Technical Note

Title:	GOSH CCC - AHU and Chiller - Noise Impact Assessment		
Client:	John Sisk & Son (Holdings) Ltd		
Reference:	2062356-RSKA-TN-001-(01)		
Date:	09 February 2023		
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1 Introduction

1.1 Overview

RSK Acoustics has been appointed by John Sisk & Son (Holdings) Ltd, to undertake a noise impact assessment for a proposed air handling unit (AHU) and chiller being installed at Great Ormond Street Hospital (GOSH) in central London. The installation forms part of the ongoing works to build a new Cancer Care Centre (CCC)

The assessment seeks to determine the operational noise impact from the proposed plant at the nearest noise sensitive receptors (NSRs) on Great Ormond Street.

A glossary is included at the end of this Technical Note.

1.2 Development Proposal

The development relates to the reprovision of ventilation, heating and cooling services to the Cheetah Ward in the Variety Club Building (VCB). Provision is currently from an AHU and chiller located on an external terrace at Level 4 of the Frontage Building, which is to be demolished to make way for the new CCC.

The equivalent service provision needs to be in place before the Frontage Building can be deconstructed. Therefore, a new AHU has been proposed at the level 4 terrace associated with the projecting element of the VCB, known as the 'Blip'.

Figure 1 below shows the proposed extent of the external plant relocation. Central to the proposal is the VCB 'Blip'. It exists over the 6 storeys of the VCB and features external terrace spaces over Levels 4, 5 and 6.

