

**Pembroke College,  
Oxford - Old Quad**

**Noise Impact  
Assessment**

**27 February 2024**

**J7411-MXF-OQ-XX-RP-Y-10000**

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## ISSUE HISTORY

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## **1.0 EXECUTIVE SUMMARY**

Max Fordham LLP has been appointed to prepare a Noise Impact Assessment report for the proposed decarbonisation works at Old Quad building within the Pembroke College estate, in Oxford.

Based on the results of a baseline noise survey undertaken on site, the report assesses the noise impact of the new plant equipment in respect to the existing neighbouring premises in accordance with relevant standards and guidance.

In order to establish a representative noise level at the site, an unattended (long term) noise survey was undertaken from Wednesday the 8<sup>th</sup> to the following Monday the 13<sup>th</sup> of November 2023.

Noise levels have been monitored at the roof of the Harold H.W Lee Building, within the Rokos Quad site, as this was deemed to characterise the lowest typical noise levels at the immediate surroundings, therefore applicable to the identified noise sensitive properties.

The existing representative free field background noise levels assessed are:

- 43 dBA daytime (07:00 and 23:00)
- 40 dBA night-time (23:00 and 07:00)

In considering Planning Conditions from Oxford City Council regarding noise pollution, it is anticipated a noise rating level limit of 5 dB below the representative background noise level.

The noise rating level due to operational plant should be targeting 38 dB ( $L_{Ar}$ ) during daytime (07:00 and 23:00) and 35 dB ( $L_{Ar}$ ) during night-time (23:00 and 07:00). Still, the sole representative background noise has been considered as an appropriate target in some context.

Plant noise rating level from the identified significant units has been assessed at the nearest sensitive properties in accordance with BS 4142:2014 and compared with the proposed noise level limit.

Noise control measures are also proposed, and with the adequate acoustic measures in place the plant noise levels are predicted to have no significant impact.

## **2.0 INTRODUCTION**

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### **Project Summary**

The Old Quad area includes the whole of Old Quad building (including Staircases 1-8), the Tower Staircase, and Broadgates Hall.

The plan for the Old Quad covers the following key objectives:

- Decarbonisation of the buildings via a combination of fabric upgrades and replacement of gas boilers and direct electric heaters with air source heat pumps (ASHPs).
- Repair of the existing historic buildings, including urgent repairs to roofs and dormer windows to ensure that the building fabric is weathertight.
- Fire safety improvements.
- Internal refurbishment.

### **Acoustic Report**

This Noise Impact Assessment report is to form part of the Planning application documents; it addresses the following aspects:

- Reviewing policies and relevant standards (Section 3.0)
- Undertaking a noise survey on site (Section 4.0)
- Describing the adopted mechanical strategy for the external fixed plant (Section 5.0)
- Assessing plant noise rating level against the identified sensitive receptor in accordance with the methodology described in the BS 4142:2014 (Section 6.0)

This report does not assess the followings:

- Traffic noise: there is not expected to be a significant change in traffic as a result of the proposal.
- Vibration: there are no significant existing sources of vibration affecting the development and the plant equipment associated with the development will be mounted on appropriate antivibration mounts where required.
- Aspects of the Old Quad decarbonisation works considered not relevant from an acoustic perspective.

A glossary of acoustic terminology used in this report is included in Appendix A.

## **3.0 POLICIES AND STANDARDS**

### **3.1 National Planning Policy**

#### **National Planning Policy Framework**

Planning Policy Guidance Note 24 (PPG24), which was generally used for overall guidance to planners regarding environmental noise, particularly for residential sites, was replaced in March 2012 by the more general advice given in the National Planning Policy Framework (NPPF).

The National Planning Policy Framework (NPPF) (last update, December 2023) states in paragraph 180e, that planning policies and decisions should contribute to and enhance 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.”

Furthermore, it states in paragraphs 191 and 193 that planning policies and decisions should:

- mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life [paragraph 191 a)],
- identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason [paragraph 191 b)], and
- be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established [paragraph 193].

#### **Noise Policy Statement for England**

The NPPF document also refers to the Noise Policy Statement for England (March 2010). The Noise Policy Statement for England (NPSE) sets out (paragraph 1.6) the long-term vision of Government noise policy: “Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.”

The NPSE also states: “Excessive noise can have wide-ranging impacts on the quality of human life, health (for example owing to annoyance or sleep disturbance) and use and enjoyment of areas of value such as quiet places and areas with high landscape quality.”

The NPSE also cites (in the Explanatory Note section) the following three aims:

- First aim of the NPSE: Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.
- Second aim of the NPSE: Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.
- Third aim of the NPSE: Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

The NPSE also states (paragraph 2.2) that “examples of noise management can be found in many areas including reducing noise source; the use of the land use and transport planning systems, compensation measures, the statutory nuisance and licensing regimes and other related legislation.”

The NPSE (in the Explanatory Note section) also introduces guidance to assist in defining the adverse impacts:

- NOEL – No Observed Effect Level: this is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to noise.
- LOAEL – Lowest Observed Adverse Effect Level: this is the level above which adverse effects on health and quality of life can be detected.
- SOAEL – Significant Observed Adverse Effect Level: this is the level above which significant adverse effects on health and quality of life occur.

These categories are discussed further in the Planning Practice Guidance section below.

The NPSE acknowledges (paragraph 2.15) that it is not possible to have a single objective noise-based measure that is mandatory and applicable to all sources of noise in all situations.

**Planning Practice Guidance, 2014**

The government’s Planning Practice Guidance web pages provide advice of various issues, including noise (<https://www.gov.uk/guidance/noise--2>). The noise advice (March 2014, last update July 2019) states in the context of considering when noise is relevant to planning, “noise needs to be considered when new development may create additional noise, or would be sensitive to the prevailing acoustic environment (including any anticipated changes to that environment from activities that are permitted but not yet commenced).” (Paragraph: 001, Reference ID: 30-001-20190722, Revision date: 22-07-2019.)

