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TECHNICAL REPORT

TUDOR CENTRE EXTENSION, HILLINGDON HOSPITAL

Plant Noise Impact Assessment

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Adrian James Acoustics Document Control Sheet

Report prepared for:	The Hillingdon Hospitals NHS Foundation Trust Batchworth House Rickmansworth Road Northwood HA6 2RN
Filename:	13753 Report 1.docx

QA Control

Rev	Date	Author	Checked by	Approved by
-	25 August 2023	Ben Hunt MIOA	Andy Thompson MIOA	Andy Thompson MIOA

Revision History

Rev	Details

Disclaimer

1 INTRODUCTION

1.1 Background

We have been appointed by The Hillingdon Hospitals NHS Foundation Trust to assess the noise impact of proposed new mechanical plant at the Tudor Centre, Hillingdon Hospital.

The proposed development will extend the rear of the existing building to provide a new home for the Medical Education & Training department. New mechanical plant will include two external condenser units, three MVHR units, and thirteen NVHR units.

The Local Authority has requested this assessment to accompany the planning application. The assessment considers the noise impact upon nearby on and off-site receptors.

1.2 Statement of technical competency

This assessment was carried out by Ben Hunt, a full member of the UK Institute of Acoustics (MIOA).

Ben's educational qualifications include a first-class BSc (Honours) in Sound Design Technology from the University of Hertfordshire (2016) and full merits in the IOA Diploma in Acoustics & Noise Control (2022).

Supervision was provided by Gary Percival, an associate with 14 years' experience in acoustics consultancy and a full member of the UK Institute of Acoustics (MIOA). Gary's educational qualifications include a first-class BSc (Honours) degree in Audio and Music Technology from Anglia Ruskin University (2009), the IOA Diploma in Acoustics & Noise Control (2012) and most recently a Master's degree in Architectural and Environmental Acoustics from London South Bank University (2019).

Gary has carried out hundreds of comparable assessments over his career and has the necessary technical competency to provide appropriate supervision for this assessment.

1.3 Source information

The report is based on the following design information provided by Llewelyn Davies, with markups for plant locations provided by Ingleton Wood.

Drawing No	Index	Title
-DG-A-0201	-B	Level 0 Proposed *markups included*
-DG-A-0202	-C	Level 1 Proposed *markups included*
-DG-A-0100	-A	Site Plan
-DG-A-0201	-G	Level 0 Proposed
-DG-A-0202	-H	Level 1 Proposed
-DG-A-0203	-F	Level 2 Proposed
-DG-A-0204	-G	Proposed 3D
-DG-A-0205	-G	Proposed Elevations
-DG-A-0206	-E	Proposed Section

Table 1 – Details of drawings used to inform this assessment

Additional information was obtained from the following document provided by Llewelyn Davies:

- 220512-THHET-LD30-1041-01-X-XXXX REV P03 'Tudor Centre Extension – Design & Access Statement'

2 PLANNING POLICY

2.1 National Planning Policy Framework

The latest version of the National Planning Policy Framework (NPPF) was released in February 2019 and was last updated in July 2021

The NPPF does not set out quantitative criteria for assessing noise affecting proposed developments, but in paragraph 174 states that planning policies and decisions should actively contribute to the enhancement of the natural and local environment by:

> *"preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability."*

According to paragraph 185, planning policies and decisions should also ensure new development is appropriate for its location, particularly considering the likely effects on health and living conditions. Planning policy and decision makers should aim to:

> *"mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life".*

The *'agent of change principle'* has been part of the NPPF since the July 2018 revision. This principle means that a person or business (i.e. the agent) introducing a new land use is responsible for managing the impact of that change. Paragraph 187 states:

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

2.2 Local Authority Planning Policy and consultation

Local environment and development planning policy are the remit of Hillingdon London Borough Council. We consulted with Philip Brewer, Noise Specialist at London Borough of Hillingdon on 09 August 2023, to discuss local noise policy and assessment criteria.

Mr Brewer confirmed that the proposed development should generally be assessed in accordance with the guidance set out in BS 4142:2014+A1:2019, *'Methods for rating and assessing industrial and commercial sound'*, but due regard should be given to noise criteria given in BS 8233:2014 *'Sound insulation and noise reduction for buildings',* modified by the WHO *Night Noise Guidance* (2009), and to any receptor-specific considerations.

Outline external noise limits of 50 dB(A) during the day and 40 dB(A) at night were stated. We understand that these criteria are related to guidance on internal and external noise levels given in BS 8233:2014, the WHO *'Guidelines for Community Noise'* (1999), and the WHO '*Night Noise Guidelines*' (2009). Further details are provided below.

3 ASSESSMENT METHODOLOGY AND CRITERIA

3.1 BS 4142:2014+A1:2019

3.1.1 Introduction

British Standard 4142:2014+A1:2019 *'Methods for rating and assessing industrial and commercial sound'* (BS 4142) describes appropriate technical methodology for the rating and assessment of sound of an industrial and/or commercial nature.

Sound of an industrial and/or commercial nature includes industrial and manufacturing processes, fixed mechanical and electrical plant installations, the unloading of goods and materials at industrial and/or commercial premises and sound from mobile plant that is an inherent part of the overall sound from industrial and/or commercial premises.

BS 4142 is applicable for the purposes of:

- Investigating complaints;
- Assessing sound from proposed, new, modified or additional source(s) of sound from an industrial and/or commercial nature; and
- Assessing sound at proposed new dwellings or premises used for residential purposes.

BS 4142 is not intended to be applied to the rating and/or assessment of sound from recreational activities (including motorsport), music and other forms of entertainment, shooting grounds, construction/demolition, domestic animals, people, public address systems and any other sources falling within the scope of other standards/guidance.

3.1.2 Summary of BS 4142 assessment methodology

The BS 4142 assessment methodology can be summarised as follows:

1. Determine the background sound level (dB $L_{A90,T}$) at the nearest noise sensitive receptor(s) of interest.
2. Determine the specific sound level of the source under assessment (dB $L_{Aeq,T}$) (T = 1 hour for day or 15 minutes at night) at the receptor location(s).
3. Apply a rating level acoustic feature correction if the sound source has tonal, impulsive, intermittent or other characteristics which attract attention.
4. Compare the rating level (dB $L_{Ar,Tr}$) with the background sound level; typically, the greater this difference, the greater the magnitude of impact.

Differences of around +10dB are likely to be an indication of significant adverse impact, depending upon the context; a difference of +5dB is likely to be an indication of adverse impact, depending upon the context. Where the rating level (dB $L_{Ar,Tr}$) does not exceed the background sound level ($L_{A90,T}$) at the nearest receptor of interest, the indication is that the specific sound source will have a low impact, depending upon the context.