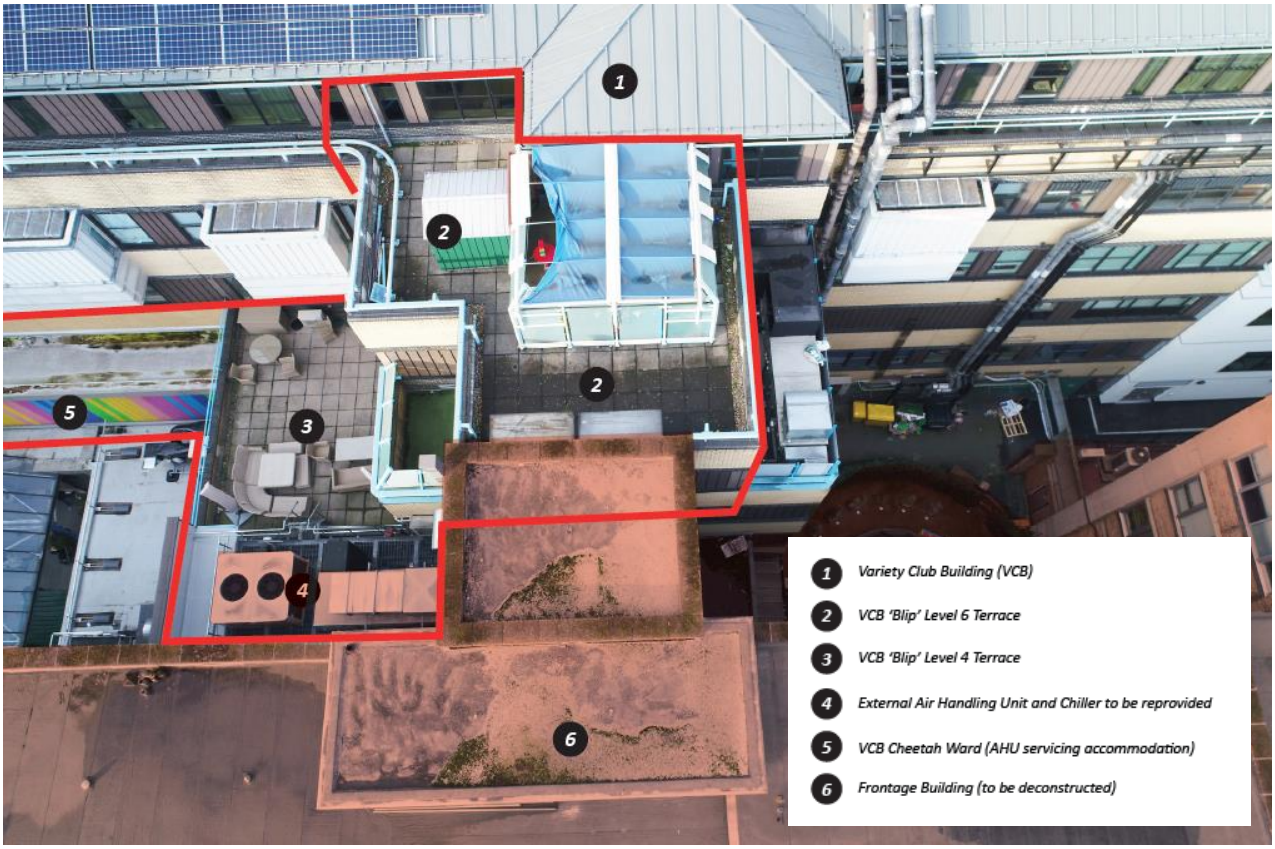

Figure 1 Drone photography of the Variety Club Building, 2017

An external terrace to the west of the projecting VCB 'blip' connects to a separate external area to its south that belongs to the Frontage Building. This is where the existing AHU plant (no. 4) is located.

The proposed external AHU is to be located to the east of the Level 4 terrace, adjacent to the VCB 'blip' west elevation.

The proposal (in full) has been provided to RSKA by the client in a document titled *'Great Ormond Street Hospital Children's Cancer Centre (GOSH CCC) – Advanced Works – Interface 64 – Cheetah Ward AHU/Chiller reprovision'*, (document ref. GOSHCCC-BDP-ZZ-ZZ-RP-A-2000-0094 – S3 – P04, dated 07 December 2023).

2 Legislation & Guidance

2.1 The London Plan (March 2021)

Policy D14 states:

"In order to reduce, manage and mitigate noise to improve health and quality of life, residential and other non-aviation development proposals should manage noise by 1) avoiding significant adverse noise impacts on health and quality of life

2) reflecting the Agent of 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

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."

2.2 Camden Local Plan 2017

2.2.1 Policy A4 Noise and Vibration

Policy A4 states:

"The Council will seek to ensure that noise and vibration is controlled and managed.

Development should have regard to Camden's Noise and Vibration Thresholds (Appendix 3). We will not grant planning permission for:

a. development likely to generate unacceptable noise and vibration impacts; or

b. development sensitive to noise in locations which experience high levels of noise unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.

We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity.

We will also seek to minimise the impact on local amenity from deliveries and from the demolition and construction phases of development."

2.2.2 Plant and other noise generating equipment

Paragraphs 6.99 to 6.101 state:

"Planning conditions will be imposed to require that plant and equipment which may be a source of noise is kept working efficiently and within the required noise limits and time restrictions. Air conditioning will only be permitted where it is demonstrated that there is a clear need for it after other measures have been considered (Policy CC2 Adapting to climate change). Conditions may also be imposed to ensure that attenuation measures are kept in place and are effective throughout the life of the development.

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. Conditions to this effect may be imposed in instances where emergency equipment forms part of the application.

Security alarms cause significant disruption to local amenity and wellbeing. Whilst security alarms would generally not require planning permission, we would strongly encourage developers and householders to install silent alarms or alarms with a maximum of a 20-minute cut out."

2.3 Camden Planning Guidance: Amenity (January 2021)

2.3.1 Noise and Vibration Thresholds

Paragraph 6.8 states:

"When assessing acoustic reports, the Council will consider the reported measurements against the noise thresholds set out in Appendix 3 of the Local Plan. The thresholds are expressed as 'effect levels', which sets out a hierarchy of expected changes in behaviour and impact on health and wellbeing in response to increasing noise levels (measured in decibels - dB). The 'effect levels' are summarised below and explained in detail in National Planning Practice Guidance (NPPG). The table detailing each 'effect level' from NPPG is also set out in Appendix 1 to this guidance for ease of reference.

