribution arising from reflection of sound at the façade. The difference between the façade level and free-field level is described as the façade correction factor.
Noise Sensitive Receptor	Premises that are used for purposes sensitive to noise and that require protection.
Line Source	A source of sound that as distance increases away from the source it still appears large in one dimension. Attenuation of this form of source occurs at a distance of (a/π) where a is the largest dimension of the source.
Point Source	A source of sound that as distance increases away from the source it appears as a point in space. Attenuation of this form of source occurs at a distance of (b/π) where b is the smallest dimension of the source.
Time Weighting	One of the standard averaging times (Fast, Slow or Impulsive) used for the measurement of RMS sound pressure level in sound level meters, specified in ISO 61671-1.
Rw	Single number quantity which characterises the airborne the airborne sound insulation of a material or building element over a range of frequencies, based on laboratory measurements.
DnT,w + Ctr	A single value that characterises the airborne sound insulation performance using the Ctr: spectrum adaption terms described in BS EN ISO 717-1. The value is based on field measurements and the value represents total sound transmission including flanking sound, not just the partition.

The table below presents an indication of sound levels associated with the environment starting from 0dB (the threshold of hearing) to 140dB (The threshold of pain).
cat

Sound Level	Location/Activity
0 dB(A)	Threshold of Hearing
20 – 30 dB(A)	Inside Quiet Bedroom at Night
30 – 40 dB(A)	Inside a Living Room During the Day
40 – 50 dB(A)	Inside Typical Office
50 – 60 dB(A)	Inside a Car
60 – 70 dB(A)	Typical High Street
70 – 90 dB(A)	Inside Factory
100 – 110 dB(A)	Burglar Alarm at 1m
110 – 130 dB(A)	Jet Aircraft on Take Off
140 dB(A)	Threshold of Pain

The 'A' denotes the A-weighting scale used to replicate the frequency response of the human ear.

Appendix B – Time History Graphs



Appendix C - Weather Conditions

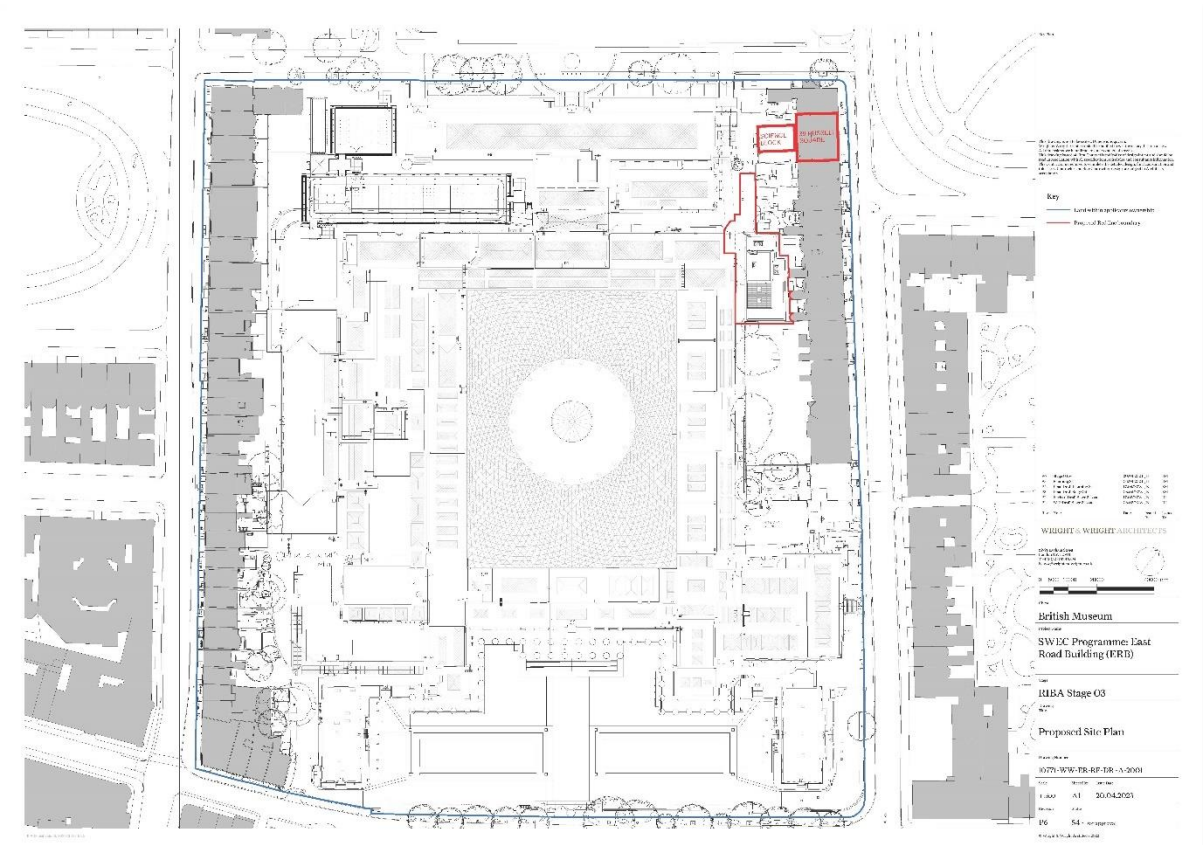
Upon installation of the noise monitoring equipment at MP1 on 20/02/2023 the sky had <90% cloud cover. When the equipment collected on the morning of 21/02/23, the sky had <90% cloud cover. No rainfall precipitation occurred when sound levels were being measured 20/02/23 – 21/02/23. Measurements were taken using a Kestrel 5500 weather meter.

