8.23 STABLE BLOCK & CAFE - ACOUSTIC REPORT

RIBA Stage 3 Acoustic Design Review

Marble Hill Stable Block Cafe

Twickenham

TW1 2NL

HRS Services Ltd.

HRS Ref: 124898 – AC – 2v1

Compiled By	Authorised By		
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I. Revision History

Revision	Description	Date	Approved
2v1	First Issue	27/01/2017	IS

II. Executive Summary

HRS Services Ltd (HRS) has undertaken a Stage 3 acoustic design review for the proposed new Marble Hill Stable Block Café. The development involves construction of a an extension to the existing Stable Block building to form a new café and Kitchen, along with limited refurbishment of the existing Stable Block building.

Good practice indoor ambient noise level criteria have been proposed for newly formed and refurbished spaces based on guidance in BS 8233:2014 '*Guidance on sound insulation and noise reduction for buildings*'. Based on typical site daytime ambient noise levels measured by HRS during proposed opening hours it is anticipated that the design range internal ambient noise level criteria proposed can be met with ventilation by open windows where required. Where mechanical ventilation systems are to be installed guidance is provided on suitable noise levels.

Internal sound insulation of the scheme has been assessed and guidance is provided in meeting the proposed airborne sound insulation requirements.

Reverberation control in the newly formed Café is to be provided by acoustic treatment to the soffit formed of timber slats backed with acoustically absorbent insulation wool. It is recommended that the system provides a minimum Class C acoustic absorption. It is recommended that an allowance should be made for Class D acoustic ceiling tiles in the newly formed Kitchen area.

HRS has proposed building services noise limits at identified noise sensitive receptors (NSRs) most exposed to the proposed scheme in line with guidance outlined in '*London Borough of Richmond upon Thames: SPD'*. It is recommended that external noise from new building services plant does not exceed 5 dB below the existing representative background noise level when assessed at the nearest noise sensitive receptors in line with BS 4142:2014 '*Methods for rating and assessing industrial and commercial sound'*. BS 4142:2014 states that this is an indication of the specific sound source having a low impact.

III. Contents

1. Introduction

1.1 HRS Services Ltd. (HRS) has been appointed by English Heritage to provide acoustic consultancy services for the proposed new Marble Hill Stable Block Cafe located within Marble Hill Park, Twickenham.

1.2 The proposed development involves expansion of the existing Marble Hill Stable Block café by means of a new build extension to the west of the existing building to provide a new café with internal and external facilities to cater for 140 dining covers.

1.3 The purpose of this report is to provide an acoustic specification for the development of the Marble Hill Stable Block Cafe. The report will consider sound insulation between noise sensitive spaces, reverberation control and the acoustic impact of external plant noise. Based on these, recommendations are provided to inform the acoustic design of the scheme. These recommendations may change as the scheme develops and may therefore need to be updated accordingly. Information was up-to-date at the time of issue.

1.4 This document has been prepared for the sole use, benefit and information of English Heritage for the purposes set out in the document or instructions commissioning the works. The liability of HRS in respect of the information contained herein will not extend to any third party.

1.5 This report is limited to addressing the specific acoustic issues contained herein and is based on information and drawings provided by the client.

1.6 Whilst every effort has been made to ensure that this report is easy to understand, it is technical in nature; to assist the reader, a glossary of terminology is included in Appendix III.

2. Site Description

2.1 The development site is located within Marble Hill Park in the London Borough of Richmond upon Thames. The existing stable block is located towards the western boundary of the park, adjacent to Montpelier Row.

2.2 The development proposals involve construction of a single storey extension to the west of the existing Stable Block providing a café, with associated kitchen and ancillary facilities. The extension will form a courtyard to the west of the existing Stable Block building.