- No observed effect level (NOEL) – the level below which no effect can be detected on health and quality of life.
- Lowest observable adverse effect level (LOAEL) – the level above which changes in behaviour (e.g., closing windows for periods of the day) and adverse effects on health (e.g. sleep disturbance) and quality of life can be detected.
- Significant observed adverse effect level (SOAEL) – the level above which adverse effects on health and quality of life occur. This could include psychological stress, regular sleep deprivation and loss of appetite."

2.3.2 Plant and Other Noise-Generating Equipment

Paragraphs 6.27 to 6.29 state:

"Developments proposing plant, ventilation, air extraction or conditioning equipment and flues will need to provide the system's technical specifications to the Council accompanying any acoustic report. 'BS4142 Method for rating Industrial and Commercial Sound' contains guidance and standards which should also be considered within the acoustic report.

There are however likely to be instances where the Council will consider that a BS4142 assessment alone is not sufficient to provide all the information necessary. Plant such as electrical substations for example, may meet BS4142 standards, but are also known to emit low frequency noise, which also needs to be considered. Developers are therefore encouraged to discuss proposals of this nature with the Council's Noise team before preparing their acoustic report - Email: RegulatoryServices@camden.gov.uk.

Plant, ventilation, air extraction or conditioning equipment and flues can cause disturbance to residential properties. The Council would therefore welcome the use of long-term maintenance agreements to ensure that equipment maintains acceptable noise levels over its lifetime and the use of timers to limit any unnecessary operation of the equipment."

2.4 British Standards and Guidance Documents

2.4.1 British Standard (BS) 4142:2014+A1:2019

British Standard 4142:2014+A1:2019 *'Methods for rating and assessing industrial and commercial sound'* describes the methods for rating and assessing noise from industrial or commercial sources. The standard is applicable to the assessment of sound affecting residential receptors, through the determination of a specific level of an industrial or commercial noise source.

Where certain acoustic features are present at the assessment location, a character correction should be applied to the specific sound level to give the rating level to be used in the assessment. Acoustic features can include tones, impulsivity, intermittency or a type of noise that is distinct from the existing noise environment.

The assessment of the impact from a commercial or industrial sound can be carried out as follows:

- A difference of around +10 dB or more, between the rating and background noise levels, 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 adverse impact depending on the context.
- 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.

2.4.2 BS 8233:2014

Guidance on the acceptable noise levels for living rooms and bedrooms within residential buildings is given in BS 8233:2014 *'Guidance on Sound Insulation and Noise Reduction for Buildings'* (BS 8233). Advice is given on the design range of internal noise levels, depending on the use of each room and the sensitivity to noise of the operations expected to be conducted in the rooms. An extract of the indoor ambient noise levels for dwellings is reproduced in Table 1.

Activity	Location	Time period	
		07:00 – 23:00	23:00 – 07:00
Resting	Living room	35 dB $L_{Aeq,16h}$	-
Dining	Dining room / area	40 dB $L_{Aeq,8h}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16h}$	30 dB $L_{Aeq,8h}$

Table 1 Indoor ambient noise levels for dwellngs (BS 8233 table 4)

BS 8233 states the following in relation to noise levels within external amenity areas:

2.4.3 WHO Environmental Noise Guidelines for the European Region (2018)

Noise is an important public health issue. It has negative impacts on human health and well-being and is a growing concern. The WHO Regional Office for Europe has developed guidelines, based on the growing understanding of these health impacts of exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. They provide robust public health advice underpinned by evidence, which is essential to drive policy action that will protect communities from the adverse effects of noise. The guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience.

2.4.4 BS 7445-1:2003, -2:1991 and -3:1991

The three-part standard BS 7445 provides the framework within which environmental noise should be quantified. Part 1 (2003) provides a guide to quantities and procedures and Part 2 (1991) provides a guide to the acquisition of data pertinent to land use. Part 3 (1991) provides a guide to the application of noise limits.

BS 7445 also refers to a further standard, BS EN 61672, which prescribes the equipment necessary for such measurements. Whilst BS 7445 does not prescribe the meteorological conditions under which noise measurements should or should not be taken, it does (part 2, paragraph 5.4.3.3) recommend that in order:

"…to facilitate the comparison of results (measurements of noise from different sources), it may be necessary to carry out measurements under selected meteorological conditions which are reproducible and correspond to quite stable propagation conditions."