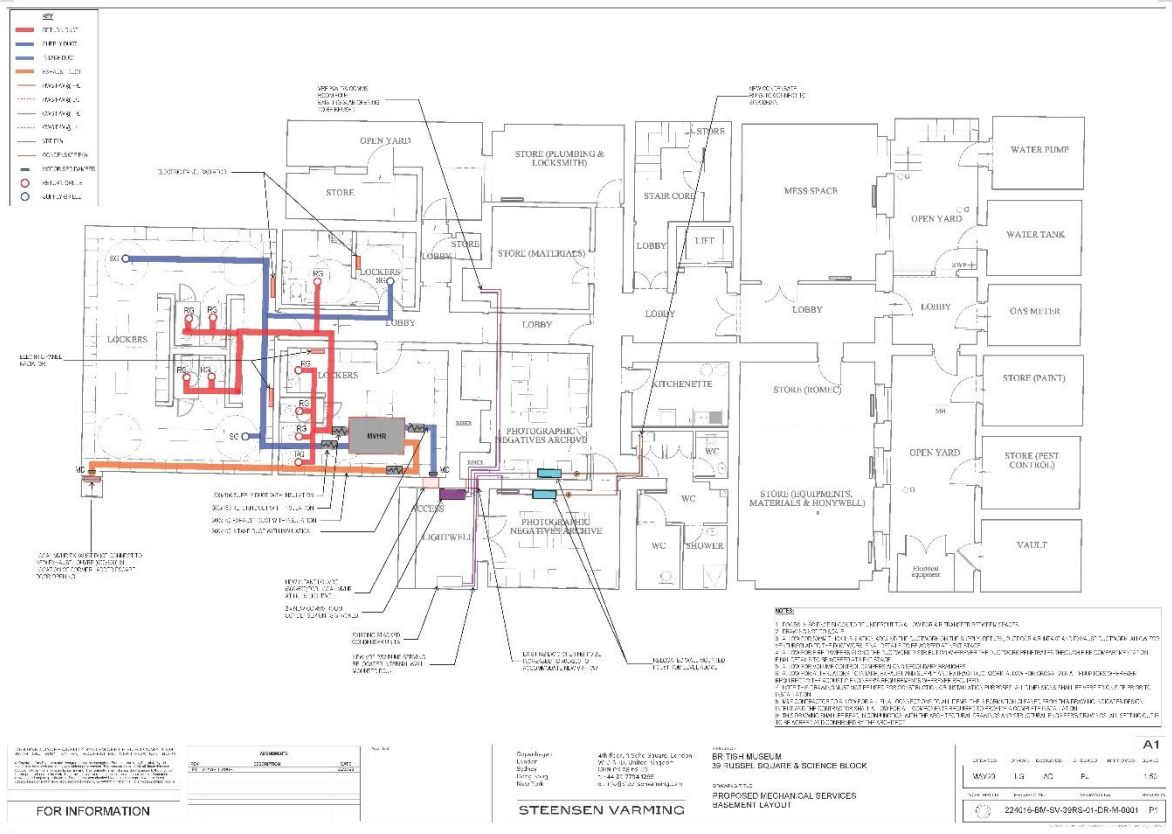
Device Information:					
Name:	WEATHER - 2655332				
Model:	5500				
Serial:	2655332				
Firmware:	1.47				
Profile Version:					
Hardware Version:	Rev 14				
LiNK Version:	1.04.04				
Time	Temp	Rel. Hum.	Wind Speed	Mag. Dir.	
yyyy-MM-dd hh:mm:ss	Celsius	%	m/s	Degrees	
20/02/2023 09:40	9.3	85.4	0.5	32	
20/02/2023 09:50	9	85.9	3.8	334	
20/02/2023 10:00	9.4	85.2	1.5	321	
20/02/2023 10:10	9.6	84.4	0.6	112	
20/02/2023 10:20	9.8	82.7	1.3	352	
20/02/2023 10:30	9.9	83.1	0.7	108	
20/02/2023 10:40	10.1	82.4	0	59	
20/02/2023 10:50	9.7	82.3	1.3	134	
20/02/2023 11:00	10	82.3	0.7	57	
20/02/2023 11:10	10.1	82.3	0.9	135	
20/02/2023 11:20	10.1	82.3	1.2	332	
20/02/2023 11:30	10.3	82.5	1.6	336	
20/02/2023 11:40	10.8	82.7	1.7	354	
20/02/2023 11:50	10.9	82.9	0	109	
20/02/2023 12:00	11.1	83	1	128	
20/02/2023 12:10	11.3	83.2	1	345	
20/02/2023 12:20	11.6	83.5	2	119	
20/02/2023 12:30	11.8	83.6	0.9	358	
20/02/2023 12:40	11.7	83.7	0.5	96	
20/02/2023 12:50	11.9	83.9	1.8	20	
20/02/2023 13:00	11.6	84	1.8	129	
20/02/2023 13:10	12.1	84.3	1.4	130	
20/02/2023 13:20	11.9	84.4	2.2	68	
20/02/2023 13:30	12	84.3	0.6	121	
20/02/2023 13:40	12	84.3	2.4	0	
20/02/2023 13:50	12.2	84.3	0.5	20	
20/02/2023 14:00	12	84.1	2.1	195	
20/02/2023 14:10	12.5	84	0.3	142	
20/02/2023 14:20	12.4	83.8	0.4	125	
20/02/2023 14:30	12	83.7	3.6	344	
20/02/2023 14:40	12	83.4	1.8	118	
20/02/2023 14:50	12	83.2	1.9	217	
20/02/2023 15:00	12	83	2.6	348	
20/02/2023 15:10	12.1	82.9	0.8	351	
20/02/2023 15:20	12.3	82.7	1.2	131	
20/02/2023 15:30	12.5	82.7	0.7	118	
20/02/2023 15:40	12.4	82.5	0.4	83	
20/02/2023 15:50	12.6	82.3	0.5	203	
20/02/2023 16:00	12.7	82.2	0.5	109	
20/02/2023 16:10	12.5	81.8	1.3	354	
20/02/2023 16:20	12.5	81.5	2.3	316	
20/02/2023 16:30	12.5	81.1	0.5	96	

