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MECHANICAL BUILDING SERVICES
NOISE ASSESSMENT REPORT

AT
SENATE HOSUE, MALET STREET, LONDON, WC1E 7HU

REPORT REFERENCE: 119094 AC 2v1

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1.0 Introduction

1.1 HRS Services Limited (HRS) has been appointed by ISG to carry out a mechanical services plant noise assessment relating to refurbishment works (Senate House Phase 4 IHR) in the IHR (Institute of Historical Research) wing of Senate House, Malet Street, London.

1.2 The purpose of this assessment is to determine the noise impact of the new plant equipment, associated with the newly refurbished spaces, upon the existing ambient noise climate to noise sensitive spaces inside Senate House and to the nearest noise sensitive receptors, with regards to satisfying the planning requirements and the Acoustic Specification for the development produced by BDP, document number SPC(00)U001.

1.3 This document has been prepared for the sole use, benefit and information of ISG 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.

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

1.5 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 I.

2.0 Site Description

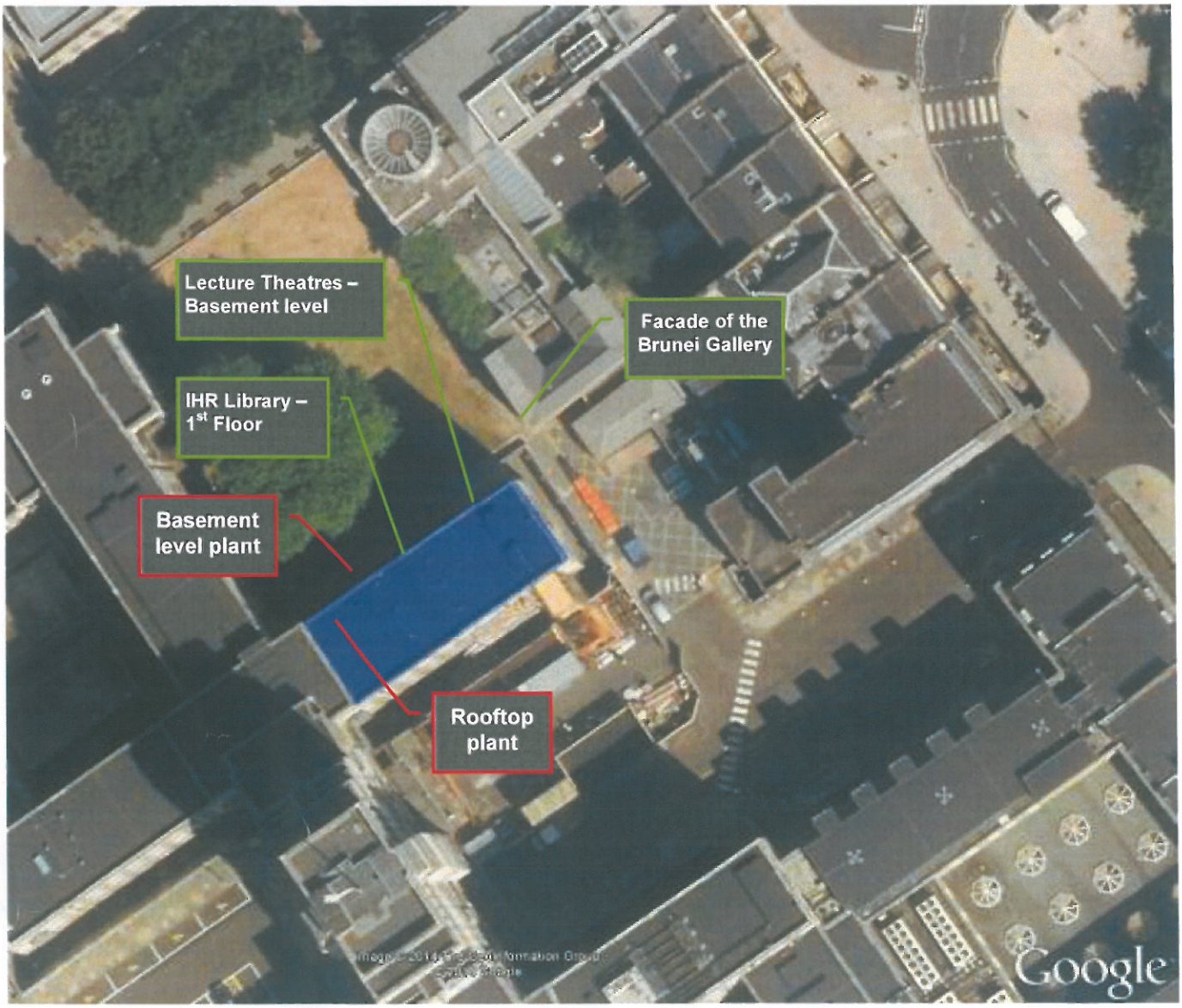
2.1. Senate House is the administrative centre of the University of London situated between Malet Street and Russell Square, with the School of Oriental and African Studies (SOAS) to the East and the British Museum to the South. The Institute of Historical Research (IHR) is located in the north-east wing of Senate House. The surrounding area comprises predominantly of university buildings with no residential buildings in close proximity to the development.