The Planning Practice Guidance pages also include more explanation of the effect level categories noted above, providing an explanatory Noise Exposure Hierarchy Table, which explores how actions such as a requirement for noise mitigation, or prevention of a development, might be assessed with respect to whether noise levels are considered above the category thresholds. The Noise Exposure Hierarchy Table (Paragraph: 005, Reference ID: 30-005-20190722, Revision date: 22-07-2019) is reproduced in Figure 1.

Response	Examples of outcomes	Increasing effect level	Action
No Observed Effect Level			
Not present	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

Figure 1: The Noise Exposure Hierarchy Table

In summary, with respect to National Planning Policy, neither the Planning Practice Guidance pages, nor the National Planning Policy Framework or Noise Policy Statement for England documents, provide quantitative advice such as the use of absolute noise limits. Thus, authorities still generally interpret and express national and local non-quantitative policies by issuing quantitative noise-related planning conditions.

## 3.2 Local Policy

### Oxford Local Plan 2036

The Oxford Local Plan 2036 (adopted 8<sup>th</sup> June 2020) sets out the policies and proposals for future development and land use in Oxford, with the objective to promote positive measures to improve the local environment and to meet the needs of communities via sustainable development.

Regarding noise and vibration, Section 4 of the Local Plan, paragraph viii, defines noise and vibration as potential issue for people’s health and wellbeing if not managed in an early stage of the design process. Appropriate attenuation measures, if needed, needs to put in place to minimise the noise impact that the proposed development when considering nearby sensitive developments.

The noise-related policy is then summarised in Policy RE8 *Noise and vibration*.

#### viii. Noise and vibration

- 44.28 Noise and vibration have a significant effect on amenity and people’s health and wellbeing. The management of noise should be an integral part of development proposals and considered as early as possible. The management of noise is about encouraging the right acoustic environment in the right place at the right time. This is important to promote good health and a good quality of life within the wider context of achieving sustainable development. Managing noise includes improving and enhancing the acoustic environment and promoting appropriate soundscapes. This can mean allowing some places or certain times to become noisier within reason, whilst others become quieter.
- 4.29 Consideration of existing noise sensitivity within an area is important to minimise potential conflicts of uses or activities. The City Council will seek to ensure that noise sensitive developments (residential, educational and health care facilities) are separated from major sources of noise, or that appropriate attenuation measures are taken. Such attenuation measures should be included on plans. In cases where noise sensitive development is proposed in close proximity to an existing noise generating use (e.g. music venues and pubs) the Council will consider whether the introduction of the sensitive use might threaten the continued operation of the existing premises, which might mean the development is inappropriate in that location. Measures to mitigate the impacts of noise and vibration associated with demolition and construction will be secured by legal agreement through Construction Management Plans which form part of the Transport Assessment.

#### Policy RE8: Noise and vibration

Planning permission will only be granted for development proposals which manage noise to safeguard or improve amenity, health, and quality of life.

Planning permission will not be granted for development that will generate unacceptable noise and vibration impacts.

Planning permission will not be granted for development sensitive to noise in locations which experience high levels of noise, unless it can be demonstrated, through a noise assessment, that appropriate attenuation measures will be provided to ensure an acceptable level of amenity for end users and to prevent harm to the continued operation of existing uses.

Conditions will be used to secure such mitigation measures and operational commitments.

Measures to mitigate the impacts of noise and vibration associated with demolition and construction will be secured by legal agreement through Construction Management Plans (Refer to Policy M2).

Figure 2: Oxford Local Plan (extract from Section 4, paragraph viii) and Policy RE8 Noise and vibration



### 3.3 British Standards

#### British Standard 4142:2014

British Standard 4142:2014 - *Methods for rating and assessing industrial and commercial sound* sets the methodology for rating and assessing sound of an industrial and commercial nature, which includes sound from fixed installations such as mechanical and electrical plant and equipment.

In BS 4142:2014, a noise rating is determined and compared with the existing local background sound level based on several more cumulative acoustic feature corrections to apply where appropriate. For example if the noise includes a distinguishable tone, impulse, intermittency or other readily distinguishable sound characteristic, then additional *cumulative* penalties individually ranging from 0 to 9 dB may be applied depending on the type of noise.

BS 4142:2014 seeks to determine a “representative” background sound level, stating that “...*the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods*”.

The assessment of the impact depends upon the margin by which the rating level of the specific sound source exceeds the background sound level (i.e. as before) but also promotes a consideration of the context in which the sound occurs when making an assessment. BS 4142:2014 states that an initial estimate of the impact of the specific sound is made by subtracting the measured background sound level from the rating level, while considering the following points:

- a) Typically, the greater this difference, the greater the magnitude of the impact.
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

Note then, a BS 4142:2014 assessment may deduce a low impact where the specific sound level is below the background sound level.

## 4.0 NOISE SURVEY

### 4.1 Site Context

The Pembroke College estate is located in Oxford City Centre (OX1 1DW). The site spans between two major roads, St Aldate's (A420) to the East and St Ebbe's to the West; the two internal streets, Pembroke St and Brewer St, bound the site to the North and to the South respectively.

The Old Quad building (including Staircases 1-8, the Tower Staircase and Broadgates Hall) sits in a central position within the site. The North Quad area will be included in the proposal to accommodate the plant serving the subject building.

The immediate surroundings comprise with St Aldates Church, educational buildings (college and schools) and private developments. Aerial view of the site context is given in Figure 3.