These conditions include:

- Wind speed not exceeding 5 m/s (measured at a height of 3 to 11 m above the ground)
- No strong temperature inversions near the ground
- No heavy precipitation.

2.4.5 International Standard (ISO) 9613-2: 1996

International Standard: ISO 9613-2: 1996(E): '*Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*' enables the prediction of noise levels in the community from sources of known sound emission.

The noise prediction method described in this part of the standard is general and is suitable for a wide range of engineering applications where the noise level outdoors is of interest. The noise source(s) may be moving or stationary and the method considers the following major mechanisms of noise attenuation:

- Geometrical divergence (also known as distance loss or geometric damping)
- Atmospheric absorption
- Ground effect
- Reflection from surfaces
- Screening by obstacles.

The method predicts noise levels under meteorological conditions favourable to noise propagation from the sound source to the receptor, such as downwind propagation, or equivalently, propagation under a moderate ground-based temperature inversion as commonly occurs at night.

3 AHU Technical Specification

A technical specification document for the AHU has been provided to RSKA by the client (document ref. '*AHS 24831 – AHU-501 Cheetah OPD (L2) – GOSH Cheetah Ward*' dated 05 February 2024)).

The document provides the following information relating to noise levels from the supply fan and extract fan elements of the AHU:

Sound Power Level, dB L_{Wz}	Octave Band Centre Frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
Supply Fan	72	75	84	84	87	86	88	85
Extract Fan	77	81	78	81	83	81	80	71

Table 2 Sound Power Levels (Supply Fan and Extract Fan)

Sound Reduction Index, dB	Octave Band Centre Frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
AHU Panel (foam panels)	19.8	19.9	24.0	26.6	23.9	33.0	54.5	58.1

Table 3 Sound Reduction Index (AHU Panel)

The document provides the following information relating to the resultant sound pressure level of the combined elements at 1 m, 3 m and 10 m:

Sound Pressure Level, dB L_{pZ}	Octave Band Centre Frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
1 m	61	65	64	63	67	57	37	<30
Total: 69 dB(A)								
3 m	57	61	60	58	63	53	32	<30
Total: 64 dB(A)								
10 m	49	53	52	50	55	45	<30	<30
Total: 56 dB(A)								
NOTES Calculation applies to an AHU on a reflecting surface in an otherwise free field. Noise levels based on mid filter conditions. Breakout level does not take into account noise from the inlet/discharge connections. Please note any penetrations will significantly reduce casework performance and noise levels quoted will no longer be achievable.								

Table 4 Sound Pressure Levels

4 Survey (August 2021)

4.1 Survey Details

In August 2021, RSKA undertook a noise survey to establish the existing baseline noise environment representative of the nearest noise sensitive receptors (NSRs) to determine future operational noise impacts from the proposed GOSH CCC.

4.1.1 Measurement Locations

The baseline noise survey was conducted over a five-day period between 20 August 2021 and 25 August 2021 to quantify the existing noise levels throughout daytime and night-time periods. Monitoring locations and their rationale are outlined below:

- Location 1 – sound level meter positioned on a flat roof of one of the buildings at GOSH at 3rd floor level; and
- Location 2 – sound level meter positioned on the flat roof of the Frontage Building at GOSH.

An aerial image of the baseline noise monitoring locations is shown in Figure 2; site photographs of the sound level meters in position are shown in Figure 3 and Figure 4.

Figure 2 Measurement Locations (August 2021)

Figure 3 Location 1 – equipment installation photographs

Figure 4 Location 2 – equipment installation photographs

4.1.2 Survey Observations

Subjective audible observations during the daytime installation and demobilisation of the unattended noise equipment were noted:

- Pedestrians – voices;
- Visitors to hospital – voices / children shouting;
- Ambulance and Taxi drop off and collection - engines / door slams / voices;
- Hospital staff with trolleys / deliveries;
- Road traffic – dominant;
- Vehicle horns / reversing beacons / emergency sirens (occasionally and throughout);
- Various plant items audible but not dominant; and
- Aeroplanes and helicopters passing overhead.