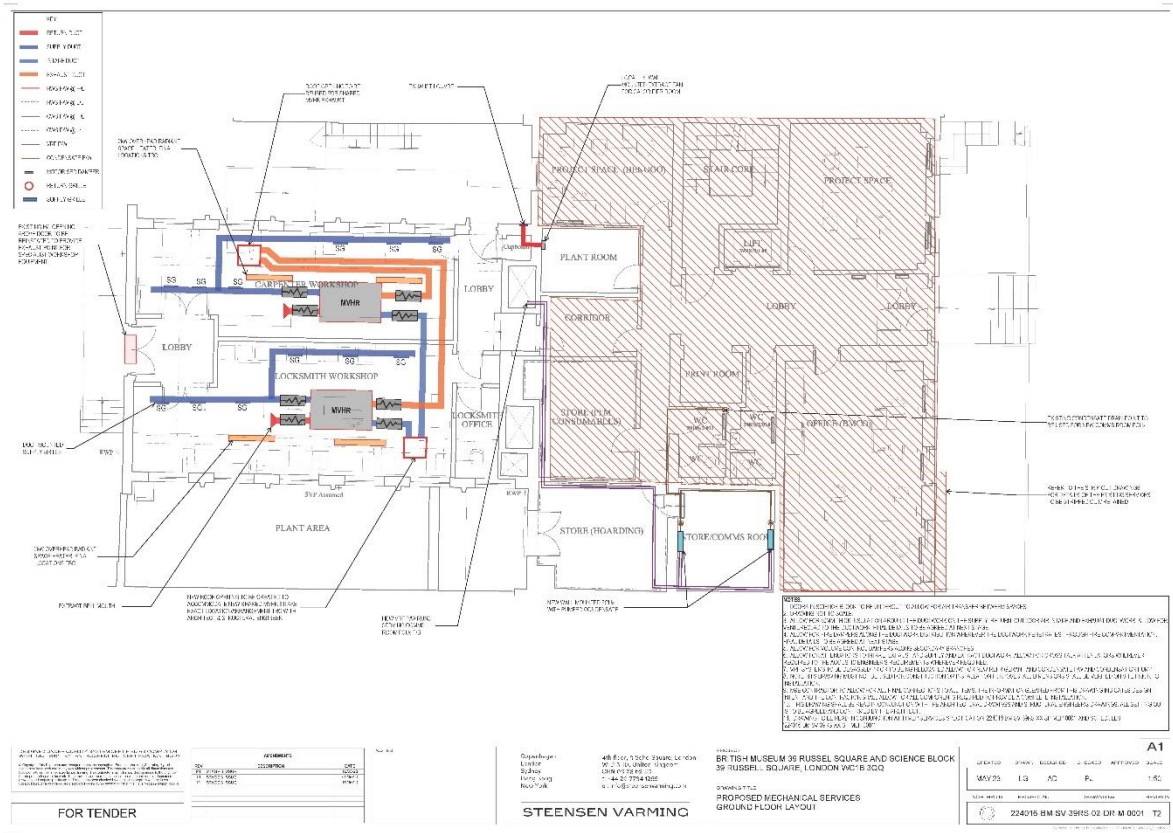
20/02/2023 16:40	12.4	80.8	0.6	162		
20/02/2023 16:50	12.3	80.5	0	123		
20/02/2023 17:00	12.4	80.3	0	347		
20/02/2023 17:10	12.2	80	0	125		
20/02/2023 17:20	12.1	79.7	1.6	124		
20/02/2023 17:30	11.9	79.5	2.8	338		
20/02/2023 17:40	11.8	79.3	0.5	59		
20/02/2023 17:50	11.6	79	1	134		
20/02/2023 18:00	11.2	78.7	1.1	18		
20/02/2023 18:10	11.3	78.5	1.3	336		
20/02/2023 18:20	11.2	78.4	0.4	94		
20/02/2023 18:30	11.1	78.4	0.9	128		
20/02/2023 18:40	10.9	78.3	0.5	311		
20/02/2023 18:50	10.9	78.3	0	342		
20/02/2023 19:00	11	78.3	0.6	339		
20/02/2023 19:10	11	78.4	0	49		
20/02/2023 19:20	11.1	78.4	0.8	341		
20/02/2023 19:30	11	78.5	0.6	323		
20/02/2023 19:40	10.8	78.4	0.6	324		
20/02/2023 19:50	10.9	78.4	1.8	239		
20/02/2023 20:00	10.8	78.4	1.4	130		
20/02/2023 20:10	10.6	78.3	1.1	161		
20/02/2023 20:20	10.5	78.3	0.9	336		
20/02/2023 20:30	10.6	78.3	1.7	341		
20/02/2023 20:40	10.5	78.4	1.2	189		
20/02/2023 20:50	10.3	78.5	0.6	294		