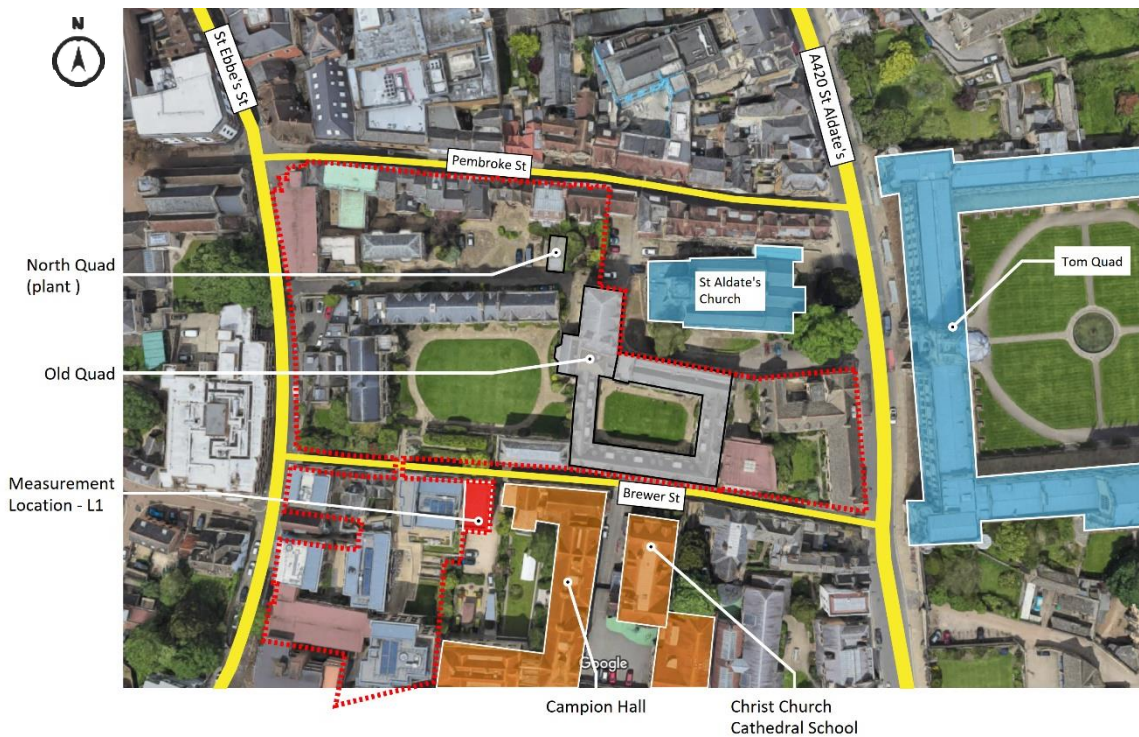


Figure 3: Aerial view showing the site context; Pembroke College site area outlined in red

## 4.2 Noise Survey

The noise environment within the site has been monitored to assess the ambient and background noise levels; the latter parameter is meant to provide an indication of the typical lowest noise levels likely to be experienced on site and within the immediate surroundings.

### Methodology

An unattended noise survey was undertaken from Wednesday the 8<sup>th</sup> to Monday the 13<sup>th</sup> of November 2023, encompassing the weekend. The survey procedure was consistent with the principles of BS 7445-1.

The equipment, a Class 1 sound level meter, was field calibrated with a portable sound calibrator before and at the end of the survey; no significant deviation from the calibrated level was observed.

Measurements were undertaken with a Fast time-weighted with a rating sample of 1 second. Noise levels were saved on consecutive 15-minute time interval.

### Weather Conditions

The weather data was taken from the Atomwide monitoring station in Reading, reporting a wind speed less than 5 m/s with sporadic light rain. Therefore, on-site weather conditions had no effect on the overall results of the survey.

### Noise Sources

The main noise sources identified are road traffic noise from St Aldate's Road and St Ebbe's Road. Pembroke St and Brewer St have been found not predominant in the context.

### Measuring Equipment

Noise measurements were made with a Norsonic 140 sound level analyser. The NOR 140 is a Class 1 sound level meter as per the specification given in the BS EN IEC 61672. The meter uses a Norsonic 1225 free-field response microphone and NOR 1209 microphone pre-amplifier. A Norsonic 1251 portable sound calibrator (complying with BS EN IEC 60942 class 1) has been used to calibrate the instrument.

Details of the monitoring equipment used are given as a reference in Appendix B.

### Measurement Location

The location found appropriate to characterise the typical noise levels at the site was on the roof of Harold H.W Lee Building within the Rokos Quad estate (indicated as L1 in Figure 3).

This location has been identified suitable to characterise low environmental noise levels within the site area as it is well shielded from the road traffic noise. Therefore, results are to be considered conservative for the immediate surroundings as well as suitable for the nearby noise sensitive receptors.

Picture of the setting up is given in Appendix C.

### 4.3 Noise Survey Results

The noise monitoring equipment was left recording from Wednesday 08/11/2023 to the following Monday morning (encompassing the weekend).

Figure 4 shows the noise data collected at Location L1 throughout the survey (approx. 113 hours) indicating the mean ( $L_{Aeq,15min}$ ), the maximum ( $L_{AFmax,15min}$ ), and the background ( $L_{AF90,15min}$ ) noise level parameters.