2.3 Figure 1 shows an aerial view of the existing site overlaid with the proposed development scheme.

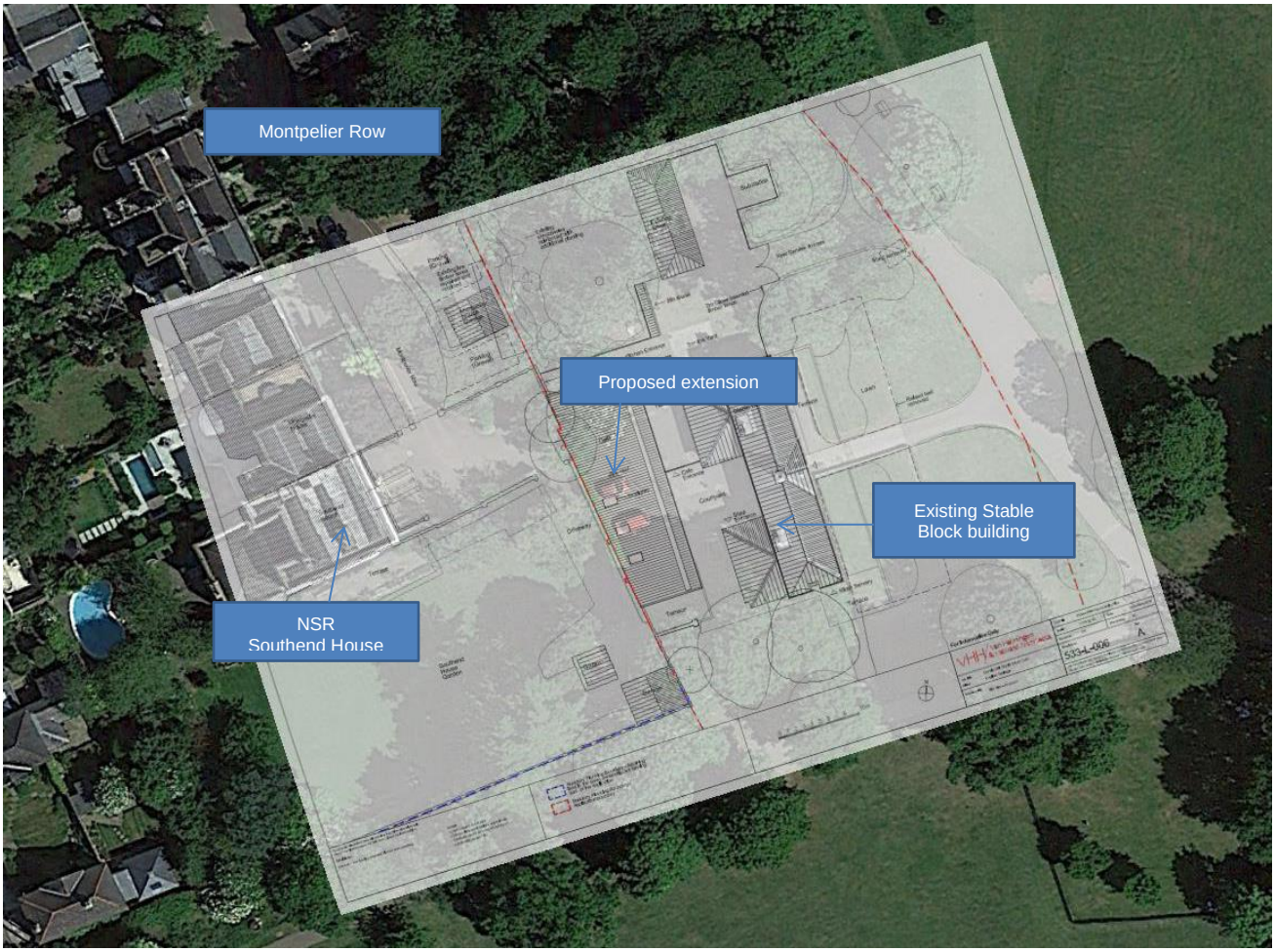


Figure 1: Aerial view of development site with extension proposal

2.4 The nearest identified noise sensitive receptors (NSR) are residential houses located on Montpelier Row to the west of the proposed development site. The closest is Southend House, a three storey residential dwelling with garden /external amenity areas located to the south of the main house bordering onto the proposed café development.

Development Proposals

2.5 HRS understands that the new café extension will provide an internal dining area with a kitchen to the north sized to cater for a maximum of 140 covers. Additional external seating will be provided to the east of the existing stable block building and under a canopy formed by the overhanging pitched roof of the proposed new Café building.

2.6 It is understood that limited refurbishment is to be undertaken within the existing Stable Block building, primarily installing new lightweight partitions to subdivide the existing café space.

3. Standards and Guidance

BS 8223:2014 'Guidance on sound insulation and noise reduction for buildings' (BS 8233)

3.1 BS 8233 provides design guidance for internal acoustic environments within buildings according to their end use. It addresses noise transfer from outside the building, internal sound insulation, room acoustics and noise from plant and services.

End User Requirements

3.2 HRS is not aware of any specific employer or end user acoustic requirements for the scheme. Any identified requirements that may affect the acoustic design of the scheme should be forwarded to HRS.

London Borough of Richmond upon Thames: Supplementary Planning Document - Noise Generating and Noise Sensitive Development

3.3 '*Development Control for Noise Generating and Noise Sensitive Development'* issued by London Boroughs of Hillingdon, Hounslow and Richmond Upon Thames in July 2014 provides planning guidance on acoustic design and requirements applicable to new noise sensitive and noise generating developments.

3.4 With reference to new noise generating commercial developments, the guidance references assessment in line with BS4142:2014 *'Methods for rating and assessing industrial and commercial sound'*, and states that noise impact from relevant proposed industrial or commercial premises or plant with a Rating Level $L_{Ar,Tr}$ at least 5 dB(A) below the background sound level would be "normally acceptable".

BS 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142)

3.1 BS 4142 describes a method for assessing the likelihood of complaints from noise sources that are of an industrial nature (e.g. fans, pumps, chillers, air handling units etc.). The assessment methodology is based upon determining a 'rating level' for the equipment being assessed, which is the level of noise from the item or items of plant being assessed (measured as $L_{Aeq,T}$).

3.2 The rating level is then compared with the underlying background noise level (measured as a L_{A90}) in the absence of noise from the item or items of plant being assessed.

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

3.3 BS 4142 states that a penalty should be added for any plant which gives rise to noise features that may increase disturbance such as tonal, impulsive or intermittent characteristics. With respect to the acoustic feature correction, BS 4142 states:

3.4 "*Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level."*

3.5 Generally a rating penalty for a sound should be based on a subjective assessment of its characteristics.

4. Internal Ambient Noise Levels

4.1 Noise monitoring was undertaken by HRS in order to assess the existing site noise climate and background sound level. Noise monitoring equipment was located to the west of the existing Stable Block building, at the boundary wall separating Mable Hill Park from Southend House. The microphone was mounted on a pole above to boundary wall at a height of approximately 3.5m, therefore measurements are considered to be free field.