Note: Adverse impacts include but are not limited to sleep disturbance. Not all adverse impacts will lead to complaints and not all complaints are proof of an adverse impact.

3.1.3 Acoustic features

Certain acoustic features (which include tonality impulsivity and/or intermittence) can also increase the significance of impact. Where such features are present a *"character correction"* should be added to the specific sound level to obtain the rating level.

The recommended BS 4142 character corrections are presented in Table 2.

Characteristic	**Perceptibility**		
	Just Perceptible	**Clearly Perceptible**	**Highly Perceptible**
Tonality	+2 dB	+4 dB	+6 dB
Impulsivity	+3 dB	+6 dB	+9 dB
Intermittency	0	+3 dB	+3 dB
Other	0	+3 dB	+3 dB

Table 2 – Summary of BS 4142:2014 character corrections

BS4142:2014 describes suitable subjective methods for assessing character features, plus additional objective (one-third octave and reference) methods for tonality.

3.1.4 Uncertainty

The BS 4142 methodology also requires that the level of uncertainty in the technical data and/or calculations is reported. Where uncertainty could affect the conclusion, reasonable, practicable steps should be taken to reduce uncertainty. If appropriate, the level and potential effects of any identified uncertainty should also be reported.

3.2 BS 8233:2014 *'Sound insulation and noise reduction for buildings'*

British Standard 8233:2014 *'Guidance on sound insulation and noise reduction for dwellings'* (BS 8233) provides guideline limits for ambient noise levels inside dwellings.

These guideline values are primarily designed to apply to steady, continuous sources (such as road traffic) but are also commonly used to provide a reasonable basis for assessing the suitability of noise levels within a dwelling, although careful interpretation and application of the guideline noise levels is often necessary.

BS 8233 suggests the following internal ambient noise levels for dwellings:

Activity	Location	07:00 to 23:00hrs	23:00 to 07:00hrs
Resting	Living room	35 dB $L_{Aeq,16\ hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16\ hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16\ hour}$	30 dB $L_{Aeq,8\ hour}$

Table 3 – Internal Ambient noise levels for dwellings (Table 4 of BS 8233:2014)

Note 5 states:

> *"If relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level."*

Note 7 states:

> *"Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."*

Section 7.7.3.2 recommends that noise levels in external amenity areas should ideally not exceed 50 dB $L_{Aeq,T}$ and that 55 dB $L_{Aeq,T}$ should be considered as an upper limit. However, BS8233 also accepts that these guideline values are not achievable in all circumstances where development might be desirable.

It is helpful to note that the internal ambient noise guideline of 35 dB $L_{Aeq,16h}$ for living areas is closely related to the external amenity guideline of 50 dB $L_{Aeq,T}$. BS 8233 states that sound reduction of 15 dB can typically be expected across a partially open window, so an internal guideline of 35 dB $L_{Aeq,16h}$ approximately equates to an external guideline of 50 dB $L_{Aeq,T}$. Therefore if external ambient noise levels during the day do not exceed 50 dB $L_{Aeq,T}$, then internal and external amenity is likely to be acceptable. We understand that this is the likely basis of the Council's external daytime criterion of 50 dB(A) as stated in Section 2.2 of this report.

3.3 World Health Organisation *'Guidelines for Community Noise'* 1999

The WHO *'Guidelines for community noise'* were published in 1999 and remain the most relevant WHO guidance in relation to appropriate noise levels inside dwellings. The guidance recommends internal ambient noise levels not exceeding 35 dB $L_{Aeq,16hr}$ during the day (07:00-23:00hrs) and 30 dB $L_{Aeq,8hr}$ at night (23:00-07:00hrs). This is consistent with the guidance in Table 4 of BS 8233, as reproduced in Table 3.

The WHO guidance for outdoor *"living"* (amenity) areas is also consistent with BS 8233, with daytime average noise levels between 50-55 dB $L_{Aeq,T}$ representing the levels at which annoyance would normally range between *"moderate"* and *"serious"*.

3.4 WHO Night Noise Guidelines 2009

The Night Noise Guidelines (NNGL) for Europe were published by the WHO in 2009, to complement the Guidelines for Community Noise (1999) and reflect the advances in research on the effects of night-time noise exposure. The NNGL found that below 30 dB(A) $L_{night\ outside}$ there are no observed effects on sleep and that there is no evidence that the biological effects observed at levels below 40 dB(A) $L_{night\ outside}$ are harmful to health. At levels above 55 dB(A) $L_{night\ outside}$ adverse health effects occur frequently and there is limited evidence that the cardio-vascular system is coming under stress.

The NNGL suggest that a *"$L_{night,outside}$ of 40 dB should be the target of the night noise guideline (NNG) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly"*. However, since that target is impossible to achieve in many situations, an *"$L_{night,outside}$ value of 55 dB is recommended as an interim target for the countries where the NNG cannot be achieved in the short term for various reasons, and where policy-makers choose to adopt a stepwise approach*".

We understand that this is the likely basis of the Council's external night-time criterion of 40 dB(A) as stated in Section 2.2 of this report.

3.5 Health Technical Memorandum (HTM) 08-01: Acoustics

HTM 08-01 is a design guide published by the Department of Health which sets out recommended acoustic criteria for the design and management of new healthcare facilities. The document defines appropriate acoustic conditions for healthcare environments and facilities in terms of maximum levels of noise from intrusive external sources and from plant and building services, as well as minimum standards of sound insulation between different areas.

HTM 08-01 states:

> *"The intrusive noise criteria do not include plant noise from adjacent hospital buildings. This should be considered as mechanical service noise (see paragraphs 2.23–2.46)."*

Noise limits from mechanical and electrical services for different room types are defined in terms of Noise Rating (NR) and are given in Table 2 of HTM 08-01. This is reproduced in Figure 1.