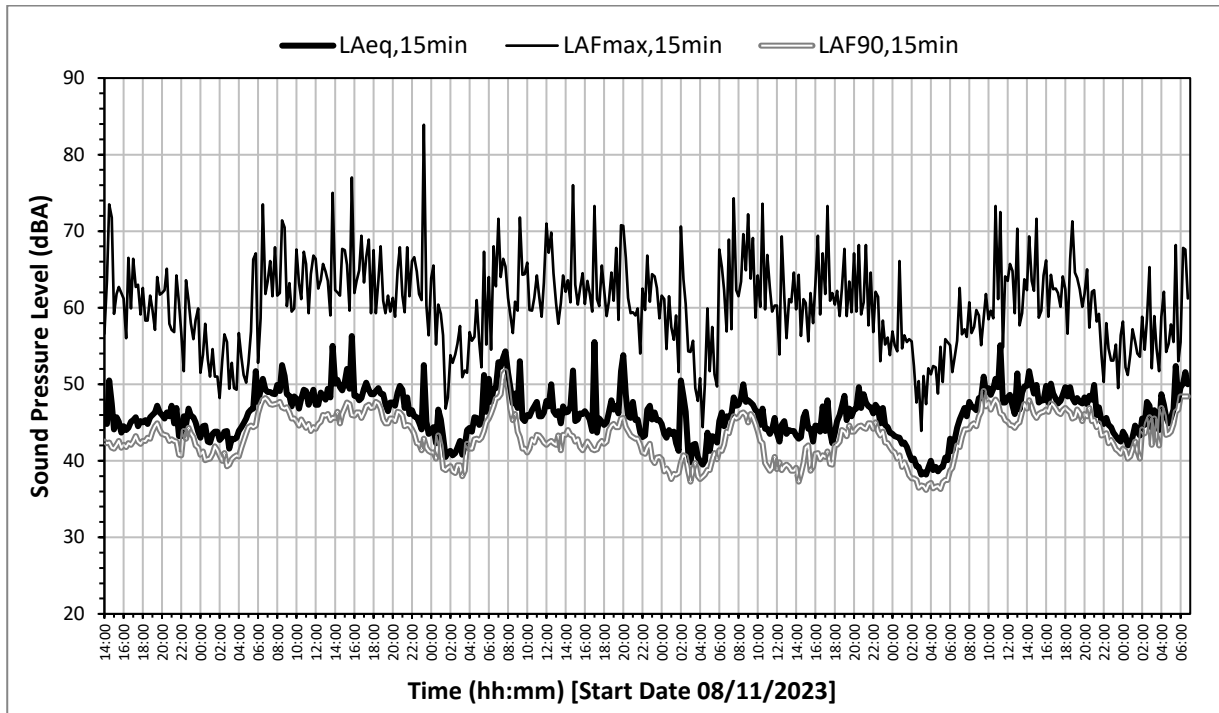


Figure 4: Noise survey data at location L1, showing  $L_{Aeq}$ ,  $L_{AFmax}$  and  $L_{AF90}$  data for consecutive 15-minute measurement period

For the purposes of this noise assessment, daytime is defined between 07:00 and 23:00, and night-time between 23:00 and 07:00.

The representative background noise level has been assessed as the 40<sup>th</sup> percentile of the  $L_{A90,15min}$  values collected over the period of the survey. The background ( $L_{AF90,15min}$ ) statistical distribution graphs showing the 40<sup>th</sup> percentile background noise levels are given in Appendix D for reference.

A summary of the results is given in Table 1 (levels are rounded to the nearest decibel).

Measurement Location	Time period	Duration, T	$L_{Aeq,T}$ (dB)	$L_{AF,max,15min}$ (dB) [1]	$L_{AF90,15min}$ (dB) [2]
L1 – Roof of Harold H.W Lee Building	Day time 07:00-23:00	73 hours	48	69	43
	Night-time 23:00-7:00	40 hours	45	64	40

[1] the 90<sup>th</sup> percentile value of the of the noise levels recorded during the time of the survey  
 [2] the 40<sup>th</sup> percentile “representative” value of the noise levels recorded during the time of the survey

Table 1: Summary of the noise levels from the survey undertaken at Location L1

## 5.0 DESIGN STRATEGY

### 5.1 Mechanical Strategy

#### Mechanical Equipment

The air source heat pump selected is a Samsung AE140BXDGG/EU (14 kW); noise level data indicates a Sound Power Level of 60 dBA per unit (copy of the technical datasheet is provided in Appendix E as reference).

#### Plant Locations

The buildings forming the Old Quad estate (i.e. Staircases 1-8, the Tower Staircase and Broadgates Hall) will be served by ASHPs grouped in two different locations as depicted in Figure 5:

- At the external area of North Quad
- On the roof of the McGowin Library roof

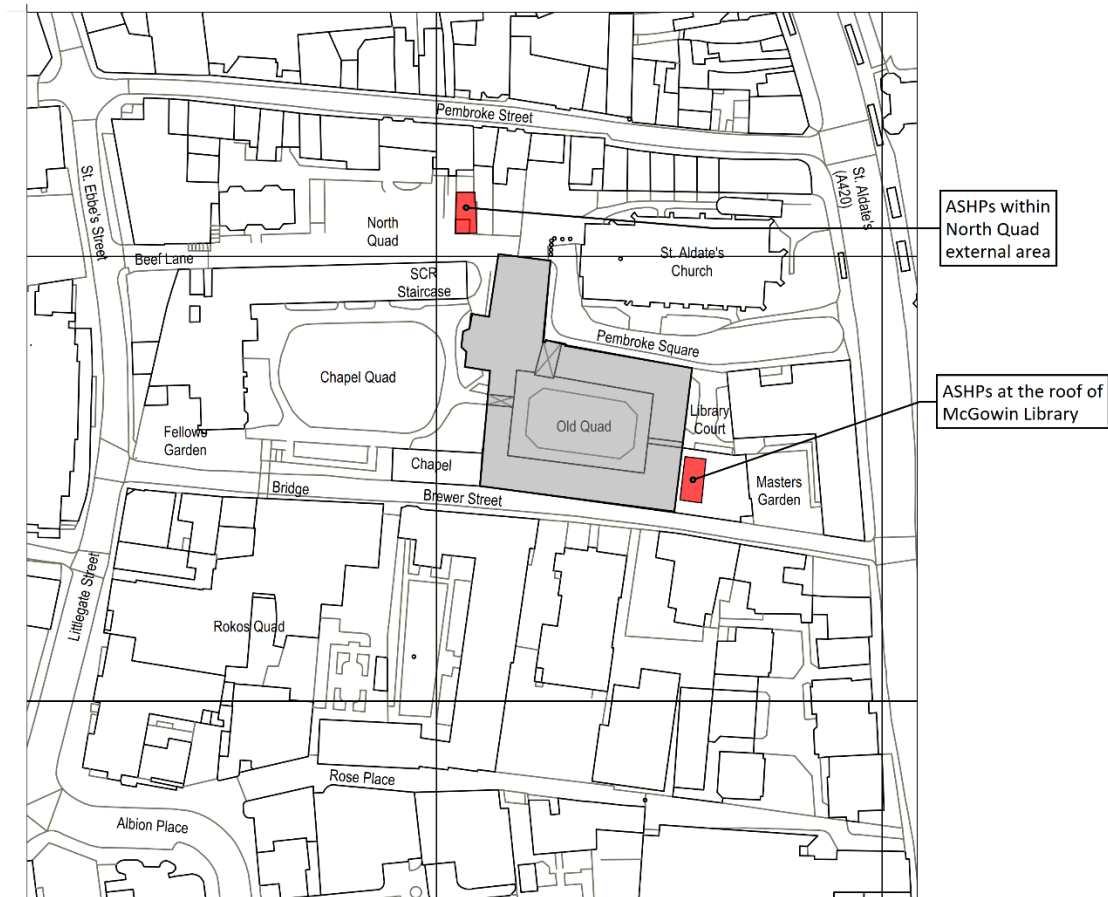


Figure 5: Identification of the plant area

### **Plant at North Quad**

The location identified is between the garden at the rear side of Staircase 18 and the ramp to the bicycle store underneath Staircase 17. The plant area is mostly screened by existing walls to the south and east; metal (bronze) fins will be built to limit the visual impact from the west and from the roof, but still open to the atmosphere to provide ventilation.

The plant will accommodate a total of 8 No. ASHPs (double stacked). In detail: 5 No. units will be operating to serve Staircases 7 and 8 and Broadgates Hall; 2 units will be used at a later time in provision of further decarbonisation works; while one unit will not be operating but in case of backup (emergency) only.

### **Plant on McGowin Library roof**

The McGowin Library roof will house the ASHPs serving Old Quad Staircases 1-6 and the Tower Staircase. It is proposed 10 No. units clustered in 2 rows of 5 elements located on the west side of the roof. The roof space will be screened to ensure that the heat pumps are not visible from ground level or surrounding upper storey windows and acoustically rated.

## **5.2 Noise Control Strategy**

### **Plant at North Quad**

It is understood that the plant area is enclosed on three sides and open to the atmosphere to the West and to the roof. The plant will be internally covered with an absorptive material (i.e. Quietstone) which will reduce reverberant noise within the space.

### **Plant at the McGowin Library roof**

It is understood that the screen included in the proposal is 1500mm in height, enough to conceal the units. Moreover, the screen and any access door(s) leading to the plant are to be acoustically rated with a minimum sound reduction index of 13 dB  $R_w$ .

## **5.3 Vibration Control Strategy**

All rotating and vibrating machinery (e.g. fans, pumps, motors, chillers etc.) must be adequately isolated so the plant does not propagate noticeable vibration into occupied spaces or give rise to unacceptable radiated noise levels. Suitable vibration isolation should be selected for individual plant items on a case by case basis.

## 6.0 PLANT NOISE ASSESSMENT

The plant noise emissions are designed such that the rating noise level from all new items of plant equipment result in a “low impact” at nearby noise sensitive receptors when assessed in accordance with the methodology described in BS 4142:2014.

### 6.1 Representative Background Noise Level

Plant noise rating limits are defined relative to the measured existing background sound levels. In setting a background level, it is noted that BS 4142:2014 seeks to determine a “representative” background sound level, stating that “...the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods”.

A definitive method of selecting a representative background sound level is not prescribed in BS 4142:2014, although an example is presented where the modal value is selected from a statistical analysis. In our experience, a reasonable approach to defining an overall representative value is to consider the 40<sup>th</sup> percentile value of the  $L_{AF90}$  data periods, which generally accounts for potentially unrepresentative high values and untypical events, while usually representing values near the median of the remaining ‘valid’ distribution.

The representative background noise levels for the daytime and night-time periods are as it follows:

- 43 dB(A) daytime (07:00 – 23:00)
- 40 dB(A) night-time (23:00 – 07:00)

### 6.2 Proposed Plant Noise Level Limits

We understand the Oxford local authority typically requires plant noise to be 5 dB below background. As such, the noise rating level ( $L_{Ar,Tr}$ ) are expected not to exceed the values reported on Table 2 when assessed at the closest noise sensitive receptors.

Period	Representative background noise level $L_{AF90}$	Oxford Local Plan	Plant Noise Rating Level Limit $L_{Ar,Tr}$
Daytime (07:00-23:00)	43 dB(A)	-5 dB	38 dB(A)
Night-time (23:00-07:00)	40 dB(A)	-5 dB	35 dB(A)

Table 2: Proposed Noise Rating Level limits

It is seen that the representative background level is to be considered low. Therefore, plant noise emission should be possibly targeting 5 dB below the representative background noise level, although it has been considered the sole background noise level as an appropriate target, depending on the context.



### 6.3 Noise Sensitive Receptors

Table 3, with reference to Figure 6, provides a list of the identified neighbouring sensitive receptors (NSRs) in respect to each plant location.