2.2. The nearest noise sensitive premises are considered to be the Brunei Gallery SOAS building immediately to the north-east of the IHR wing.

2.3. HRS understands that the only new items of plant associated with the development are those located in two specific areas: 3no. condenser units situated in the light well at basement level on the north-east elevation of the IHR wing (basement plant), and 1no. condenser unit on the roof of the IHR wing (rooftop plant). The scope of the plant noise impact assessment is limited to these new items only.

2.4. The approximate location of mechanical building service plant locations, nearby noise sensitive premises and spaces within the IHR wing of Senate House are indicated in Figure 1 below. The IHR wing is highlighted in blue.

Figure 1: Aerial photograph indicating approximate building service plant locations, relevant spaces and measurement positions.



3.0 Noise Survey

3.1 Noise measurements were carried out between 0925–1140 hours on 31st July 2014.

3.2 Noise levels were measured using a UKAS calibrated B&K 2250 Investigator Class 1 precision integrating sound level meter. Calibration checks were carried out both before and after the measurements with no significant variance observed. The sound level meter was fitted with a proprietary windshield. The weather was noted as being calm and sunny with wind speeds below <5ms^{-1} and no precipitation.

3.3 Noise measurements were generally taken over 30 second sample periods across 6 measurement positions; immediately adjacent to both the basement and rooftop plant, in both the large and small lecture theatres (basement level), in the IHR Library (1st floor) and at the facade of the Brunei Gallery. Short measurement periods were used to reduce the influence of extraneous noise on the measurements. The period is considered sufficiently representative of the steady continuous plant noise.

3.4 Initially, measurements were carried out in each measurement position with the relevant items of mechanical building service plant inoperative. Subsequently, measurements were carried out in each measurement position with the relevant items of plant in operation. The M&E service contractor was in attendance to activate the plant items and ensure that, when in operation, they were running at full capacity, thereby representing the worst case noise impact.

3.5 The measurement results are summarised in Table 1, with the full survey results detailed in Appendix II.

Table 1: Summary of measured noise levels

Measurement Position	Plant Off		Plant On	
	dB $L_{Aeq,30secs}$	dB $L_{AF90,30secs}$	dB $L_{Aeq,30secs}$	dB $L_{AF90,30secs}$
Position 1 – Light well / Basement Level – approximately 1m from plant – external position	51-59	50-53	60-72	54-66
Position 2 – Large Lecture Theatre – Basement Level – internal position	37-38	36-37	36-37	36-37
Position 3 – Small Lecture Theatre – Basement Level – internal position	33-34	31-32	35	34-35
Position 4 – IHR Wing Rooftop – approximately 1m from plant – external position	47-49	46-48	51-56	50-55
Position 5 – IHR Library – 1st Floor – internal position	28-33	27-31	33-35	28-33
Position 6 – Brunei Gallery SOAS – approximately 2m from the facade – external position	50	50	51-53	49-51

4.0 Noise Impact Assessment

4.1 The plant noise emission limits for the development are set out in the Acoustic Specification produced by BDP, document number SPC(00)U001, and are summarised in Table 2 below.