20/02/2023 21:00	10.3	78.5	1.1	119		
20/02/2023 21:10	10.2	78.5	1.3	304		
20/02/2023 21:20	10.2	78.7	1.3	7		
20/02/2023 21:30	10.1	78.7	0.4	302		
20/02/2023 21:40	10.1	78.8	3	313		
20/02/2023 21:50	9.7	78.8	0.8	321		
20/02/2023 22:00	9.8	78.8	1	205		
20/02/2023 22:10	10	79	0.5	127		
20/02/2023 22:20	9.7	79.1	0.3	311		
20/02/2023 22:30	9.8	79.2	2	344		
20/02/2023 22:40	9.9	79.3	0	189		
20/02/2023 22:50	9.8	79.5	0.5	106		
20/02/2023 23:00	9.7	79.6	0.6	227		
20/02/2023 23:10	9.8	79.8	0	326		
20/02/2023 23:20	9.6	80	0.9	326		
20/02/2023 23:30	9.6	80.1	0	322		
20/02/2023 23:40	9.5	80.2	2.5	344		
20/02/2023 23:50	9.5	80.3	1.1	18		
21/02/2023 00:00	9.4	80.4	0.4	19		
21/02/2023 00:10	9.6	80.6	1.1	117		
21/02/2023 00:20	9.6	80.7	0.6	196		
21/02/2023 00:30	9.6	80.8	1.1	5		
21/02/2023 00:40	9.6	81	1.1	8		
21/02/2023 00:50	9.6	81.2	2.4	256		
21/02/2023 01:00	9.5	81.3	1.8	346		
21/02/2023 01:10	9.6	81.4	1.3	304		
21/02/2023 01:20	9.5	81.3	1.5	57		