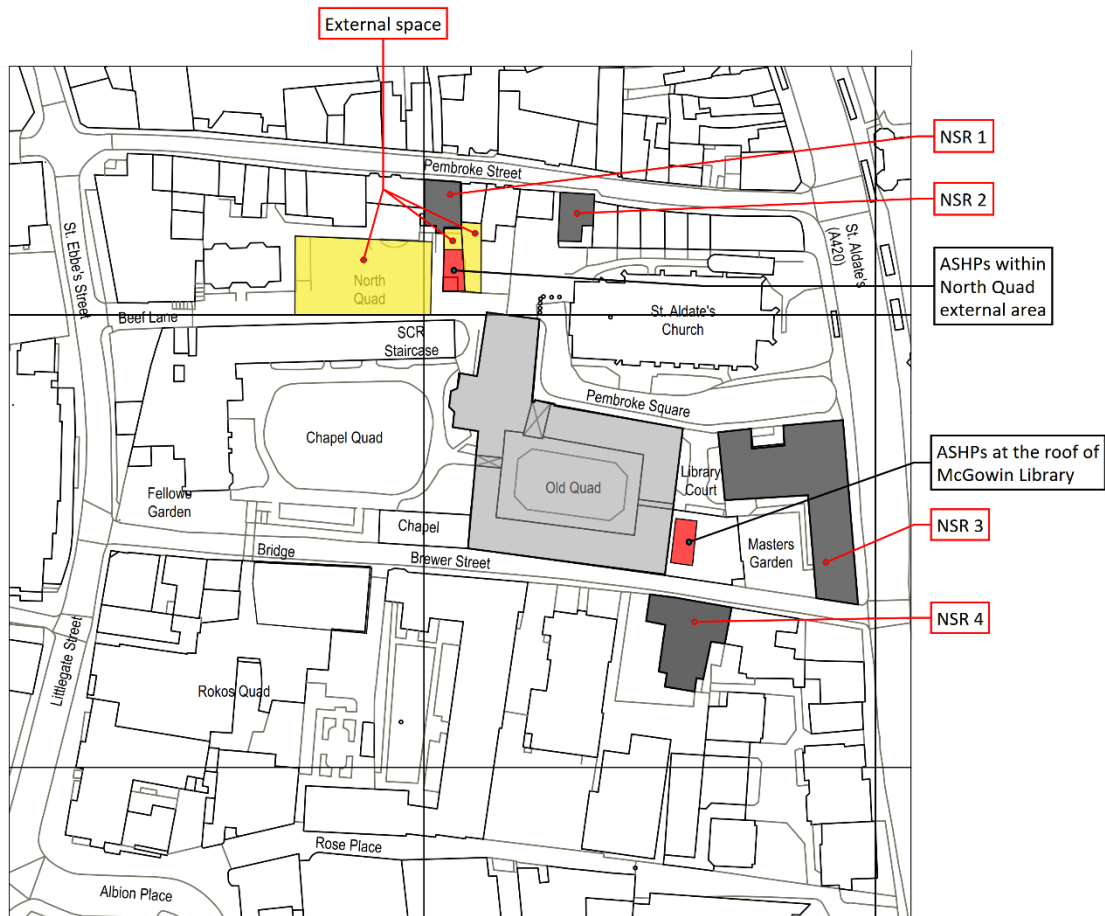


Figure 6: Identification of the NSRs in relation to the plant area

Noise Sensitive Receptors	Type of development	Predominant noise source
NSR 1 – Staircase No.17	Student accommodation	Plant noise at the North Quad
NSR 2 – No. 11 Pembroke Street	Private property	
NSR 3 - Master house	Private property	Plant noise at the McGowin Library roof
NSR 4 – No.2 Brewer Street	Private property	
External space	<ul style="list-style-type: none"> <li>New seating area at Staircase 17</li> <li>Garden at Staircase 18</li> <li>Area to the west</li> </ul>	Plant noise at the North Quad

Table 3: List of the nearest noise sensitive receptors/area



## 6.4 Plant Noise Assessment

### Methodology

The assessment has been made assuming the ASHPs (i.e. the specific sound sources) operating simultaneously (i.e. worst case scenario) with a Sound Power Level emission as specified in Table 4 below.

Plant	Manufacturer-Modal	Sound Power Level per unit (dBA)	Quantity	Overall Sound Power Level (dBA)
North Quad	Samsung - AE140BXYDEG/EU	60	7 (*)	68.5
McGowin Library roof	Samsung - AE140BXYDEG/EU	60	10	70
(*) Note: all the 7 units have been included in the assessment (worst case scenario of the future situation)				

Table 4: Plant noise level emission

Noise rating level ( $L_{Ar,Tr}$ ) is evaluated in compliance with BS 4142:2014 and includes several cumulative corrections to the specific sound source ( $L_{Aeq}$ ) taking into account factors such as distinguishable tones, impulses, intermittency or other sound characteristics, depending on the type source.

Domestic air source heat pumps generally do not exhibit a prominent noise characteristic; hence, no acoustic feature correction (0 dB) have been applied to the specific sound source.

The rating level ( $L_{Ar,Tr}$ ) from the ASHPs has been predicted and compared with the proposed noise rating level limit as appropriate.

The overall significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs; usually, the greater this difference, the greater the magnitude of the impact.

### NSR 1 - Staircase No.17

As the plant on North Quad is open to the roof and to the west side, noise will be propagating to the atmosphere mainly from these two sides. As such, the assessment has been done at the students' accommodation windows on the upper levels, as the most exposed to noise breaking out from the plant roof. The distance estimated from the centre of the plant to the façade is approx. 10m.

NSR 1 - Staircase No.17	Value	Unit
Total Sound Power Level for North Quad plant area	68.5	dB $L_{wA}$
Distance between specific sound source and NSR	10	m
Specific sound level at the NSR façade (due to distance accounting for a directivity factor $Q = 2$ ; hemispherical propagation)	40	dB
Noise reduction due to barrier effects	0	dB
Acoustic feature correction	0	dB
Rating Level	40	dB $L_{Ar,Tr}$
Proposed Plant noise Rating Level Limit (night-time)	40	dB $L_{Ar,Tr}$
Excess of rating over background sound level	0	dB

Table 5: Noise rating level assessment at NSR 1

As the noise sensitive location would be indoor (student bedrooms) with windows closed, targeting the representative night-time background noise level has been considered appropriate. In this context, the excess of the rating level over the proposed background noise level is null (0 dB). Therefore, no adverse effect is predicted.