Table 2: Plant noise emission limits, given in terms of dB L_{Aeq}

Position	Daytime (0700–2300 hours)		Night-time (2300–0700 hours)	
	Non-tonal	Tonal	Non-tonal	Tonal
1m from the window of the nearest noise sensitive receiver of Brunei Gallery facade	42	37	40	35
1m from the window of the nearest noise sensitive receiver of Senate House	42	37	40	35

4.2 Spectral data from HRS' noise measurements obtained at 1 metre from the relevant items of building service plant display tonal peaks that indicate that the more onerous 'Tonal' noise limit should be applied.

Brunei Gallery Facade

4.3 A comparison of noise levels measured immediately adjacent to the nearest part of the Brunei Gallery facade with and without the relevant building service plant in operation suggests that there is no meaningful change in noise levels at that position. While noise levels obtained with the plant in operation are 1-3dB higher, this is deemed to be a result of noise sources other than the relevant items of building service plant, such as nearby construction activity, rustling trees and an aircraft passing overhead. Note that noise levels obtained outside the Brunei Gallery with the plant inoperative were made during a break in construction activity. In subjective listening terms, the new plant was not discernibly audible at this location.

4.4 Source noise levels were obtained at around 1 metre from both the basement plant and the rooftop plant when in operation. The noise levels obtained adjacent to the basement plant display some variation. The highest noise levels were obtained during condenser unit operation start-up. After this period, the condenser unit operation was observed to settle into regular operation and measured noise levels reduced accordingly. The average of noise levels measured during regular operation is circa 65dB L_{Aeq}, and is representative of normal operating conditions.

4.5 A calculation has been carried out using measured source noise levels to determine noise levels at the window on the nearest facade of the Brunei Gallery resulting from the operation of the relevant items of building service plant. As a conservative estimate, the barrier attenuation provided by the plant canopy, the light well retaining wall and the rooftop parapet will provide at least 5dBA of attenuation. The calculation is summarised in Table 3 below.

Table 3: Plant noise at the nearest facade of the Brunei Gallery

Plant location	Sound Pressure Level (dBA)	Distance (m) / attenuation (dBA)	Screening attenuation (dBA)	Sound Pressure Level at facade (dBA)
Basement level plant	65	25 / 28.0	5	32.0
Rooftop plant	54	30 / 29.5	5	19.5
Total plant noise at the nearest facade of the Brunei Gallery (dBA)				**32.2**

4.6 A comparison of the total plant noise at the nearest facade of the Brunei Gallery with the plant noise emission limits given in Table 2 shows that the noise levels comply with the Acoustic Specification and, therefore, the planning requirements for the development.

Noise Sensitive Spaces in Senate House

4.7 The nearest noise sensitive spaces in Senate House to the basement plant are the large and small lecture theatres at basement level, and the IHR Library on the 1st floor. It is understood that all other spaces in proximity to the basement plant are ancillary spaces. The nearest noise sensitive space is the small lecture theatre, the nearest window being approximately 5 metres from the basement plant. Based on measured source noise levels and the reverberant nature of the light well, noise levels at 1 metre from the facade of the small lecture theatre will not be significantly less than immediately adjacent to the items of plant and, therefore, will not meet the noise limits set out in the acoustic specification and summarised in Table 2.

4.8 Given the proximity of the basement plant to Senate House it is not practicable to achieve the noise limits set out in the acoustic specification. To do so would require extensive acoustic treatment, i.e. selection of low noise models, a full enclosure with attenuated inlets/outlets and absorptive treatment to the light well.

4.9 Our understanding of the planning permission requirement is to protect nearby noise sensitive receptors and this typically refers to those outside the subject development. Normally it is expected that more relaxed criteria are appropriate for occupants of the subject development as they will have greater tolerance of their own plant noise and also control over its' operation. Therefore it may not be considered appropriate to apply the same noise limits for the nearest noise sensitive premises, i.e. the Brunei Gallery, to the Senate House development. There is no appreciable risk of elevated noise levels in the light well resulting in a noise complaint within Senate House and there are no external areas designated for noise sensitive activities. Both lecture theatres are mechanically ventilated and have secondary glazing installed specifically to maintain the acoustic insulation provided by the building envelope.