4.1.3 Survey Equipment

Noise monitoring was undertaken using the following equipment, detailed in Table 5 below:

Equipment	Type	Serial Number	Calibration date
Class 1 sound level meter	Rion NL-52	01043374	19 April 2021
Class 1 sound level meter	Rion NL-52	00197783	19 April 2021
Acoustic calibrator	Rion NC-74	34425552	06 June 2021

Table 5 Monitoring Equipment

All measurements were undertaken with the microphones positioned away from reflecting surfaces and at heights of 1.5 m above the ground to the requirements of BS 7445.

The calibration of each sound level meter was checked before and after the measurements, using the acoustic calibrator at 94 dB at 1 kHz; no significant calibration drift was noted (+/- 0.3 dB).

The sound level meters used conform to the Class 1 requirements of BS EN 61672-1: 2013 *'Electroacoustics. Sound level meter, Specifications'*. The calibrator used conforms to the requirements of BS EN 60942: 2003 *'Electroacoustics, Sound calibrators'*. The equipment used has a calibration history that is traceable to a certified calibration institution. Calibration certiciates are available upon request.

4.1.4 Weather Conditions

Weather conditions during the unattended measurement period were obtained from Wunderground (www.wunderground.com), using the weather station closest to the measuring locations (with available historical data), which was judged to be at London City airport (EGLC). This weather data is summarised in Table 6; conditions were considered conducive to environmental noise monitoring.

Date	Temperature High (°C)	Temperature Low (°C)	Wind Speed High (m/s)	Wind Direction	Accumulated precipitation (mm)
20.08.21	21	15	5	W	0.0
21.08.21	21	16	4	E	0.0
22.08.21	21	16	6	W	0.0
23.08.21	21	14	4	N	0.0
24.08.21	22	13	7	E	0.0
25.08.21	22	14	6	N	0.0

Table 6 Summarised weather data during monitoring period

4.2 Survey Results

Analysis of the dataset accounting for the 16-hour daytime period (07:00 – 23:00) and 8-hour night-time period (23:00 – 07:00) is provided to quantify the noise fluctuations at those positions during a representative period.

Summaries of the measured noise levels at Location 1 and Location 2 are presented in Table 7 and Table 8:

Date	Time Period (T)	Measured Noise Levels [1]			
		Average $L_{Aeq,T}$ dB	Highest $L_{AFmax,T}$ dB	Average $L_{A90,T}$ dB	Average $L_{A10,T}$ dB
20.08.21	14:00 – 23:00	58	81	57	59
20.08.21	23:00 – 07:00	58	66	57	58
21.08.21	07:00 – 23:00	60	81	57	59
21.08.21	23:00 – 07:00	58	72	57	59
22.08.21	07:00 – 23:00	59	77	58	59
22.08.21	23:00 – 07:00	57	64	57	58
23.08.21	07:00 – 23:00	59	89	57	60
23.08.21	23:00 – 07:00	57	62	57	58
24.08.21	07:00 – 23:00	59	75	57	59
24.08.21	23:00 – 07:00	57	72	56	58
25.08.21	14:00 – 23:00	58	81	57	59

NOTES

[1] $L_{Aeq,T}$ values are the logarithmic average of $L_{Aeq,15min}$ samples, and the $L_{A10,T}$ and $L_{A90,T}$ are the arithmetic average of the $L_{A10,15min}$ and $L_{A90,15min}$ samples

Table 7 Noise Measurement Results – Location 1

Date	Time Period (T)	Measured Noise Levels [1]			
		Average $L_{Aeq,T}$ dB	Highest $L_{AFmax,T}$ dB	Average $L_{A90,T}$ dB	Average $L_{A10,T}$ dB
20.08.21 (a)	14:00 – 23:00	55	82	53	57
20.08.21	23:00 – 07:00	53	76	52	54
21.08.21	07:00 – 23:00	58	81	53	57
21.08.21	23:00 – 07:00	54	75	52	54
22.08.21	07:00 – 23:00	55	82	53	57
22.08.21	23:00 – 07:00	54	82	52	54
23.08.21	07:00 – 23:00	59	96	54	60
23.08.21	23:00 – 07:00	54	79	52	54
24.08.21	07:00 – 23:00	58	86	54	59
24.08.21	23:00 – 07:00	54	79	52	54
25.08.21 (a)	14:00 – 23:00	55	82	53	57
NOTES [1] $L_{Aeq,T}$ values are the logarithmic average of $L_{Aeq,15min}$ samples, and the $L_{A10,T}$ and $L_{A90,T}$ are the arithmetic average of the $L_{A10,15min}$ and $L_{A90,15min}$ samples					