4.2 The full noise survey methodology and detailed results are included in Appendix I of this report.

4.3 Section 7 of BS 8233 provides guidance on appropriate internal ambient noise levels for various types of building. Internal ambient noise criteria applicable to this project are outlined in Table 1.

Table 1: BS 8233 typical noise levels for non-domestic buildings

Room/Area	Classification	Design Range $L_{Aeq,T}$ dB
Café	Restaurant	40 - 55
Kitchen	Kitchen	50 - 55
Shop	Gallery	40 - 50
Staff Welfare	Staff / Meeting room	35 - 45
Office	Cellular Office	40 - 50[1]
WCs	Washroom, Toilet	45 – 55[1]

[1] - Guidance is taken from BS 8233:1999 *'Sound insulation and noise reduction for buildings - Code of practice'*

4.4 It should be noted that the internal ambient noise limits include the total noise from all building services, generated both internally and externally, as well as noise from external sources such as building services plant and road traffic. Therefore, noise emission from internal building services must be designed to be sufficiently below the internal ambient noise limit so that cumulative noise levels remain within the relevant criterion. Further guidance is provided in section 7 of this report.

4.5 Based on existing site noise levels measured by HRS, the indoor ambient noise levels outlined in Table 1 will be achieved with typical solid façade constructions and glazing, with no identified requirements to enhance the sound insulation of the building envelope.

4.6 It is recommended that roof lights to the Café are formed of double glazed glass units comprising two panes of minimum 6mm glass separated by minimum 12mm airspace in order to control external noise ingress and rain noise.

4.7 Typical site daytime ambient noise levels measured by HRS during typical Café opening hours ranged from 47 – 57 dB $L_{Aeq,T}$. The sound insulation provided by partially open windows is typically considered to be 15 dB, therefore based on existing measured site noise levels it is anticipated that the design range internal ambient noise level criteria outlined in Table 1 can be met with ventilation by open windows where required.

5. Internal Sound Insulation

5.1 Sound insulation between the Kitchen and Servery / Café area of the new building will be limited by the presence of doors to access the Kitchen. It is recommended that an acoustic doorset rated at 30 dB R_w set in a partition rated at a minimum of 40 dB R_w is recommended to be used. It is anticipated that hygiene requirements may limit the use of acoustic seals to kitchen doors; in which case it may not be practically possible to meet the proposed acoustic criterion.

5.2 HRS understands that new partitions are to be installed to the existing Stable Block to separate the existing Café area into four separate spaces. Table 3 of BS 8233 provides guidance for on-site sound insulation performance of separating walls based on privacy requirements, source room activity noise and receiving room noise sensitivity, as outlined below.

Table 3 Example on-site sound insulation matrix (dB $D_{nT,w}$)

Privacy requirement	Activity noise of source room	Noise sensitivity of receiving rooms		
		Low sensitivity	Medium sensitivity	Sensitive
Confidential	Very high	47	52	57 [A)]
	High	47	47	52
	Typical	47	47	47
	Low	42	42	47
Moderate	Very high	47	52	57 [A)]
	High	37	42	47
	Typical	37	37	42
	Low	No rating	No rating	37
Not private	Very high	47	52	57 [A)]
	High	37	42	47
	Typical	No rating	37	42
	Low	No rating	No rating	37

NOTE Background noise can also influence privacy. See also 7.7.6.3.

[A)] $D_{nT,w}$ 55 dB or greater is difficult to obtain on site and room adjacencies requiring these levels should be avoided wherever practical.

Figure 2: BS8233 sound insulation matrix (table 3 of BS8233:2014)

5.3 The only newly formed space considered noise sensitive is the Staff Welfare room within the existing Stable Block building, adjacent to the newly formed serving Kiosk. Based on BS 8233 guidance a sound insulation requirement of 42 dB $D_{nT,w}$ is proposed between the Staff Welfare and the adjacent Kiosk. In order to achieve a sound insulation of 42 dB $D_{nT,w}$ it is recommended that a partition with minimum laboratory sound insulation performance of 50 dB R_w is selected. This requirement could typically be met with a lightweight partition build-up of 1 x 15 mm British Gypsum SoundBloc board each side of a 92mm stud with 50mm insulation wool to the cavity, although alternative build-ups may be suitable depending on requirements.

5.4 Where partitions are to be installed, their in-situ performance may be limited by sound transfer via flanking elements. Careful consideration of junction details between partitions and other structures will be necessary in order to maintain sound insulation performance. Proposals should be forwarded to HRS for review at the appropriate design stage.

5.5 To achieve the sound insulation $D_{nT,w}$ performances set out above, the recommended minimum partition performances in terms of the R_w laboratory test performance parameter are indicated in the Acoustic Criteria mark-up in Appendix II of this report.

6. Room Acoustics

New Café

6.1 There is little existing guidance on appropriate reverberation times within commercial cafes and restaurants, however HRS consider an average reverberation time of ≤ 1.0 seconds between 500 Hz and 2 kHz to be an appropriate target. This allows the noise level within the room to provide some acoustic masking, providing privacy between adjacent tables whilst avoiding excessive internal noise levels.