21/02/2023 01:30	9.5	81.4	1	73			
21/02/2023 01:40	9.6	81.5	1.3	349			
21/02/2023 01:50	9.6	81.5	0.5	81			
21/02/2023 02:00	9.6	81.6	2.1	274			
21/02/2023 02:10	9.4	81.6	0.9	128			
21/02/2023 02:20	9.4	81.5	1.3	313			
21/02/2023 02:30	9.4	81.5	0.5	102			
21/02/2023 02:40	9.4	81.6	1.7	47			
21/02/2023 02:50	9.4	81.7	0.8	346			
21/02/2023 03:00	9.3	81.7	0.8	332			
21/02/2023 03:10	9.3	81.9	2.7	316			
21/02/2023 03:20	9.2	82	1.2	346			
21/02/2023 03:30	9.2	82.2	0.8	233			
21/02/2023 03:40	9	82	2.1	294			
21/02/2023 03:50	9.2	82	0.7	214			
21/02/2023 04:00	9.1	82	0.4	167			
21/02/2023 04:10	9.1	82	0.5	133			
21/02/2023 04:20	9.1	82	0.8	130			
21/02/2023 04:30	9.1	82.1	1.1	333			
21/02/2023 04:40	9	82.2	0.6	18			
21/02/2023 04:50	8.9	82.3	0.5	148			
21/02/2023 05:00	8.8	82.3	0.5	189			
21/02/2023 05:10	9	82.3	0	9			
21/02/2023 05:20	9	82.4	0.7	173			
21/02/2023 05:30	9	82.5	0.7	352			
21/02/2023 05:40	8.8	82.6	0.5	339			
21/02/2023 05:50	8.8	82.5	0.4	298			
21/02/2023 06:00	8.9	82.6	0	133			
21/02/2023 06:10	8.6	82.5	0.9	293			
21/02/2023 06:20	8.5	82.5	0.4	337			
21/02/2023 06:30	8.4	82.5	0.7	170			
21/02/2023 06:40	8.4	82.5	1.6	143			
21/02/2023 06:50	8.3	82.4	0.5	353			
21/02/2023 07:00	8.1	82.2	0.8	115			
21/02/2023 07:10	8.1	82.1	1.3	341			
21/02/2023 07:20	8.1	82	0.5	213			
21/02/2023 07:30	8.2	82.1	0	107			
21/02/2023 07:40	8.2	82.1	0	192			
21/02/2023 07:50	8.3	82.2	0.9	354			
21/02/2023 08:00	8.2	82.3	0.4	0			
21/02/2023 08:10	8.2	82.5	0	142			
21/02/2023 08:20	8.3	82.7	0.4	269			
21/02/2023 08:30	8.2	82.8	0.8	331			
21/02/2023 08:40	8.4	83.1	0	293			
21/02/2023 08:50	8.6	83.5	0.5	239			
21/02/2023 09:00	8.5	83.6	0.4	35			
21/02/2023 09:10	8.7	83.8	0.5	111			
21/02/2023 09:20	8.7	83.8	0.4	39			
21/02/2023 09:30	8.6	83.9	0.5	116			
21/02/2023 09:40	8.9	84.2	0.7	292			
21/02/2023 09:50	9.2	84.4	0	146			
21/02/2023 10:00	9.2	84.5	0.4	83			
21/02/2023 10:10	9.2	84.6	0	127			