Area type	Example	Noise from mechanical and electrical services
Ward areas, sleeping areas	Single-bed ward, multi-bed ward, on-call rooms, relatives' overnight stay Recovery rooms	NR 30 NR 35
Small office-type spaces	Private offices, treatment rooms, interview rooms, consulting rooms	NR 35
Open clinical areas	A&E	NR 40
Circulation spaces	Corridors, hospital street, atria	NR 40
Public areas	Waiting areas, dining, playroom	NR 40
Personal hygiene (en-suite)	Toilets, showers	NR 40
Personal hygiene (general access)	Toilets, showers	NR 45
Small food-preparation areas	Ward kitchens	NR 40
Large food-preparation areas	Main kitchens	NR 50 (NR 55 below extract hoods)
Large meeting rooms (>35 m^2 floor area)	Lecture theatres, meeting rooms, seminar rooms, board rooms, classrooms	NR 30
Small meeting rooms (≤35 m^2 floor area)	Meeting rooms, seminar rooms, board rooms, classrooms	NR 35
Operating theatres (excluding laminar-flow theatres)	Operating theatres	NR 40
Laminar-flow theatres	Ultra-clean theatre	NR 50
Laboratories		NR 40 when laboratory has no fume cupboards NR 60 at 1 m from fume cupboards with open sash
Utility rooms	Clean utility, dirty utility	NR 40

Figure 1 – EXTRACT: Table 2 of HTM 08-01: Criteria for internal noise from mechanical and electrical services

4 DESCRIPTION OF SITE AND PROPOSALS

4.1 Description of site and proposals

The Tudor Centre is located on the southern boundary of Hillingdon Hospital. Areas to the south consist largely of residential dwellings, and existing hospital buildings are to the immediate north, east, and west. The proposed development will see the southern-most section of the Tudor Centre extended.

We have identified the nearest noise-sensitive receptors as follows

- A row of houses located to the immediate south on Lavender Road is the nearest residential noise-sensitive receptors and at its nearest point is approximately 32 m from the proposed location of the external condenser units.
- The Woodlands Centre mental healthcare facility is located to the immediate east.
- The Old Creche building is located to the immediate west and is currently unused. We understand that this building is set to be demolished and replaced, and we have therefore not included it in our assessment.

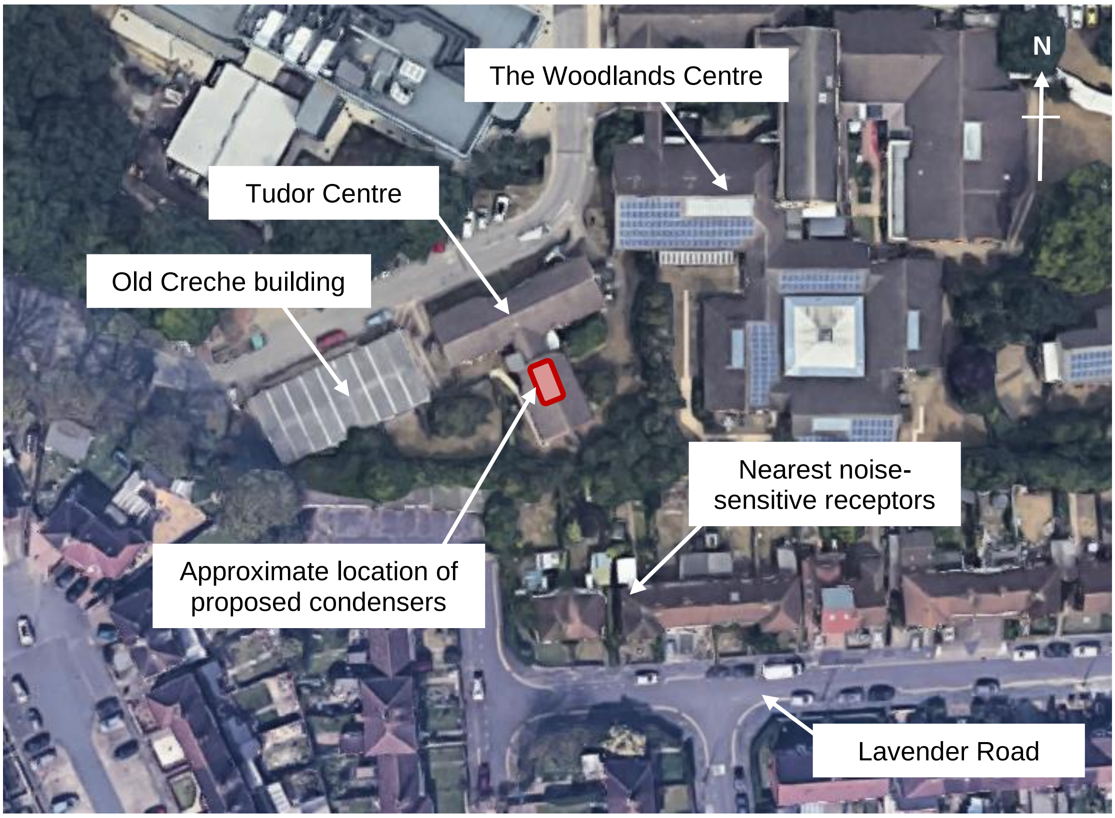

Figure 2 – Annotated aerial photograph of existing site and surroundings © Google 2023