### NSR 2 - No. 11 Pembroke Street

The distance estimated from the centre of the North Quad plant to the subject receptor is approx. 25m. Additional noise reduction has been included into the assessment to consider the barrier effect provided by the existing brick wall to the east.

NSR 2 - No. 11 Pembroke Street	Value	Unit
Total Sound Power Level from North Quad plant area	68.5	dB L <sub>WA</sub>
Distance between specific sound source and NSR	25	m
Specific sound level at the NSR façade (due to distance accounting for a directivity factor Q = 2; hemispherical propagation)	33	dB
Noise reduction due to barrier effects	-10	dB
Acoustic feature correction	0	dB
Rating Level	23	dB L <sub>Ar,Tr</sub>
Proposed Plant noise Rating Level Limit (night-time)	35	dB L <sub>Ar,Tr</sub>
Excess of rating over background sound level	-12	dB

Table 6: Noise rating level assessment at NSR 2

The excess of the rating level over the background sound level is -12 dB. Therefore, no significant impact is predicted.

### NSR 3 - Master house

The distance estimated from the centre of the plant on the roof of the McGowin Library and the subject receptor is approx. 10m. Noise reduction provided by the acoustic screen (13 dB) has been included into the assessment.

NSR 3 - Master house	Value	Unit
Total Sound Power Level for McGowin Library roof	70	dB L <sub>WA</sub>
Distance between specific sound source and NSR	10	m
Specific sound level at the NSR façade (due to distance accounting for a directivity factor Q = 2; hemispherical propagation)	42	dB
Acoustic screen reduction	-13	dB (R <sub>w</sub> )
Acoustic feature correction	0	dB
Rating Level	29	dB L <sub>Ar,Tr</sub>
Proposed Plant noise Rating Level Limit (night-time)	35	dB L <sub>Ar,Tr</sub>
Excess of rating over background sound level	-6	dB

Table 7: Noise rating level assessment at NSR 3

The excess of the rating level over the background sound level is -6 dB. Therefore, no significant impact is predicted.

#### NSR 4 - No.2 Brewer Street

The distance estimated from the centre of the plant on the roof of the McGowin Library and the subject receptor is approx. 11m. Noise reduction provided by the acoustic screen (13 dB) has been included into the assessment.

NSR 4 - No.2 Brewer Street	Value	Unit
Total Sound Power Level from McGowin Library roof	70	dB L <sub>WA</sub>
Distance between specific sound source and NSR	11	m
Specific sound level at the NSR façade (due to distance accounting for a directivity factor Q = 2; hemispherical propagation)	41	dB
Acoustic screen reduction	-13	dB (R <sub>w</sub> )
Acoustic feature correction	0	dB
Rating Level	28	dB L <sub>Ar,Tr</sub>
Proposed Plant noise Rating Level Limit (night-time)	35	dB L <sub>Ar,Tr</sub>
Excess of rating over background sound level	-7	dB

Table 8: Noise rating level assessment at NSR 4

The excess of the rating level over the background sound level is -7 dB. Therefore, no significant impact is predicted.

#### Seating area for Staircase No.17

The relevant noise source affecting this property is the plant on North Quad. In this scenario, noise reduction has been included to consider the barrier effect provided by the wall between the plant and the outdoor area.

Seating area on Staircase No.17	Value	Unit
Total Sound Power Level for North Quad plant area	68.5	dB L <sub>WA</sub>
Distance between specific sound source and NSR	5	m
Specific sound level at the NSR façade (due to distance accounting for a directivity factor Q = 2; hemispherical propagation)	47	dB
Noise reduction due to barrier effects	-10	dB
Acoustic feature correction	0	dB
Rating Level	37	dB L <sub>Ar,Tr</sub>
Proposed Plant noise Rating Level Limit (daytime)	43	dB L <sub>Ar,Tr</sub>
Excess of rating over background sound level	-6	dB

Table 9: Noise rating level assessment at the seating area on Staircase No.17

As the outdoor terrace for Staircase 17 will be used for socialising and outdoor dining, targeting the daytime representative background noise level has been considered appropriate. In this context, the excess of the rating level over the background noise level is -6 dB. Therefore, no adverse effect impact is predicted.

### Garden at Staircase No.18

The relevant noise source affecting this property is the plant on North Quad. In this scenario, noise reduction has been included into the assessment to consider the barrier effect provided by the wall between the plant and the adjacent garden.

Garden on Staircase No.18	Value	Unit
Total Sound Power Level for North Quad plant area	68.5	dB L <sub>WA</sub>
Distance between specific sound source and NSR	5	m
Specific sound level at the NSR façade (due to distance accounting for a directivity factor Q = 2; hemispherical propagation)	47	dB
Noise reduction due to barrier effects	-12	dB
Acoustic feature correction	0	dB
Rating Level	35	dB L <sub>Ar,Tr</sub>
Proposed Plant noise Rating Level Limit (daytime)	43	dB L <sub>Ar,Tr</sub>
Excess of rating over background sound level	-8	dB

Table 10: Noise rating level assessment at the garden on Staircase No.18

As the garden for Staircase 18 will be used as outdoor space, targeting the daytime representative background noise level has been considered appropriate. In this context, the excess of the rating level over the background noise level is -8 dB. Therefore, no adverse effect is predicted.

### North Quad outdoor area to the West

The relevant noise source affecting this property is the plant on North Quad. In this scenario, no noise reduction has been considered as the west side of the plant is open to the atmosphere. This external space is approx. 30m wide. An average distance of 15m has been considered for the assessment.