6.2 In order to assess reverberation control within the new café, an acoustic model has been created using CATT acoustic software. Acoustic modelling uses ray tracing techniques to approximate sound waves as rays, analogous to light rays. The software does not fully account for the wave properties of sound and therefore there are some inherent inaccuracies and approximations within the software. Notwithstanding, without the use of physical scale models of a space, ray tracing software is the most accurate currently available prediction method for the acoustics of an internal space.

6.3 HRS understands that the café is to feature an acoustically reflective polished concrete floor, and soffit formed of timber slats backed with acoustically absorbent insulation wool to the underside of the mono-pitched roof. The area of flat soffit above the servery is to be solid plasterboard. Courtyard elevations are fully glazed, the western internal wall is to be formed of exposed brickwork.

6.4 The acoustic model incorporates the proposed room geometry and surface finishes, in order to predict the reverberation time in the finished space. Figure 3 provides an overview of the modelled space.

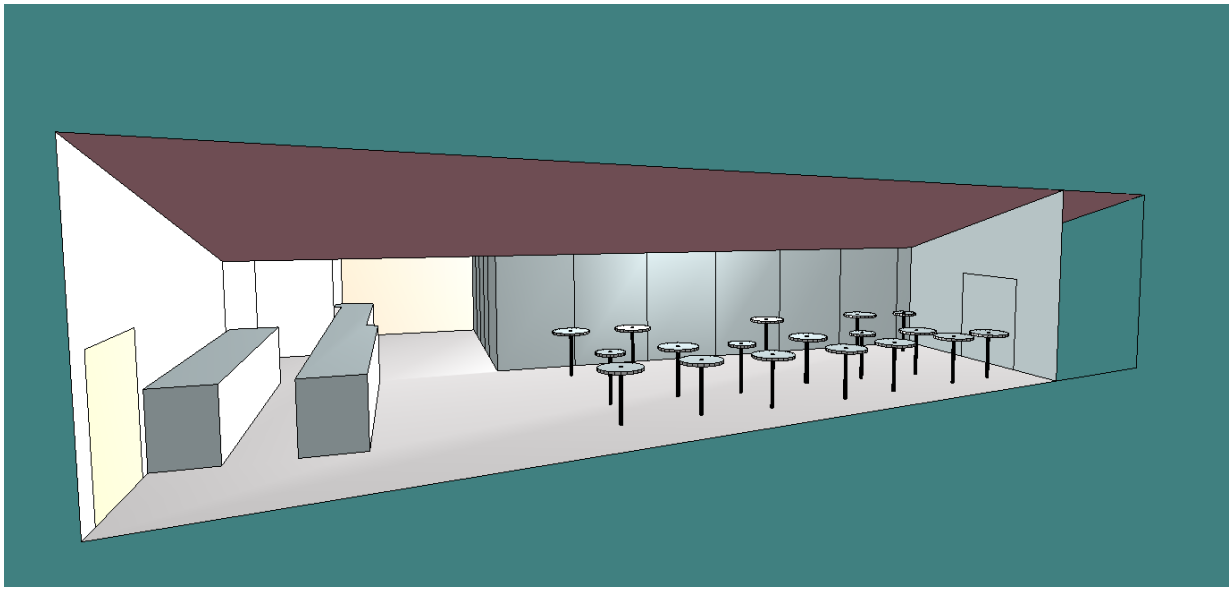


Figure 3: Acoustic model of Café

6.5 In order to meet the reverberation time target of ≤ 1.0 seconds it is recommended that underside of the mono-pitch soffit provides minimum Class C acoustic absorption ($\alpha_w \geq 0.6$, as defined in BS EN ISO 11654:1997)

6.6 The proposed timber slat ceiling is suitable to provide the required Class C absorption. Calculations indicate that timber slats of width 25 mm and depth 20 mm, separated by 25 mm spacing and backed by 50 mm thick mineral wool insulation of density 48 kg/m^3 will meet the identified absorption requirement. Other proposals can be reviewed to estimate acoustic absorption and suitability.

Kitchen

6.7 HRS understands that a lay in grid ceiling is proposed within the Kitchen. To control reverberation and noise build up within the kitchen it is recommended that minimum Class D absorbent ceiling tiles ($\alpha_w \geq 0.3$, as defined in BS EN ISO 11654:1997) are allowed for.

Refurbished areas

6.8 HRS understands that existing ceilings, understood to be plasterboard, are to be retained and made good within the refurbished areas of the Stable Block building. As such opportunities for reverberation control will be limited in these areas. Based on proposed room volumes and typical furnishings it is expected that reverberation times in refurbished spaces will be ≤ 1.0 seconds at 500 Hz, which is considered suitable for office, catering and ancillary areas.

7. Mechanical Services Noise

Internal Mechanical Services Noise

7.1 It should be noted that the internal ambient noise limits include the total noise from all building services, generated both internally and externally, as well as noise from external sources. Therefore, noise emission from internal building services must be designed to be sufficiently below the internal ambient noise limit so that cumulative noise levels remain within the relevant criterion.

7.2 It is recommended that generally any building services systems are designed such that resulting services noise levels are at least 5 dB below the internal ambient noise level limits in Table 1 to allow for contributions from all noise sources, including external nose break in through the facade/glazing.

7.3 It should be ensured that all building services plant is appropriately mounted in order to reduce the transmission of vibration into the building structure. It is recommended that advice is sought from equipment manufacturers regarding the use and installation of appropriate isolating materials, taking into account, amongst other things, the frequency of vibrations produced and the loads involved.