Table 8 Noise Measurement Results – Location 2

4.2.1 Measurement Summary

The representative background noise levels are presented below, derived from the arithmetic average of the $L_{A90,15min}$ measurements at each location. The presented background noise levels refer to daytime and night-time levels as they correspond to the potential operational times of the proposed development.

- Location 1 – Daytime 57 dB $L_{AF90,1hr.}$; Night-time 57 dB $L_{A90,15min}$.
- Location 2 – Daytime 53 dB $L_{AF90,1hr.}$; Night-time 52 dB $L_{A90,15min}$.

5 Assessment

5.1 Previous Assessment (2022)

RSKA was previously commissioned to undertake a plant noise assessment in relation to this development. This scope of work, commissioned to RSKA by RSK ADAS Ltd, was to inform the planning application for the proposal. As part of this, RSKA carried out an assessment to derive maximum limits for plant noise (RSKA report ref. 297154-RSK-RP-002-(03), dated 16 May 2022).

Noise limits for plant were provided in terms of source sound power level, with provision for multiple plant items provided.

It was considered that, if the recommendations contained within the report regarding proposed plant noise level limits were achievable, the development would be suitable with its proposed layout and location (at that time).

BDP Acoustics provided RSKA with a document that provided a summary of the 3D acoustic noise modelling process that was undertaken to review and provide advice for external plant noise emissions associated with the new CCC. It was considered that the strategy proposed by BDP Acoustics would be acceptable in meeting the external noise emissions limits at nearby residential receptors imposed by planning conditions.

In accordance with the methodology contained within BS 4142, maximum permissible Rating Levels ($L_{Ar,Tr}$) at the surrounding NSRs were derived based upon the measured noise levels from the baseline survey.

5.1.1 Assumptions

The assessment was based on certain assumptions regarding the plant to be installed. It was assumed that:

- The ground between the source and the receivers is acoustically hard;
- The worst-case distance from the source (plant item/termination) to the receptor is taken, i.e., from the closest edge of the roof of each building;
- The source height is taken to be 1 metre above the roof level, i.e., no screening is applied between source and receptor;
- There are two reflective planes close to the source, giving a realistic worst-case source directivity correction (the plant room is considered to be a fully enclosed room and the plant deck enclosure is considered to be enclosed on four sides);
- Plant will operate during both the daytime and night-time periods.

5.1.2 Plant Noise Criteria

Based on the relevant legislation and guidance and the results of the 2021 noise survey, as well as the guidelines provided by BS 4142, the plant noise criteria for the nearby noise sensitive receptors was provided for daytime and night-time. Night-time reflects the worst case. The background noise level from monitoring location 2 was used as representative for the NSRs on the south side of Great Ormond Street.

The representative background noise levels are presented below, derived from the arithmetic average of the $L_{AF90,15min}$ measurements:

- Location 2 – Daytime 53 dB $L_{A90,1h.}$; Night-time 52 dB $L_{A90,15min}$.

The assessment of the impact from the fixed plant was carried out using the criterion in BS 4142 where the Rating Level does not exceed the background sound level. This provides an indication of the specific sound source having a low impact and has been used to provide a robust assessment of any proposed fixed plant items.

5.2 Assessment of AHU and Chiller

It should be noted that only noise impacts associated with the proposed AHU have been included as part of this noise impact assessment.

The wider proposal for the CCC (for which a noise assessment was completed in May 2022) determined that the noise emissions from any proposed plant items should not exceed the background noise levels at the NSRs. Therefore, the intention of this assessment is to determine that the addition of the new AHU and Chiller will not contribute to the noise environment such that the background levels are not exceeded at the NSRs, whilst accounting for the plant associated with the CCC proposal.