4.10 Noise levels were measured inside the lectures theatres with the basement plant both inoperative and in operation. A comparison of the measured noise levels in the large lecture theatre shows no change in noise levels. A comparison of the measured noise levels in the small lecture theatre shows an increase in noise levels of around 1-2dB with the basement plant in operation. An increase in noise levels of this magnitude would be deemed as insignificant as it is not perceptible to the human ear. Given noise levels at 1 metre from the building facade, the increase in noise levels within the small lecture theatre indicates that the facade is providing a reasonable level of sound insulation. Calculations show that the contribution to the ambient noise level in the small lecture theatre due to break-in noise from basement plant operation is around 29-30dB L_{Aeq}, thereby meeting the criteria for these rooms.

4.11 A comparison of measured noise levels in the IHR Library on the 1st floor with the basement plant both inoperative and in operation shows a 3dB increase in noise levels, however, it was observed that nearby construction activity was the dominant noise and will have influenced measured noise levels. If it is assumed that the increase is due to break-in noise from basement plant operation then calculations show the level of break-in noise to be around 31dB L_{Aeq}, thereby meeting the criteria for the room.

4.12 The rooftop plant is located approximately 4 metres from the nearest facade of Senate House, and at least 10 metres from any noise sensitive spaces. Based on measured noise levels circa 54dB L_{Aeq} at 1 metre from the rooftop plant when in operation, noise levels at 1m from the facade of noise sensitive spaces taking distance and barrier attenuation, provided by the barrier and the parapet, into will be circa 30dB L_{Aeq}, thereby, meeting the noise limit set out in the acoustic specification and summarised in Table 2.

5.0 Summary and Conclusions

5.1 A noise impact assessment for mechanical building services associated with refurbishment works in the IHR wing of Senate House, Malet Street, London, to satisfying the planning requirements and the Acoustic Specification for the development.

5.2 Noise measurements were carried out immediately adjacent to the relevant items of mechanical building service plant associated with the refurbishment works, and in the vicinity of the nearest noise sensitive locations to establish whether or not they meet the planning requirements/acoustic specification.

5.3 Measurements show that noise levels at the nearest noise sensitive premises as a result of the mechanical building service plant operation meet the planning requirements/acoustic specification.

5.4 The acoustic specification sets noise limits at the facade of noise sensitive spaces within Senate House. The limits are unlikely to be achieved and unnecessary. Measurements show that the mechanical building service plant operation will have a negligible influence on internal noise levels in noise sensitive spaces in Senate House and that the risk of complaint is unlikely.

APPENDIX I – Glossary of Terms

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. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (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)

As well as the loudness of a sound, the frequency content of a sound is also very important. 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.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20,000 Hz. However, the upper frequency limit gradually reduces as a person gets older.

Noise Indices

When a noise level is constant and does not fluctuate over time, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple dB(A) value. In order to describe noise where the level is continuously varying, a number of other indices, including statistical parameters, are used. The indices used in this report are described below.

L_{Aeq} This is the A-weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period. In other words, L_{Aeq} is the level of a continuous noise which has the same total (A-weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.

L_{Amax} This is the maximum A-weighted noise level that was recorded during the monitoring period.

L_{A10} This is the A-weighted noise level that was recorded for at least 10% of the monitoring period.

L_{A90} This is the minimum A-weighted noise level that was recorded for at least 90% of the monitoring period. Usually taken as the underlying 'background' noise level.

APPENDIX II – Survey Results

31st July 2014 - all measurements free field.

Measurements in *Italics* indicate that they were taken with the mechanical building service plant items in operation.