7.4 Preferably, there should be no service penetrations of walls between occupied spaces. Where ductwork passes through partition walls, it may be necessary to use crosstalk attenuation to maintain the acoustic integrity of the partition. This will be particularly critical for high activity noise rooms and rooms with a low noise tolerance. It may be necessary to provide acoustic lagging to ducts where these pass across occupied areas.

7.5 Where mechanical ventilation systems are proposed, recommended M&E noise limits for newly formed spaces are outlined in Table 2 based on Chartered Institution of Building Services Engineers (CIBSE) guidance. The limits presented are cumulative for all internal building services noise affecting the space, inclusive all noise sources.

Table 2: CIBSE Recommended Comfort Criteria for Internal Building Services 2015

Space	Noise M&E noise Criterion	
	dB $L_{Aeq,T}$	NR
Café	40	35
Kitchen	45	40
Shop	40	35
Staff Welfare	35	30
Office	35	30
WCs	40	35

7.6 Criteria are specified in terms of Noise Rating (NR) levels, as defined in Annex B of BS 8233 and should be calculated in terms of the L_{eq} noise index.

7.7 The criteria shall apply to any normally occupied position within the fit-out, with the measurement microphone positioned between 1.2 m and 1.5 m from the floor and least 1.5 m from any relevant noise source. Noise levels shall be “steady” in nature and shall not demonstrate any characteristic(s) that will serve to attract attention such as tonality or impulsive characteristics.

External Mechanical Services Noise

7.8 In line with guidance outlined in *‘London Borough of Richmond upon Thames: Supplementary Planning Document - Noise Generating and Noise Sensitive Development’* it is recommended that external noise from new building services plant does not exceed 5 dB below the existing representative background noise level when assessed at the nearest noise sensitive receptor in line with BS 4142. BS 4142 states that this is an indication of the specific sound source having a low impact.

7.9 Based on HRS measured background noise survey data, assessment in accordance with BS 4142 indicates that total emission levels for plant noise, including acoustic feature corrections where applicable, should not exceed the maximum Rating Level value provided in Table 3.

7.10 It is recommended that the relevant building services engineers are made aware of the proposed plant noise limits in order to inform plant unit specification and selection.

Table 3: BS 4142 Recommended maximum plant noise limits

Location	Daytime (07:00 – 23:00)	
	Representative background noise level range dB $L_{A90,T}$	**BS 4142:2014 Rating Level dB $L_{Ar,Tr}$**
Residential Dwellings on Montpelier Row including gardens	37	32

7.11 The Rating Level described above should be assessed in accordance with BS 4142:2014, including appropriate consideration of any tonal or impulsive characteristics of the proposed building services plant. It is prudent to ensure that building services noise is designed to be sufficiently below the recommended plant noise limit criteria such that the cumulative noise level from all sources does not exceed the stated target level.

7.12 HRS understands that new building services plant associated with the scheme comprises two condenser units located to the north of the new building in an enclosure formed of a timber louvre to

allow air flow. The kitchen is to be services by a supply air handling unit and extract fan, both contained within the building envelope and ducted to air supply and discharge louvres located on the northern building elevation. Atmosphere side attenuators are to be provided in order to control noise emissions such that the criterion in Table 3 is met.

7.13 HRS understands that proposed condenser units have a noise level of 42 dB $L_{Aeq,T}$ at 5 m from source. Based on this noise level calculations indicate that proposed condenser units will meet the rating level proposed in Table 3.

7.14 In order to meet the identified plant noise rating level atmosphere side attenuators will be required for both the supply Air Handling Unit and the Kitchen extract fan. Based on manufacturers noise data supplied to HRS, the following minimum atmosphere side attenuator insertion loss requirements have been identified. These requirements should be fully reviewed if plant selections, ducting layouts or locations are revised as the design develops.

Table 4: Atmosphere attenuators - minimum insertion loss requirements

Unit	Octave Band Insertion Loss Hz, dB							
	63	125	250	500	1k	2k	4k	8k
Supply AHU Atmosphere side	0	0	9	15	13	12	10	6
Extract Fan Atmosphere side	0	0	0	2	10	5	2	0

Appendix I. HRS Noise Survey

Noise monitoring was carried out in order to assess the existing noise climate during the daytime and night-time periods. Measurements were taken between 16 and 20 December 2016.

Noise levels were measured using a UKAS calibrated 01dB Cube precision integrating sound level meter equipped with audio recording facility. Calibration checks were carried out both before and after the measurements with no significant variance observed, calibration certificates are available on request. Noise was measured in terms of broadband A-weighted indices and spectral terms to assist with the design of noise control measures.

Weather conditions during HRS' site attendance on 16th and 20th December 2016 were dry and calm with wind speeds less than 5 m/s. HRS understands that weather during the cause of the unattended survey predominantly dry, with average and maximum wind speed less than 5 m/s. A weather summary for the nearest weather station located at Heathrow airport is summarised below, taken from www.wunderground.com.