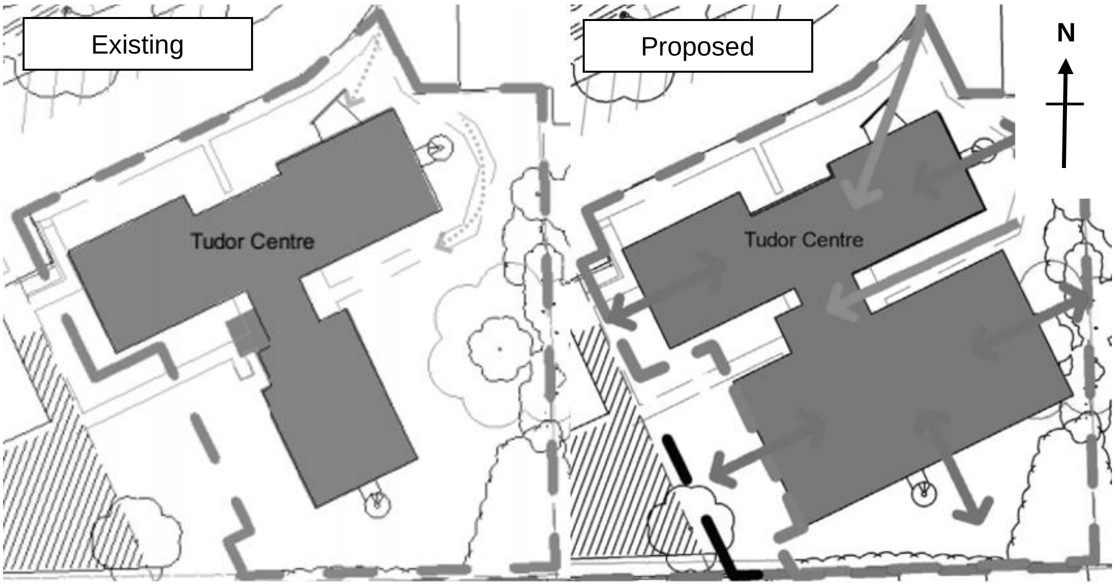

Figure 3 – EXTRACT: Tudor Centre plan – existing vs proposed

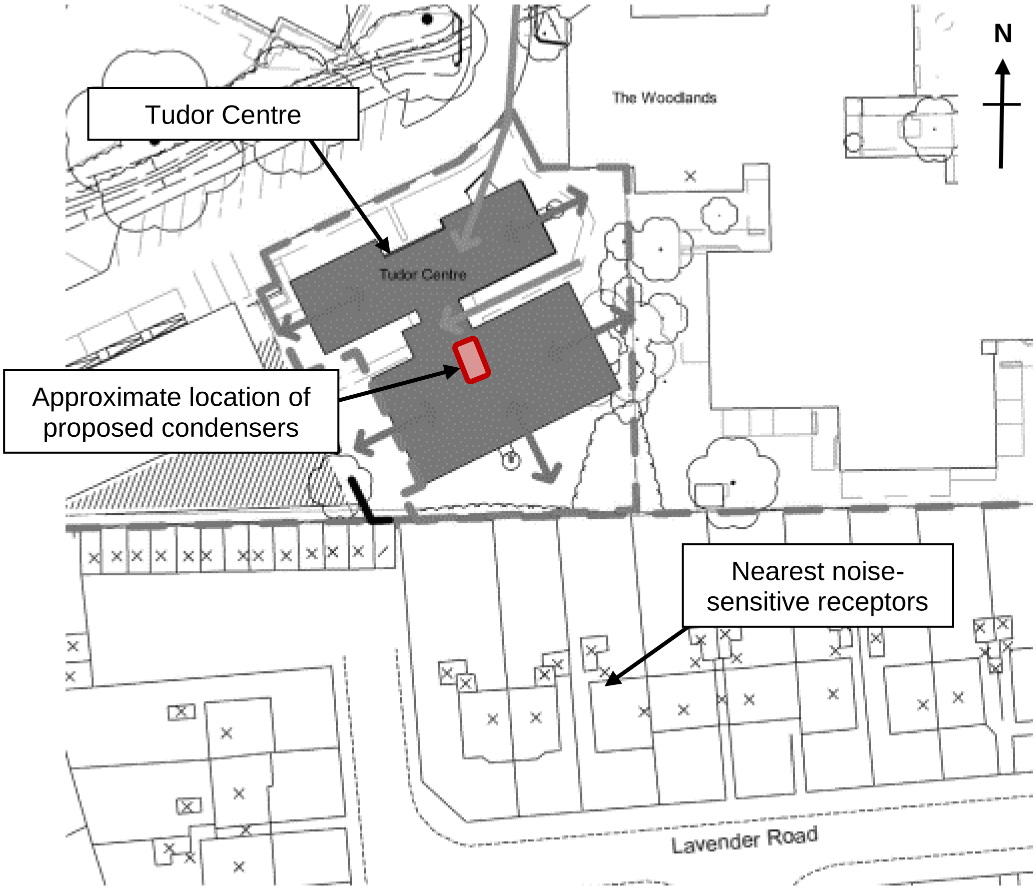

Figure 4 – EXTRACT: Annotated plan of proposed development

4.2 Description of sound sources

4.2.1 Overview of plant

The most significant sources of noise-generating plant are shown in Table 4.

Plant Type	Make/Model	Quantity
External condenser unit	Mitsubishi PURY-M300YNW-A1(-BS)	2
MVHR	Nuaire XBOXER XBC+ 55	3
NVHR	Breathing Buildings NVHR1100	13

Table 4 – Proposed plant

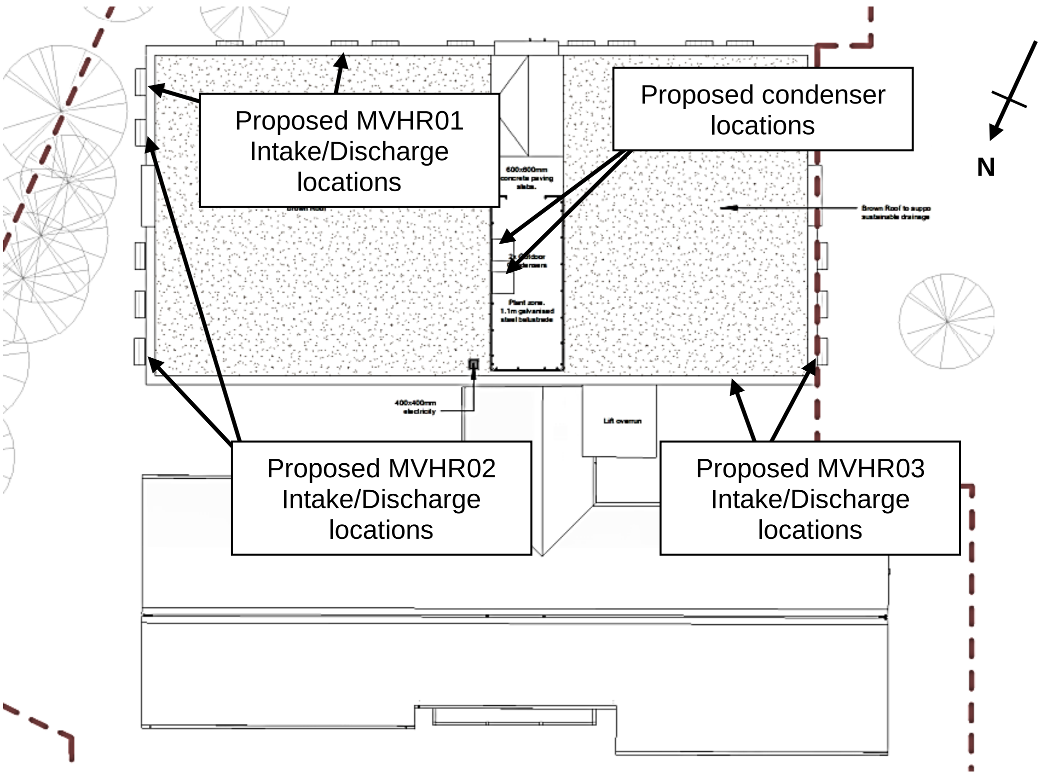

Figure 5 – Proposed condenser and MVHR locations

The proposed locations for the NVHR units are shown in blue in Figure 6 and Figure 7.

Figure 6 – GF: Proposed NVHR locations (shown in blue)

Figure 7 – 1F: Proposed NVHR locations (shown in blue)

4.2.2 Plant operating periods

Llewelyn Davies have stated that no plant will operate during night-time periods. We have therefore assessed plant noise during daytime periods only.