Appendix D – Site Plan






PROJECT SPACE (HOARDING)
STAIR CORE
PROJECT SPACE
PLANT ROOM
LIFT
CARPENTER WORKSHOP
MVHR
LOBBY
CORRIDOR
LOBBY
LOBBY
LOCKSMITH WORKSHOP
MVHR
PRIVY ROOM
LOCKSMITH OFFICE
STORE (HOARDING)
W.C.
W.C.
OFFICE (HOARDING)
W.C.
PLANT AREA
STORE (HOARDING)
STORE/COMMS ROOM
FOR TENDER
STEENSEN VARMING
BRITISH MUSEUM 35 RUSSEL SQUARE AND SCIENCE BLOCK
39 RUSSELL SQUARE, LONDON WC1B 3QQ
PROPOSED MECHANICAL SERVICES
GROUND FLOOR LAYOUT
A1
224016 BIM SV 39RS 02 DR M 0001 T2

Appendix E – Instrument Calibration Certificates

CERTIFICATE OF CALIBRATION

ISSUED BY **Cirrus Research plc**

DATE OF ISSUE **19 August 2021** CERTIFICATE NUMBER **161679**

Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

Page 1 of 2

Approved signatory
M.McDonald
Electronically signed:

M J McDonald

Sound Level Meter : IEC 61672-3:2013

Instrument information

Manufacturer:	Cirrus Research plc	Notes:
Model:	CR:171B	
Serial number:	G303154	
Class:	1	
Firmware version:	5.6.3177	

Test summary

The calibration was performed respecting the requirements of ISO/IEC 17025:2017.
Periodic tests were performed in accordance with procedures from IEC 61672-3:2013.