Date	Mean Temperature (°C)	Average Wind Speed (m/s)	Max Wind Speed (m/s)	Precipitation (mm)
16.12.16	8	1.9	3.6	0
17.12.16	6	1.1	3.6	0
18.12.16	6	1.4	3.6	0
19.12.16	5	1.7	3.1	0.8
20.12.16	6	2.8	4.7	0

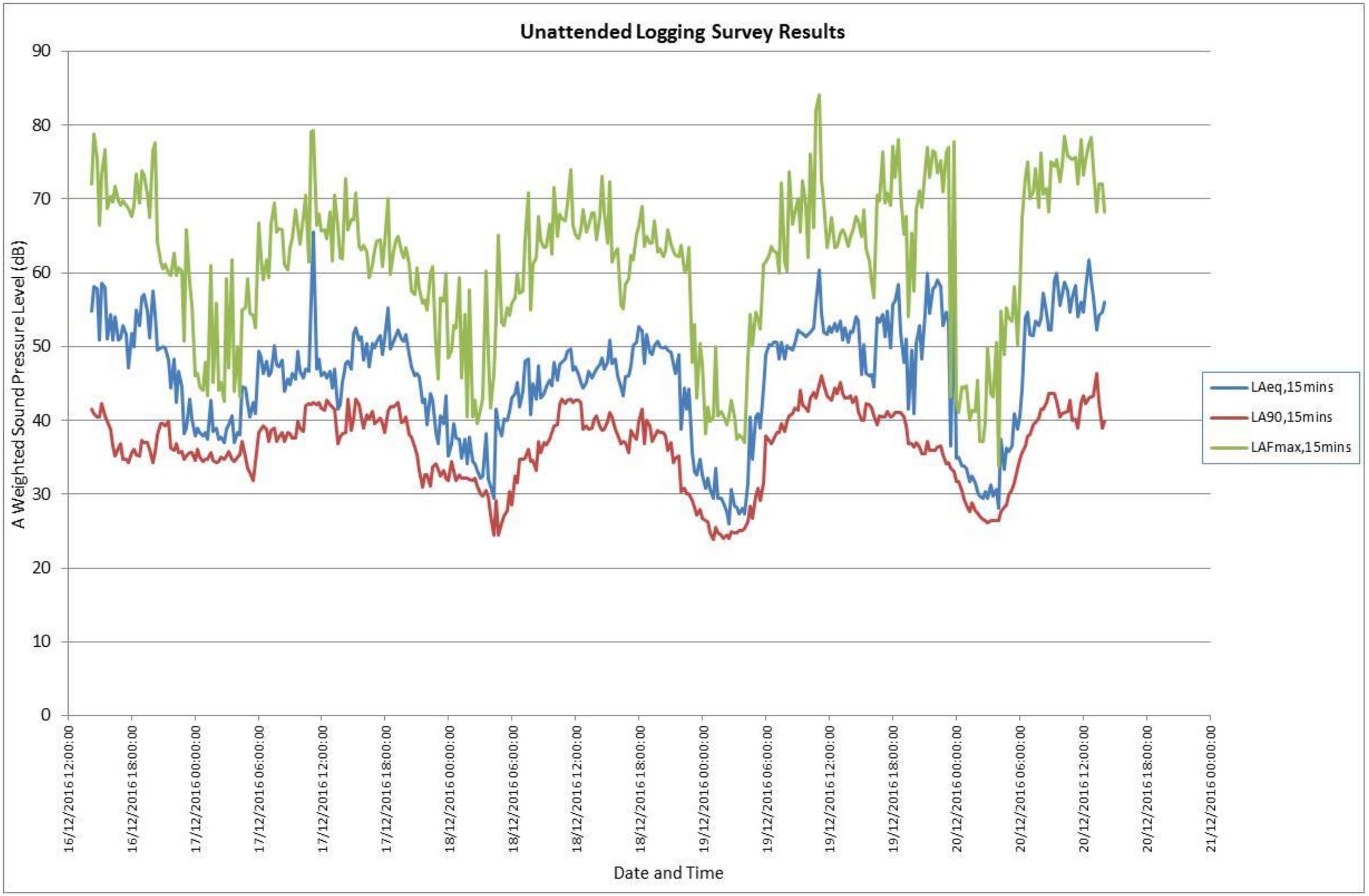
Noise monitoring equipment was located to the west of the existing Stable Block building, at the boundary wall separating Mable Hill Park from South End House. The microphone was mounted on a pole above to boundary wall at a height of approximately 3.5 m, therefore measurements are considered to be free field. A photo of the location is included in Figure A1.

Noise monitoring equipment was set to measure all typical broadband noise indices in 15 minute logging periods, as well 1/3 octave spectral data. The noise monitor was installed on Friday 16th December 2016, and continued monitoring until Tuesday 20th December 2016.

A site plan indicating the noise measurement location is shown in Figure A1.

Figure A1: Location of noise monitoring equipment

The representative daytime background sound level has been assessed in line with guidance outlined in BS4142:2014 as 37dB $L_{A90,15mins}$.