4.2.3 Plant noise data

Condensers

The octave-band sound pressure levels of the external condenser unit type PURY-M300YNW-A(-BS) provided by the manufacturer Mitsubishi are shown in Table 5.

Frequency, Hz	63	125	250	500	1k	2k	4k	8k	dBA
Sound Pressure Level, dB	75.5	62.5	62.5	60.0	54.0	49.5	44.5	40.0	61

Note: These levels are measured at 1 m from the unit under hemispherical conditions.

Table 5 – Sound pressure levels of proposed external condenser units

MVHRs

The octave-band sound power levels of the MVHR units type XBOXER XBC+ 55 provided by the manufacturer Nuaire are shown in Table 6.

Frequency, Hz	63	125	250	500	1k	2k	4k	8k	dBA
In-duct Intake Sound Power Level, dB	81	74	75	63	64	61	53	41	70
In-duct Discharge Sound Power Level, dB	86	81	84	71	72	71	66	63	79

Table 6 – Sound power levels of proposed MVHR units

NVHRs

We contacted Breathing Buildings for noise data for the NVHR1100 units, but were advised that no data exists for atmosphere-side noise levels for this product. We understand that these units use very low-powered fans and are inherently very quiet. Given that these units will therefore be much quieter than the condensers and MVHR units, we therefore consider that omitting the NVHR1100 units from our calculations is unlikely to significantly affect the results.

5 SOUND MEASUREMENTS

5.1 Introduction

We undertook a survey from 7 August 2023 to 14 August 2023 to establish typical background sound levels at the nearest noise-sensitive receptors, using an unattended logging sound level meter. The microphone was mounted on a pole at a height of 1.2 m in free-field conditions. Values for L_{AF90} were measured at 1-hour intervals for daytime periods in line with the BS 4142 daytime reference time interval.

5.2 Survey methodology

5.2.1 Measurement locations

The measurement position was on the south-east side of the Tudor Centre, approximately 32 m to the north of the nearest noise-sensitive receptors on Lavender Road. The position was chosen to be on the hospital site for security reasons, but we consider it to be representative of noise levels at the receptor.

Figure 8 – Annotated aerial photograph of measurement position © Google 2023

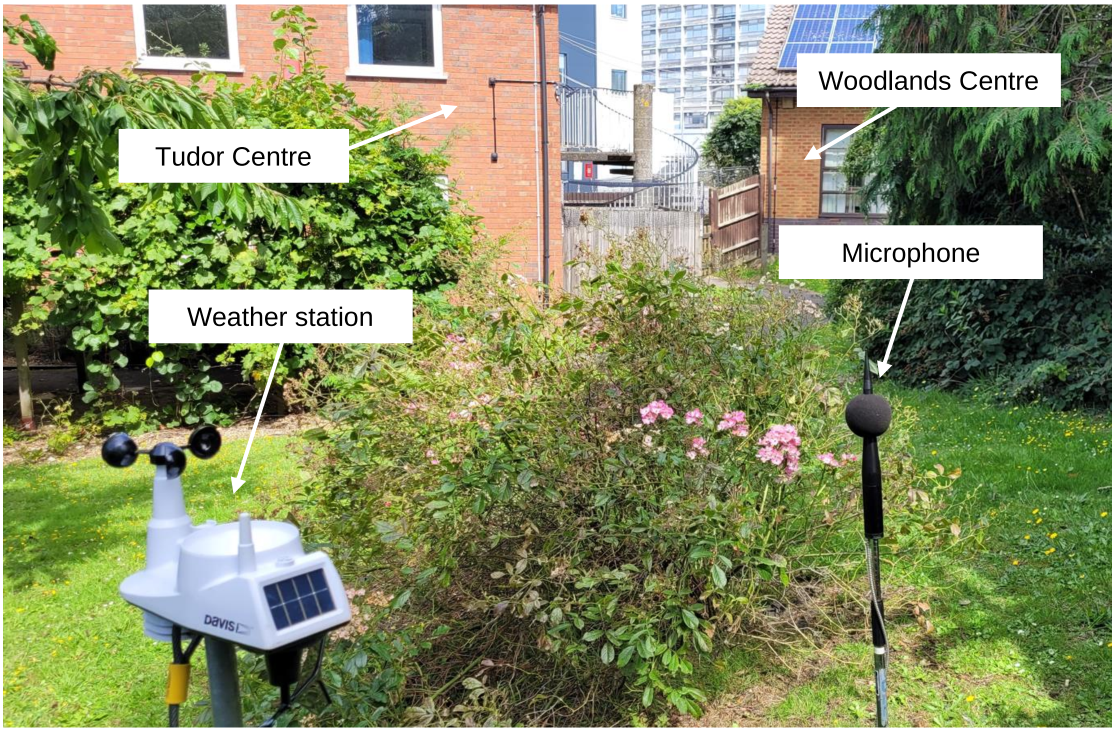

Figure 9 – Annotated photograph of measurement position

5.2.2 Instrumentation

Details of the sound measurement systems used are presented in Appendix B.

The measurement systems were calibrated before and after use using the reference calibrator described in Appendix B. The results are presented in Table 7.

Instrument	Calibrator reference level (dB @ 1kHz)	Level before (dB)	Level after (dB)	Calibration drift (+/- dB)
NTi XL2-TA	114.0	114.0	114.0	0.0

Table 7 – Details of operational calibration test

5.2.3 Weather conditions

Weather data was obtained from a Davis Vantage VUE weather station installed on site. Windspeeds throughout the survey remained below 5 ms^{-1}, and temperatures ranged from 11-26 °C. Where periods of rainfall were observed, the noise data for the corresponding period was omitted from the results.

5.3 Subjective impressions

The sound environment was dominated by passing aircraft, road traffic on the hospital road running in front of the Tudor Centre, and distant traffic from surrounding roads. Other contributory sources include birdsong, rustling of leaves, and visitors to the Tudor Centre and neighbouring buildings.

5.4 Measurement results

Figure 10 presents the measured daytime background sound levels in a histogram (showing the frequency of occurrence for the full range of background sound levels).