5.2.1 Calculation Assumptions

To assess the impact from the proposed AHU and Chiller at the nearest NSRs on Great Ormond Street, the following have been assumed:

- Mitigation measures are implemented (installation of attenuators) for the intake and exhaust connections;
- Predicted noise levels for the overall AHU, as provided by BDP Acoustics, are as follows:
    - 69 dB(A) SPL at 1 m;
    - 64 dB(A) SPL at 3 m; and
    - 56 dB(A) SPL at 10 m.
- The nearest NSRs are considered to be those on the south side of Great Ormond Street (to the south) at a distance of 30 m from the proposed installation;
- The Frontage Building is to be demolished but will be replaced by the new CCC that will provide a barrier between the proposed installation and the NSRs. The CCC will provide a level of attenuation to the NSRs conservatively estimated as 10 dB;
- In the absence of any noise information for the existing plant items (that are to be replaced), the calculations include any noise contributions from the existing plant items at the site (which will be replaced). This presents a worst-case scenario as, in reality, both sets of plant will not be operational and all existing plant will be decommissioned and removed simultaneously with the installation and operation of the new AHU and Chiller;

5.2.2 Calculation of Specific Noise Level

The rated noise level predicted at the nearest NSRs has been assessed against existing background noise levels to assess the likelihood for impact in accordance with BS 4142. The assessment accounts for and includes noise emissions from any proposed plant items associated with the operation of the (not yet constructed) CCC.

As the project is the removal, and replacement of plant, the current plant emissions are considered to form part of the background noise environment.

Table 9, below, shows the results of the assessment:

Plant Item	Predicted Level at 10m	Distance to nearest NSR (m)	Attenuation (dB)		Specific Noise Level at 30 m
			Distance	Barrier	
AHU intake / exhaust	56	30	-10	-10	36

Table 9 Assessment Results

Predicted noise levels (combined for the AHU intake and exhaust connections) would be > 10 dB below the existing background noise (inclusive of the existing plant items due to be removed) at the nearest NSRs on Great Ormond Street (Daytime 53 dB $L_{AF90,1hr.}$; Night-time 52 dB $L_{AF90,15mins.}$).

5.2.3 Acoustic Correction and Calculation of Rating Level

According to BS 4142:2014+A1: 2019, where certain features of the specific noise level can increase the significance of impact of a sound level, a character correction is applied to provide a rated noise level. The characteristics of a sound that are likely to cause an increase in the significance of impact are tonality, impulsivity, intermittency or other characteristic features such as an identifiable 'hiss'.

Taking the above acoustic features into consideration, the application of rating penalties is as follows:

- Tonality – Given that the Specific Level is >10 dB below the background level, it is considered that the installation would not be perceptibly tonal
- Impulsivity – The character of the sound from plant items will generally be of a low level and constant, with no rapid change in the level or character of noise. It is therefore considered unnecessary to apply an impulsive correction; and
- Intermittency – It is considered that the plant items will not have identifiable on/off conditions, with items operating at varying loads. It is therefore considered unnecessary to apply an intermittency correction.

5.2.4 Assessment

Therefore, additional forms of mitigation (beyond those already proposed to mitigate noise for the hospital buildings) are not considered necessary.

There will likely be a period post-demolition of the Frontage Building and pre-construction of the new CCC, that the proposed AHU and Chiller will not benefit from noise attenuation to the NSRs on Great Ormond Street from the barrier effect of an intervening building. However, given the results in Table 9 (prior to a correction for the effect of a barrier), the combined sound pressure level for the AHU intake and exhaust connections are predicted to be between 4 dB and 11 dB below the existing background noise (inclusive of the existing plant items due to be removed) at the nearest NSRs on Great Ormond Street.

Additional forms of mitigation, beyond those already proposed to mitigate noise for the hospital buildings, are therefore not considered necessary, even during the (temporary) period when there will be no building providing a barrier between the proposed plant and the NSRs.

It is worthy of note that the new AHU and Chiller are proposed to be installed with attenuators to account for the intake and exhaust connections.