The sound level meter submitted for testing successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to determine that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Notes

CERTIFICATE OF CALIBRATION

Certificate Number: **161679**

Page 2 of 2

Environmental conditions

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

Before	Pressure:	99.97 kPa	Temperature:	22.0 °C	Humidity: 43 %
After	Pressure:	99.91 kPa	Temperature:	22.2 °C	Humidity: 43 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Signal Generator	TTi	TGA1241	439193
Attenuator	Cirrus Research	ZE 952	80381
Environmental Monitor	Comet	T7510	17963955

Additional instrument information

Instruction manual:

Reference level range: Single range

Pattern approval: No

Source of pattern approval: -

Preamplifier

Model: MV:200F

Serial number: 11733F

Microphone

Model: MK:224

Serial number: 214535A

Test results summary

Test	Result
Toneburst response	Complies
Electrical noise-floor	Complies
Linearity	Complies
Electrical Frequency weightings	Complies
Frequency and time weightings at 1 kHz	Complies
C-weighted peak	Complies
Overload indication	Complies
High level stability	Complies
Long-term stability	Complies

CERTIFICATE OF CALIBRATION

ISSUED BY	Cirrus Research plc		
DATE OF ISSUE	19/08/21	CERTIFICATE NUMBER	161681

Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

Page 1 of 2

Test engineer:
D.Swalwell
Electronically signed:

Microphone

Microphone capsule

Manufacturer: Cirrus Research plc

Model: MK:224

Serial Number: 214535A

Calibration procedure

Open circuit: 45.9 mV/Pa

Sensitivity at 1 kHz: -26.8 dB rel 1 V/Pa

The microphone capsule detailed above has been calibrated to the published data as described in the operating manual of the associated sound level meter (where applicable).

The frequency response was measured using an electrostatic actuator in accordance with BS EN 61094-6:2005 with the free-field response derived via standard correction data traceable to a National Measurement Institute.

The absolute sensitivity at 1 kHz was measured using an acoustic calibrator conforming to IEC 60942:2003 Class 1.

Environmental conditions

Pressure: 99.60 kPa

Temperature: 20.0 °C

Humidity: 31.0 %

CERTIFICATE OF CALIBRATION

Certificate Number
161681

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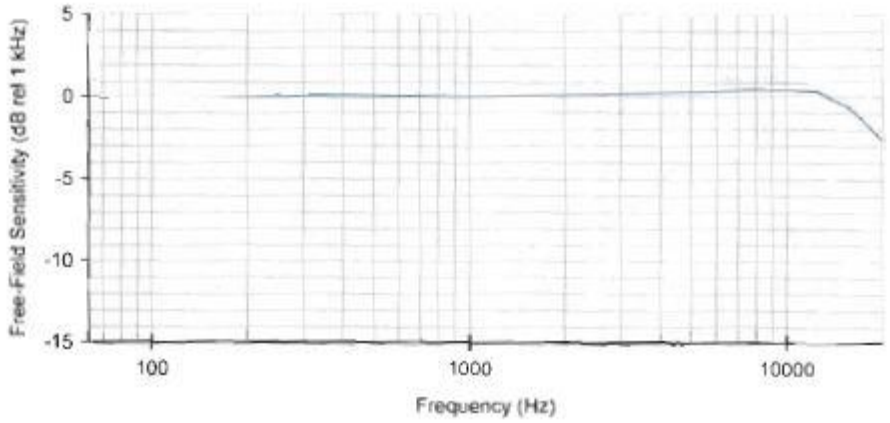
Free-Field Frequency Response : Tabular