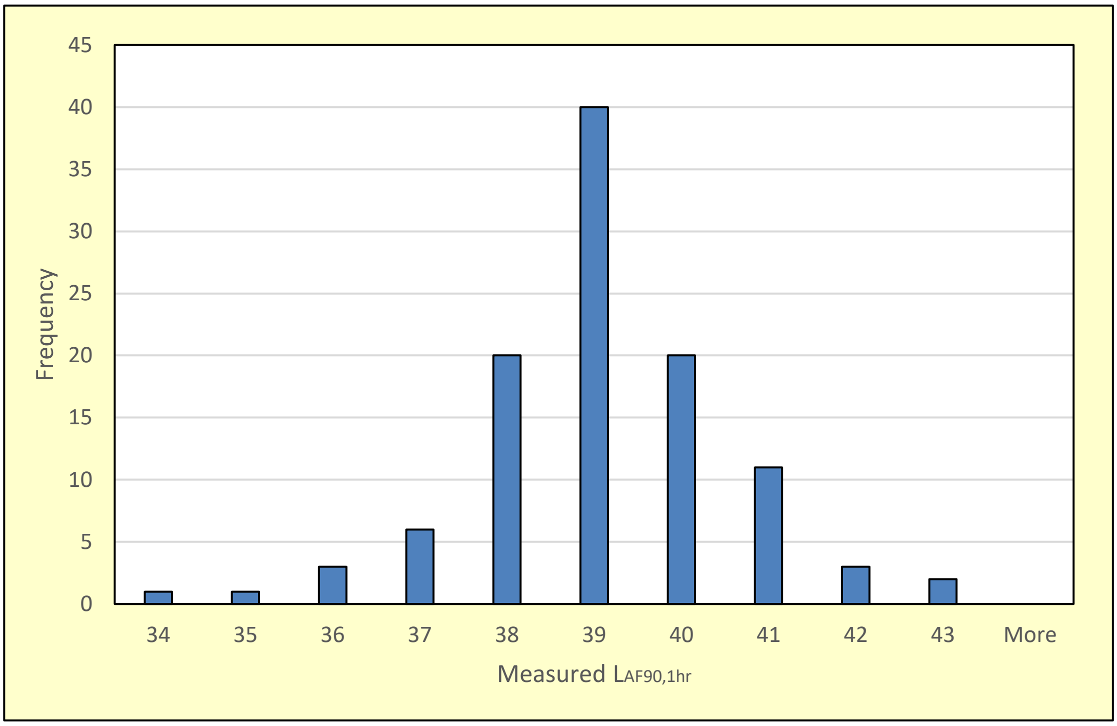

Figure 10 – Histogram of measured daytime background sound levels

6 BS 4142 ASSESSMENT

6.1 Background sound level

According to BS 4142, the representative background sound level for assessment should not simply be the lowest or most common (modal) value, but rather should be the level which is considered typical during each period. In accordance with BS4142 (and the associated Association of Noise Consultants' Technical Note on the use of BS4142) we have identified a suitable representative background sound level from the measured data.

	Daytime ($L_{AF90,1hr}$)
Background sound level, dB	38

Table 8 – Measured daytime background sound level

6.2 Specific sound level

We created a 3D noise model using CadnaA software to predict plant noise levels around the site. The calculation methodology from ISO 9613-2 *'Attenuation of sound during propagation outdoors'* was adopted for this.

ISO 9613-2 sets out an engineering method for calculating the attenuation of sound during propagation outdoors to predict downwind environmental noise levels at distance from a variety of sources. As well as accounting for the distance between each source and receiver, the ISO 9613-2 method also includes the following factors:

- **Geometrical divergence, A_{div}**

  Accounts for spherical spreading in the free field from a point sound source.

- **Atmospheric absorption, A_{atm}**

  Depends primarily on the frequency of the sound, the ambient temperature and relative humidity of the air.

- **Ground effect, A_{gr}**

  Mainly the result of sound reflected by the ground surface interfering with the sound propagating directly from source to receiver.

- **Screening by obstacles, A_{bar}**

  Screening obstacles (often called barriers) must have a closed surface (without large cracks or gaps) and have a surface density of at least 10 kg/m^2.

- **Reflections**

  Reflections off horizontal or vertical surfaces (such as the facades of buildings) which can increase the sound pressure levels at the receiver.

- **Meteorological correction, C_{met}**

  Only applied where local meteorological conditions vary from those which are favourable to propagation for several months or a year. This is rarely applied.

Table 9 sets out the main configuration settings from our CadnaA model which define the correction factors applied according to the ISO 9613-2 calculation method.

Atmospheric absorption	Ambient temperature	10 °C
	Relative humidity	70 %
Ground effect	Default ground absorption	1.00 (soft ground)
	Roads, hardstanding on site	0.00 (hard ground)
Surface reflection and absorption	Freestanding barriers	Absorption coefficient: 0.10
	Buildings	Absorption coefficient: 0.05
	Number of reflections calculated	5

Table 9 – ISO 9613-2 correction configurations applied in the CadnaA model

ISO 9613-2 has a calculation tolerance of +/- 3 dB.

The A-weighted sound level propagation map for all plant operating simultaneously is shown in Figure 11.

Figure 11 – A-weighted sound level propagation map

6.3 Rating level

The specific sound level at the nearest residential noise-sensitive receptor is shown in Table 10.

Specific Sound Level, dB $L_{Aeq,T}$
37

Table 10 – Specific sound level at nearest residential noise-sensitive receptor

BS 4142 requires that potentially distinctive acoustic characteristics are identified and, if necessary, corrections applied to the specific sound level to obtain the rating level. We have assessed this as follows:

- **Impulsivity:** The assessed noise sources are all fan-based systems and are therefore not impulsive.
- **Tonality:** Modern fan systems should not inherently exhibit any identifiable tonality if they are appropriately specified and are regularly and appropriately maintained. As a result, we do not expect the proposed plant to exhibit any distinctive tonal components.
- **Intermittency:** The external condenser units and MVHR units are likely to operate continuously. The condenser units may occasionally switch on and off depending on requirements, but this would happen relatively infrequently and not typically within any reference time interval (1 hour during daytime periods).

We therefore do not consider that it is necessary to apply any character corrections to the specific sound level to obtain the rating level.

6.4 Assessment of impact

The impact of the specific sound source can initially be estimated by subtracting the representative background sound level from the rating level. Typically, the greater this difference, the greater the magnitude of impact (depending on context).

The results of the BS 4142 assessment are presented in Table 11.

Assessment Period	Specific sound level dB $L_{Aeq,Tr}$	Combined feature corrections dB	Rating level dB $L_{Ar,Tr}$	Background sound level dB $L_{A90,T}$	Difference (+/- dB)
Daytime 07:00–2300 hrs	37	0	37	38	-1

Table 11 – Summary of BS 4142 assessment results

In accordance with BS 4142, the above assessment indicates that an adverse impact is unlikely to occur.