Unattended Logging Survey Results
A Weighted Sound Pressure Level (dB)
90
80
70
60
50
40
30
20
10
0
16/12/2016 12:00:00
16/12/2016 18:00:00
17/12/2016 00:00:00
17/12/2016 06:00:00
17/12/2016 12:00:00
17/12/2016 18:00:00
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19/12/2016 18:00:00
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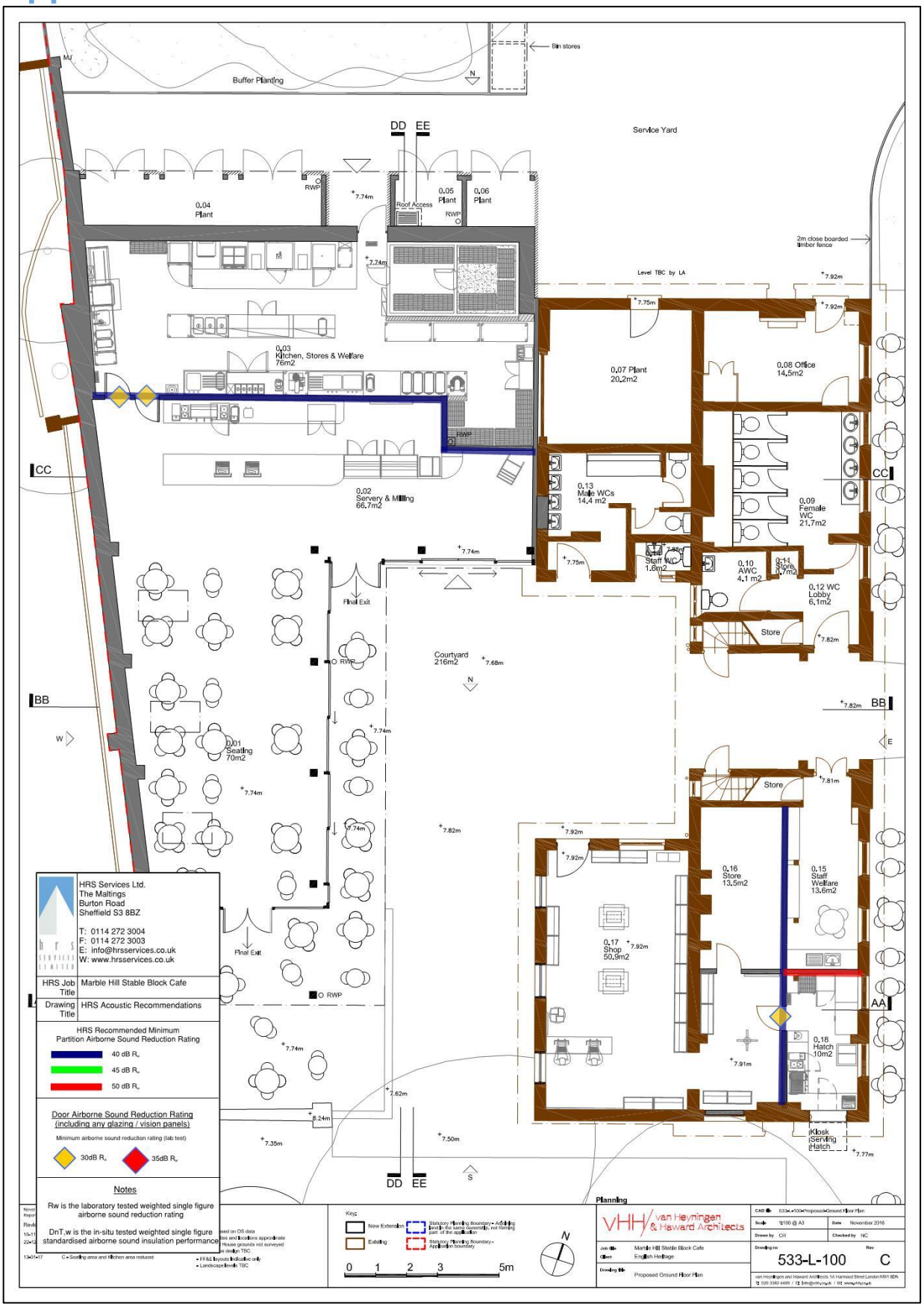
20/12/2016 06:00:00
20/12/2016 12:00:00
20/12/2016 18:00:00
21/12/2016 00:00:00
Date and Time
LAeq,15mins
LA90,15mins
LAFmax,15mins

Appendix II. Sound Insulation Recommendations



Appendix III. Acoustic Glossary

Sound pressure level and the decibel, dB

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. The decibel is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120 dB (threshold of pain).

Frequency and hertz, Hz

Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kilohertz (kHz), where 1 kHz = 1000 Hz. The human range of hearing is commonly accepted to be 20 Hz to 20,000 Hz. Additionally, an octave can be used to describe the interval between a frequency in Hz and either half or double that frequency.

Frequency weighting

Different weighting networks can be applied to a given sound level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The most commonly used weighting network is the 'A' weighting, and the letter 'A' will be included within a descriptor to indicate that the value has been 'A' weighted, e.g. $L_{Aeq,T}$ or L_{A90}. An 'A' weighted noise level may also be written as dB(A). Other weightings less commonly used are 'C' and 'D' weighting.

Noise indices

When a noise level varies with time, the measured 'A' weighted dB level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple 'A' weighted dB value. In order to describe noise where the level is continuously varying, a number of other indices, including statistical parameters, are used. The various indices used are described as below:

$L_{Aeq,T}$	The 'A' weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period, *T*
L_{Amax}	The maximum 'A' weighted noise level that was recorded during the monitoring period.
L_{A10}	The 'A' weighted noise level that was recorded for at least 10% of the monitoring period.
L_{A90}	The 'A' weighted noise level that was recorded for at least 90% of the monitoring period, usually taken as the underlying 'background' noise level.

Sound level difference, *D*

The sound level difference between two internal spaces, or between internal and external spaces. The '*D*' value is used to denote the differences at each third octave or octave band, with a single figure 'weighted'

value to describe an overall performance. Note that the '*D*' value will always describe an in-situ or on-site acoustic performance. All values are described using the decibel.