5.2.5 Uncertainty

BS 4142:2014+A1: 2019 requires that the assessment considers the level of uncertainty in the data and associated calculations. Consideration of the uncertainty can enable a more informed decision regarding the likely significance of impact, within the context of assessment.

It is accepted that uncertainty may arise from all levels of measurement and assessment and reasonably practicable steps have been made at all stages with the aim of reducing uncertainty.

The following measures have been taken to reduce uncertainty:

- Background sound level measurements were obtained at representative assessment locations over a duration of five days to fully characterise the existing residual environment during the intended operational hours of the proposed plant items;
- The assessment has considered a full operational scenario, with all plant items operating 24 hours a day during daytime and night. Representative background levels obtained at daytime and night have been utilised to inform the assessment;
- Use of monitoring equipment in accordance with section 5 of BS 4142: 2014+A1: 2019, using Class 1 instrumentation;
- Measurement procedures followed in accordance with section 6 of BS 4142: 2014+A1: 2019 with all precautions taken to minimise interference; and
- Specific sound levels have been calculated to the requirements of ISO 9613-2: 1996 which is the widely accepted procedure for the calculation of sound propagation (including favourable wind conditions from source to receiver). The plant has yet to be installed therefore, the assessment is informed by comparison of the predicted rated noise levels against the representative background levels at each receptor in accordance with section 7 of BS 4142: 2014+A1: 2019.

Given the measures outlined above and the magnitude of predicted operational levels in the context of the existing local noise environment, it is considered that the uncertainty does not have any significance on the outcome of the assessment. Because the approach taken is likely to be an over-prediction of the noise levels, while there are many uncertainties present in the assessment, it is considered that the outcome is unlikely to change.

6 Conclusions

RSKA was appointed by John Sisk & Son (Holdings) Ltd, to undertake a noise impact assessment for a proposed AHU and Chiller being installed as part of the ongoing works to build a new Cancer Care Centre (CCC) at Great Ormond Street Hospital (GOSH) in central London.

The assessment seeks to determine the operational noise impact from the proposed plant at the NSRs on Great Ormond Street.

The assessment has shown that the predicted noise levels for both the AHU intake and exhaust connections would be > 10 dB below the existing background noise (inclusive of the existing plant items due to be removed) at the nearest NSRs on Great Ormond Street.

Additional forms of mitigation, beyond those already proposed to mitigate noise for the hospital buildings, are therefore not considered necessary.

Glossary

Term	Definition
Ambient sound	The total sound at a given place, usually a composite of sounds from many sources near and far.
Background sound, $L_{A90,T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval.
dB	Decibel. Scale for expressing sound pressure level. It is defined as 20 times the logarithm of the ratio between the root mean square pressure of the sound field and a reference pressure i.e. $2x10^{-5}$ Pascal.
dB(A)	A-weighted decibel. This provides a measure of the overall level of sound across the audible spectrum with a frequency weighting to compensate for the varying sensitivity of the human ear to sound at different frequencies. Example sound levels include: 140 dB(A) Threshold of pain 120 dB(A) Threshold of feeling 100 dB(A) Loud nightclub 80 dB(A) Traffic at busy roadside 60 dB(A) Normal speech level at 1m 40 dB(A) Quiet office 20 dB(A) Broadcasting studio 0 dB(A) Median hearing threshold (1000 Hz)
Frequency	The repetition rate of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted as kHz, e.g. 2 kHz = 2000 Hz. Human hearing ranges approximately from 20 Hz to 20kHz.
$L_{Aeq,T}$	This is defined as the notional steady sound level over a stated period of time (T), would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.
NR	Noise rating. A set of curves based on the sensitivity of the human ear. They are used to give a single-figure rating for a range of frequencies.
Rating level	Specific sound level of a source plus any adjustment for the characteristic features of the sound.
Residual sound	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.
Sound absorption	Process whereby sound energy is converted in to heat. Sound absorption properties is expressed as the sound absorption coefficient α or the sound absorption class (A-E).
Sound insulation	The reduction or attenuation of airborne sound by a solid element between source and receiver.
Specific sound	Sound pressure level produced by the source being assessed at the assessment location.

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