6.5 Uncertainty

Certain aspects of the field measurement method in this case introduce uncertainty. BS 4142 recommends that any significant uncertainties are reported, potential effects highlighted and, where practicable, reasonable steps taken to reduce the effects.

6.5.1 Uncertainty of measured values

- Measurement position
  - The measurement position was on the hospital site for security reasons. It is possible that the noise levels at the receptor may be slightly different, but we expect any differences to be minimal.
- Weather conditions
  - Unfavourable weather conditions such as rain and high winds can cause inaccuracies in measured data. Where unfavourable weather conditions occurred, we have identified and omitted the data from our analysis.
  - Some foliage was present at the measurement location. Periods of high wind may have caused some rustling of leaves which could affect the survey data. However, as stated above, any periods of this nature were identified and omitted from our analysis.

6.5.2 Uncertainty in calculations

The following are statements of uncertainty in our calculations, including details of steps taken to reduce the effects.

- Plant noise data
  - Plant noise data was obtained directly from the plant manufacturers, and as such we are reliant on this data being accurate.
- Computer model
  - Our noise model was created in CadnaA software and used the calculation methodology from ISO 9613-2 to predict outdoor sound propagation of the plant noise. ISO 9613-2 has a calculation uncertainty of ±3 dB. Due to the relatively low plant noise levels, a difference of ±3 dB would not significantly affect the results.
- Other plant
  - No noise data is available for the NVHR units due to their inherently low-noise design. Our assessment is therefore based on the assumption that these units are significantly quieter than the other plant.

7 ASSESSMENT OF ABSOLUTE SOUND LEVELS

7.1 Assessment periods

As stated in Section 4.2.2, we understand that plant will not be operational during night-time periods, and we have therefore assessed plant noise during daytime periods only.

7.2 Residential buildings (Lavender Road)

Based on our consultation with the Local Authority, we understand that the daytime absolute noise limit for proposed plant at the façade of the nearest residential noise-sensitive receptor on Lavender Road is as follows:

Daytime absolute noise limit, dB(A)	50

The results of our computer model show that the highest noise level at any residential noise-sensitive receptor with all plant operating simultaneously is 37 dB(A).

This is well below the absolute noise limit specified by the Local Authority, and therefore conforms with the local requirements.

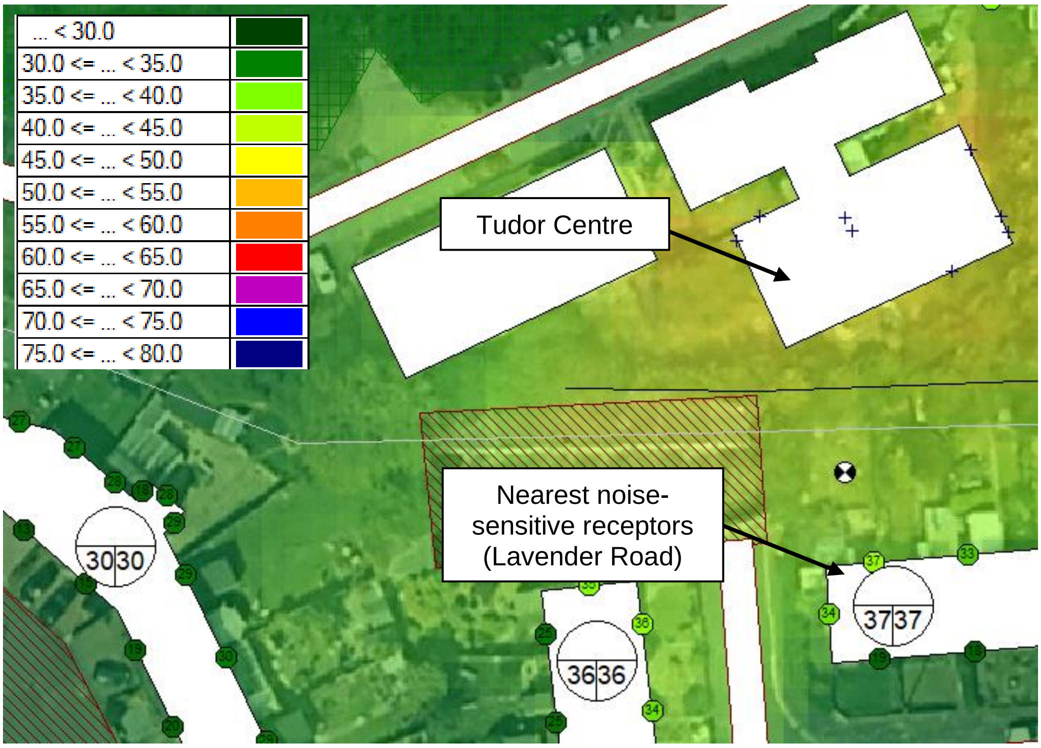

Figure 12 – CadnaA model showing noise levels at nearest residential noise-sensitive receptors

7.3 Healthcare buildings

We have assessed noise break-in to the Woodlands Centre following the methodology detailed in BS 8233:2014 with windows partially open for ventilation and have compared the results to the criterion given in HTM 08-01.

As discussed in Section 4.1, the Old Creche building is set to be demolished and has therefore not been included in our assessment.

We were unable to obtain detailed plans for the current layout of the Woodlands Centre, but after consulting with Northmores we were advised that the rooms adjacent to the Tudor Centre are likely to be part of a Children's Development Centre. We have therefore based our assessment on this information. HTM 08-01 does not specify criteria for this exact type of space, but the closest room specified is likely to be a '*small treatment room*'. The internal noise limit for the Woodlands Centre rooms adjacent to the Tudor Centre is therefore as follows:

Woodlands Centre internal noise limit, NR	35

The results of our assessment show that the NR35 criterion is likely to be met with all plant operating simultaneously.