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
63	0.01	-0.19
80	0.02	-0.07
100	0.00	-0.06
125	0.03	0.02
160	0.03	0.04
200	0.02	0.05
250	0.03	0.06
315	0.01	0.01
400	0.01	0.03
500	0.01	0.02
630	0.01	0.02
800	0.02	0.01
1 000	0.00	-0.02
1 250	0.01	-0.04
1 600	0.03	-0.08
2 000	0.06	-0.15
2 500	0.09	-0.25
3 150	0.14	-0.43
4 000	0.19	-0.70
5 000	0.26	-1.09
6 300	0.36	-1.71
8 000	0.46	-2.70
10 000	0.37	-4.25
12 500	0.32	-6.19
16 000	-0.75	-8.70
20 000	-2.59	-11.71

Free-Field Frequency Response : Graphical



Laboratory Location
Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, GB-CM6 1HD
Phone 01371 871030

Certificate of Calibration and Conformance

Certificate number: **U41812**

Test Object: **Sound Calibrator**

Producer: **Cirrus**
Type: **515**
Serial number: **96656**
Customer: **Encon Associates Ltd**
Address: **10 Chapel Lane, Arnold, Nottingham, NG5 7DR**
Contact Person: **Benjamin Daniel Phipps**
Order No:

Measurement Results	Level dB	Level Stability dB	Frequency Hz	Distortion %
Measurement 1	93.86	0.02	1000.30	0.76
Measurement 2	93.88	0.01	1000.30	0.82
Measurement 3	93.89	0.01	1000.29	0.65
Result (Average):	**93.88**	**0.01**	**1000.30**	**0.74**
Expanded Uncertainty:	0.1	0.02	1	0.27
Degree of Freedom:	>100	>100	>100	>100
Coverage Factor:	2	2	2	2

The stated level is relative to 20µPa. The level is traceable to National Standards. The stated level is valid at reference conditions. The following correction factors have been applied during the measurement
Pres:0 dB/kPa Temp:0 dB/°C Humi:0 dB/%RH Load volume: 0 dB/mm3

Conditions	*Pressure kPa*	*Temperature °C*	*Humidity %RH*
Reference conditions	101.325	23	50
Measurement conditions	101.704 ±0.040	21.9 ±0.1	49.8 ±1.6

The reported expanded uncertainty of measurements is based on a standard uncertainty multiplied by the coverage factor of k=2, providing a level of confidence of approximately 95%. Where the degrees of freedom are insufficient to maintain this confidence level, the coverage factor is increased to maintain this confidence level. The uncertainty has been determined in accordance with UKAS requirements.

Records: K:\C A\Calibration\Nor-1504\Nor-1018 CalCal\2022\CIR515_96656_M1.nmf

Preconditioning
The equipment was preconditioned for more than 4 hours in the specified calibration environment.

Method
Calibration has been performed as set out in the current version of CA Technical procedure TP01

Calibration Dates:

Received date:	19/08/2022	Reviewed date:	31/08/2022
Calibration date:	30/08/2022	Issued date:	31/08/2022

Technicians: (Electronic certificate)
Calibrated by: *David Egan*
Reviewed by: *Jenny Crawford*

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It 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.

Doc ref: Calb-Cert-Master-V3-05

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Certificate of Calibration and Conformance

Continuation of Certificate number: **U41812**

Reference Microphone: WSM5 - B&K4192-2496459

Measurements

The calibrator has been tested as described in the following annexes to BS EN IEC60942:2003 Sound Calibrators; B3.4 for sound pressure level, B3.5 for frequency, B3.6 for total distortion and A4.4 for short term stability of the pressure level.

Instruments and Program
A complete list of instruments, hardware and software that have been used for this calibration is available from the calibration laboratory

Comments

Statement of Conformance and Calibration
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 BS EN IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of that BS EN IEC 60942:2003.

*This evidence is held on file at the calibration laboratory.

Observations:
Continued on next page.

Certificate of Calibration and Conformance

Continuation of Certificate number: **U41812**

Decision Rule:
The decision rules have been applied in accordance with the procedure as described in BS EN 60942:2003

This certificate relates only to the items tested above.

** End of Certificate **