D_w	Single figure weighted sound level difference, simply the measured source noise level minus receiver noise level, not adjusted to reference conditions
$D_{nT,w}$	Weighted normalised sound level difference – a single, weighted sound insulation value, normalised to a reference reverberation time using the measured reverberation time in the receive room
$D_{nT,w} + C_{tr}$	As above, with a spectral adaptation term applied to account for the effects of low frequency noise, and based on urban traffic noise
$D_{nf,w}$	Overall flanking normalised level difference - A parameter that defines the flanking transmission of sound from room to room where a dividing partition or floor construction abuts a flanking building element common to both rooms, such as the building façade or ceiling

Sound reduction index, *R*

This describes the sound transmitted through a material or building element, such as a wall, door or window. It is measured in a laboratory with suppressed flanking transmission. The '*R*' value is used to denote the differences at each third octave or octave band, with a single figure 'weighted' value to describe an overall performance. All values are described using the decibel.

R_w	Weighted single figure sound reduction index
$R_w + C_{tr}$	As above, with a spectral adaptation term applied to account for the effects of low frequency noise, and based on urban traffic noise
R'_w	The 'apparent sound reduction index', a field measurement to obtain the sound reduction index of a material or element, with all effects of site installation accepted.

Standardised impact sound pressure level, $L'_{nT,w}$

$L'_{nT,w}$ is the single figure used to characterise the impact sound pressure level in a receiving room, normalised to a reference reverberation time. Impact noise can be classified as (but is not limited to) the result of footfall impact on a separating floor to a habitable space below. All values are described using the decibel.

Reverberation time, *T* and T_{mf}

The reverberation time of a space is a measure of the rate at which sound decays, measured in seconds. It is defined as the time taken for the sound pressure level to reduce by 60 dB from its original impulse level. Reverberation time is commonly quoted in terms of the mid-frequency reverberation time, T_{mf}, the arithmetic average of the reverberation times in the 500 Hz, 1 kHz and 2 kHz octave bands.

Noise rating, NR

The noise rating or NR system is commonly used in the design of noise emitted by internal building services systems. The system is frequency dependent, and was empirically derived to prevent disturbance to

occupants in habitable or working areas from building services noise that exhibits 'tonal' elements, e.g. rumbles, whines, whistles etc. There is no direct relationship between the average 'A' weighted noise level in dB and the NR. However, as a guide, and assuming the absence of strong low frequency content in a given noise, the NR could generally be said to be 6 dB less than the average 'A' weighted dB value.

Privacy

Privacy is the addition of the level of sound insulation between two rooms and the background noise within a receiving room. It can be used to assess the level of privacy afforded in the 'receiving room' for speech from the 'source room'. The 'privacy factor' is a unit-less value that is the combination of the average 'A' weighted background noise level in dB and the weighted sound level difference (D_w) in dB.

Appendix IV. HRS Acoustic Credentials

HRS Services Ltd. (HRS) have specialised in providing the UK Construction Industry with a range of acoustics services since 2006. Specialising in Building Acoustics, all HRS acousticians are members of the Institute of Acoustics.

HRS has been accredited for on-site acoustic testing by United Kingdom Accreditation Service (UKAS) since 2006 (Testing Laboratory Number 2587).
HRS meet the relevant acoustic requirements typically required in the UK, including for sound insulation testing as defined in Approved Document E for the purposes of testing for Part E to the Building Regulations 2010.

This report has been authorised by Iain Sanderson, HRS Acoustic Consultant who meets the BREEAM requirements for a suitably qualified acoustician (SQA) as follows;

1. Holds a BSc in Music Technology and a PGDip in Acoustics and Noise Control.
2. Has been an acoustic consultant since 2012 and therefore has more than three year's relevant experience (within the last five years). This experience includes a practical understanding of factors affecting acoustics in relation to construction and the built environment; including, acting in an advisory capacity to provide recommendations for suitable acoustic performance levels and mitigation measures.
3. Holds Associate Membership of the Institute of Acoustics - AMIOA membership.

This report has been read and reviewed by Iain Sanderson and has been found to;

1. Represent sound industry practice
2. Be appropriate given the building being assessed and scope of works proposed
3. Avoid invalid, biased and exaggerated recommendations.

Appendix V. Report Conditions

This document has been prepared for the sole use, benefit and information of the Client. The liability of HRS Services Ltd. in respect of the information contained herein will not extend to any third party unless prior agreement is obtained in writing from HRS Services Ltd.

This report is limited to addressing the specific acoustic issues contained herein. Advice has been provided for acoustic reasons only and it is recommended that appropriate expert advice be sought on all the ramifications, e.g. safety, fire, structural, CDM etc., associated with any proposals contained herein.

The in-situ performance of acoustic measures is influenced to a large extent by the quality of workmanship and compliance with the specifications on-site during construction, as such, HRS Services Ltd. accepts no liability for issues with acoustic performance arising from such factors.

Acoustic survey and testing work carried out for the project is representative of the prevailing conditions at the time of the work. Conditions can vary and no warranty is given as to the possibility of changes in the environment of the site and surrounding area at differing times.

In particular, it should be noted that where calculations are carried out that are based on assumptions regarding certain aspects where information has not been supplied, these are provided for indicative purposes only and should be treated as such.