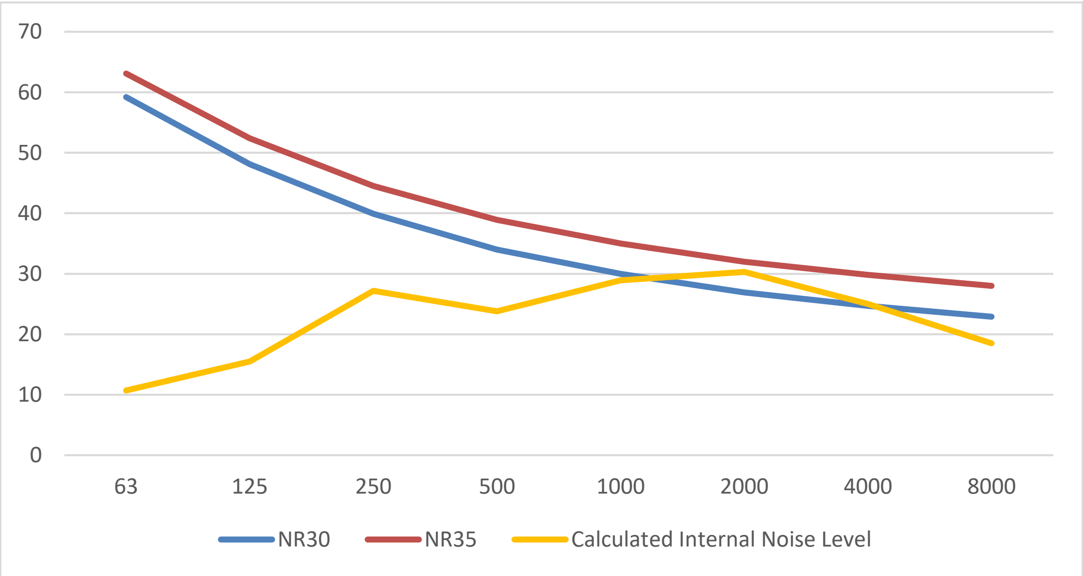

Figure 13 – Calculated internal noise levels in Woodlands Centre vs NR reference curves

8 CONCLUSIONS

- We have assessed noise from proposed plant at the Tudor Centre, Hillingdon Hospital.
- We understand that the proposed plant will not operate during the night, and have therefore assessed plant noise during daytime periods only.
- We took daytime measurements to ascertain the representative (lowest typical) background noise level at the nearest noise-sensitive receptors. The representative daytime background sound level was found to be 38 dB $L_{AF90,1h}$.
- We used manufacturers' data and a computer model to calculate cumulative plant noise levels at the façades of the nearest noise sensitive receptors. We have not applied any character corrections to these levels as the plant is not expected to exhibit clear and/or perceptible characteristics. We predicted a rating level of 37 dB $L_{Ar,Tr}$ at the nearest residential façades.
- The calculated rating level is below the daytime background sound level at the assessed locations.
- In accordance with BS 4142, our assessment indicates that an adverse impact is unlikely at all residential noise-sensitive receptors.
- We calculated internal noise levels in the Woodlands Centre based on noise emanating from the proposed Tudor Centre plant. We predict that the NR35 criterion is likely to be met with all plant operating simultaneously.
- Based on the outcome of this assessment, no further mitigation is required to reduce noise levels from the proposed plant.
- We therefore find no noise-related reason to withhold planning permission for this development.

APPENDIX A TECHNICAL TERMS AND UNITS RELEVANT TO THIS REPORT

Acoustic environment - Sound from all sources as modified by the environment

Ambient sound level, LA = $L_{Aeq,T}$ - Totally encompassing sound, usually composed of many sources. Comprises the residual sound and specific sound when present.

Background sound level, $L_{A90,T}$ - A weighted SPL exceeded by the residual sound for 90% of the a given time interval, T and rounded to the nearest whole dB.

Measurement time interval, T_m - Total time over which measurements are taken. May be the sum of multiple non-contiguous, short-term intervals

Rating level, $L_{Ar,Tr}$ - Specific sound level plus adjustment for characteristic features

Reference time interval, T_r - Specified interval over which the specific sound level is determined, i.e. 1h during the day (0700-2300) and 15mins at night (2300-0700).

Residual sound level, L_r = $L_{Aeq,T}$ - Ambient sound remaining when specific sound source does not contribute

Specific sound level, L_s = $L_{Aeq,Tr}$ - Level produced by specific sound source over reference time interval, Tr. Can also be calculated and/or predicted.

Sound Pressure Level (L_p or SPL) - This is a function of the source and its surroundings and is a measure in decibels of the total instantaneous sound pressure at a point in space. The SPL can vary both in time and in frequency. Different measurement parameters are therefore required to describe the time variation and frequency content of a given sound. These are described below.

Frequency - This refers to the number of complete pressure fluctuations or cycles that occur in one second. Frequency is measured in Hertz (Hz). The rumble of thunder has a low frequency, while a whistle has a high frequency. The sensitivity of the ear varies over the frequency range and is most sensitive between 1KHz and 5KHz.

Octave and One-Third Octave Bands - The human ear is sensitive to sound over a frequency range of approximately 20 Hz to 20,000 Hz and is more sensitive to medium and high frequencies than to low frequencies. To define the frequency content of a sound, the spectrum is divided into frequency bands, the most common of which are octave bands. Each band is referred to by its centre frequency, and the centre frequency of each band is twice that of the band below it. Where it is necessary for a more detailed analysis octave bands may be divided into one-third octave bands.

'**A' Weighting** - The sensitivity of the human ear varies with frequency, some frequencies sound louder than others. The 'A'-weighting curve represents the non-linear frequency response of the human ear and is incorporated in an electronic filter used in sound level meters. Measurements using an 'A'-weighting filter makes the meter more sensitive to the middle range of frequencies, which approximates to the response of the ear and the subjective loudness of the sound. Sound level measurements using 'A'-weighting will include the subscript A, e.g. dB(A).

Statistical Analysis - These figures are normally expressed as LN, where L is the sound pressure level in dB and N is the percentage of the measurement period. The LN figure represents the sound level that is exceeded for that percentage of the measurement period. L_{90} is commonly used to give an indication of the background level or the lowest level during the measurement period.

APPENDIX B MEASUREMENT SYSTEMS AND CALIBRATION

Job reference and title:	13753 Tudor Centre, Hillingdon Hospital
Measurement location:	See Section 5.2 of this report
Measurement date(s):	07 August 2023 – 14 August 2023

Measuring equipment used:

Equipment description / serial number	Type number	Manufacturer	Date of calibration expiration	Calibration certificate number
Precision sound level meter serial no. A2A-09025-E0	XL2-TA	NTi Audio	19/05/2025	TCRT23/1387
Microphone serial no. 8123	MC230	NTi Audio	19/05/2025	TCRT23/1387
Microphone pre-amplifier serial no. 5139	MA220	Neutrik	19/05/2025	TCRT23/1387
Microphone calibrator serial no. 2342835	4231	B&K	19/05/2025	TCRT23/1386
Weather station serial no. ML160329010	6250UK Vantage Vue	Davis Instruments	n/a	n/a

Calibration level:	114.0 dB @ 1 kHz
Persons in charge of measurements:	Ben Hunt MIOA
Measurement parameters	Octave band and A-weighted $L_{eq,T}$
	Octave band and A-weighted $L_{F90,T}$