Start Time	dB $L_{Aeq,30secs}$	dB $L_{AF90,30secs}$	dB $L_{AF10,30secs}$	dB $L_{AFmax,30secs}$	Comments
Position 1 – Basement Level – approximately 1m from plant					
09:24	50.7	50.9	49.5	59.8	Construction activity occasionally audible
09:32	58.2	59.8	52.5	62.2	Generator operation audible
09:33	51.3	52.4	50.3	55.2	
09:34	51.7	52.5	50.4	60.1	
09:35	54.0	56.3	50.5	61.0	
09:36	58.5	51.8	50.3	77.4	Construction activity occasionally audible
09:36	53.0	54.7	49.8	66.3	Construction activity occasionally audible
11:01	51.0	51.4	50.7	52.0	
11:02	50.6	51.1	50.1	52.8	
11:06	*66.3*	*72.1*	*53.5*	*73.8*	Obtained during condenser unit start-up
11:07	*71.7*	*73.6*	*66.4*	*74.0*	
11:08	*70.9*	*73.8*	*64.3*	*74.9*	
11:09	*61.7*	*62.1*	*61.2*	*63.5*	
11:10	*60.9*	*61.7*	*60.3*	*62.6*	
11:11	*63.4*	*66.5*	*61.8*	*67.7*	
11:13	*66.9*	*69.9*	*64.8*	*73.3*	
11:14	*64.7*	*67.5*	*60.3*	*68.6*	Obtained during continuous condenser unit regular operation
11:15	*62.7*	*63.0*	*61.9*	*66.6*	
11:16	*64.0*	*64.3*	*62.8*	*71.0*	
11:17	*59.6*	*61.2*	*58.8*	*61.9*	
Position 2 – Large Lecture Theatre – Basement Level					
09:46	37.2	37.9	36.4	42.0	Air handling audible
09:46	37.7	38.6	37.0	39.8	
09:52	38.0	39.7	36.7	41.0	
09:53	37.5	38.0	36.8	46.0	
11:18	*36.1*	*36.5*	*35.7*	*38.2*	
11:19	*37.1*	*37.8*	*36.5*	*39.0*	

Start Time	dB $L_{Aeq,30secs}$	dB $L_{AF90,30secs}$	dB $L_{AF10,30secs}$	dB $L_{AFmax,30secs}$	Comments
Position 3 – Small Lecture Theatre – Basement Level					
10:01	33.3	35.3	31.4	38.0	Air handling operation audible, although much less so than in the Large Lecture Theatre
10:02	33.7	35.9	31.3	45.4	
10:03	33.8	36.2	31.7	40.2	
10:05	32.5	33.4	31.5	34.6	
11:20	*34.6*	*35.0*	*34.2*	*35.7*	
11:21	*35.0*	*35.5*	*34.5*	*36.4*	
Position 4 – IHR Wing Rooftop – approximately 1m from plant					
10:21	46.9	47.7	46.3	50.5	
10:22	48.9	50.0	47.6	55.2	
10:23	48.5	49.2	47.6	51.7	
10:26	*51.1*	*52.9*	*49.6*	*56.7*	Occasional power tool operation from construction works at ground level audible.
10:26	*55.9*	*57.3*	*54.9*	*59.1*	
10:27	*54.0*	*54.6*	*53.3*	*57.2*	
10:29	*54.1*	*55.0*	*53.4*	*59.7*	
10:29	*53.7*	*54.6*	*52.7*	*57.8*	
Position 5 – IHR Library – 1st Floor					
10:34	32.6	34.7	30.8	37.4	Construction activity occasionally audible
10:35	32.7	34.4	30.7	38.6	
10:40	28.3	29.1	27.4	30.3	
10:41	29.6	30.9	27.2	41.1	
10:42	28.1	29.5	26.8	31.7	
10:43	28.1	29.8	26.5	35.2	
10:43	27.7	28.4	27.0	34.1	
11:22	*35.3*	*36.8*	*33.3*	*40.0*	Construction activity occasionally audible
11:24	*33.9*	*36.5*	*30.9*	*39.0*	Generator operation audible
11:26	*32.5*	*34.1*	*29.1*	*40.2*	
11:26	*32.8*	*34.8*	*28.4*	*44.7*	
11:28	*32.9*	*34.5*	*30.8*	*43.2*	
Position 6 –Brunei Gallery SOAS – approximately 2m from the nearest facade					
10:48	50.3	50.7	49.8	52.1	Obtained during a break in Construction activity
10:49	50.4	51.5	49.5	52.0	
10:50	50.3	50.8	49.7	52.5	
11:33	*51.6*	*53.0*	*49.3*	*63.1*	
11:34	*52.4*	*54.0*	*49.2*	*64.2*	
11:34	*50.7*	*52.7*	*49.2*	*55.7*	
11:35	*53.3*	*55.3*	*51.0*	*60.9*	Aircraft passing overhead
10:48	*50.3*	*50.7*	*49.8*	*52.1*	