West area on North Quad	Value	Unit
Total Sound Power Level for North Quad plant area	68.5	dB L <sub>WA</sub>
Distance between specific sound source and NSR	15	m
Specific sound level at the NSR façade (due to distance accounting for a directivity factor Q = 2; hemispherical propagation)	37	dB
Noise reduction due to barrier effects	0	dB
Acoustic feature correction	0	dB
Rating Level	37	dB L <sub>Ar,Tr</sub>
Proposed Plant noise Rating Level Limit (daytime)	43	dB L <sub>Ar,Tr</sub>
Excess of rating over background sound level	-6	dB

Table 11: Noise rating level assessment at the area to the West

As this area is mainly used by pedestrians and vehicles to get access to the Pembroke College, targeting the daytime representative background noise level has been considered appropriate. In this context, the excess of the rating level over the background noise level is -6 dB. Therefore, no adverse effect is predicted.

## **7.0 SUMMARY AND CONCLUSION**

The report addresses the noise impact for the decarbonisation works at the Old Quad building within the Pembroke College in Oxford (OX1 1DW).

Part of the proposal includes the installation of air source heat pump (ASHPs) and associated plant rooms, to serve the Old Quad building (comprising with Staircases 1-8, the Tower staircase and Broadgates Hall).

A long-term noise survey has been undertaken from Wednesday the 8<sup>th</sup> to the following Monday the 13<sup>rd</sup> of November 2023; the survey procedures were consistent with BS 7445-1.

The equipment has been set up at the roof of the Henderson Building, as this was deemed to characterise the lowest typical noise levels in the immediate surroundings, including the closest noise sensitive receptors.

The representative background noise levels have been estimated as per the 40<sup>th</sup> percentile of the values from the distribution of  $L_{A90,15min}$  noise levels recorded during the survey period, giving the following values:

- 43 dBA daytime (07:00 – 23:00)
- 40 dBA night-time (23:00 – 07:00)

In anticipating Oxford City Council planning conditions, it is expected a target of 5 dB below the representative background noise levels as it follows:

- 38 dB  $L_{A,r,Tr}$  daytime (07:00-23:00)
- 35 dB  $L_{A,r,Tr}$  night-time (23:00-07:00)

Plant noise rating level ( $L_{A,r,Tr}$ ) has been assessed in accordance with the BS 4142:2014 methodology at the identified noise sensitive premises.

The assessment has been made assuming the worst-case scenario and targeting the noise rating level limit found appropriate in each context.

With the proposed noise control measures in place, no observed adverse effect level due to plant noise is predicted and therefore no significant impact is anticipated.

## 8.0 APPENDIX A

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### 8.1 Acoustic Glossary

#### **SOUND POWER LEVEL, or $L_w$ (decibels, dB)**

The total amount of sound energy per unit of time generated by a particular sound source. This corresponds to a reference sound power of 10 pW.

#### **SOUND PRESSURE LEVEL, SPL or $L_p$ (decibels, dB)**

A measure of the instantaneous sound pressure at a point in space. The threshold of hearing occurs at approximately  $L_p=0$  dB (which corresponds to a reference sound pressure of 20  $\mu$ Pa).

#### **A-WEIGHTED SOUND PRESSURE LEVEL, $L_A$ (dBA)**

A-weighted sound pressure level values are frequency-weighted in a way that approximates the frequency response of the human ear and allows sound levels to be expressed as a single figure value.

Alternative frequency-weightings are C-weighting and Z-weighting.

#### **EQUIVALENT CONTINUOUS A-WEIGHTED SPL, $L_{Aeq,T}$ (dBA)**

Energy average of the A-weighted sound pressure level over a time period, T. The level of a notional continuous sound that would deliver the same A-weighted sound energy as the actual fluctuating sound over the course of the defined time period, T.

#### **MAXIMUM A-WEIGHTED SPL, $L_{AFmax}$ (dBA)**

The maximum A-weighted sound pressure level measured. If not specified, usually assumed to mean  $L_{AFmax}$ , i.e.  $L_{Amax}$  determined with a 'fast' (F) sound level meter time constant of 125 ms.

#### **BACKGROUND SOUND LEVEL, $L_{A90,T}$ (dBA)**

The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90% of a given time interval, T, measured using time weighting, and quoted to the nearest whole number of decibels.

#### **NOISE RATING LEVEL, $L_{Ar,Tr}$ (dBA)**

The A-weighted specific sound level plus any adjustment for characteristic features of the sound (for example if the sound features impulsive or tonal components). Used in BS 4142:2014 assessments.

#### **SPECIFIC SOUND LEVEL, $L_s = L_{Aeq,Tr}$ (dBA)**

The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval,  $T_r$ .

#### **RESIDUAL SOUND LEVEL, $L_r = L_{Aeq,T}$ (dBA)**

The 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 and is equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T

#### **SPECIFIC SOUND SOURCE**

The sound source being assessed.

## 9.0 APPENDIX B

### 9.1 Calibration Certificate

The equipment summarised below has been calibrated by a UKAS accredited laboratory in accordance with the laboratory requirements of the United Kingdom Accreditation Service (UKAS) on the dates indicated.

UKAS calibration data sheets and certificates are available upon request.

Item	Make	Type	Serial no.	Date of Calibration	Date of Calibration	Calibration Certificate Number
Class 1 sound level meter	Norsonic	140	1406755	28/10/2022	2 years	U42262 U42263
Microphone preamplifier	Norsonic	1209	21284	28/10/2022	2 years	U42262 U42263
Microphone	Norsonic	1225	251518	28/10/2022	2 years	42261
Calibrator	Norsonic	1251	34890	17/03/2023	1 year	U43710

Table B1: Equipment certificate calibration details

## 10.0 APPENDIX C

### 10.1 Noise Survey Pictures



Figure 7: Measurement location on the roof of the Harold H.W Lee building (Campion Hall building in the background)

# 11.0 APPENDIX D

## 11.1 Noise Survey Graphics

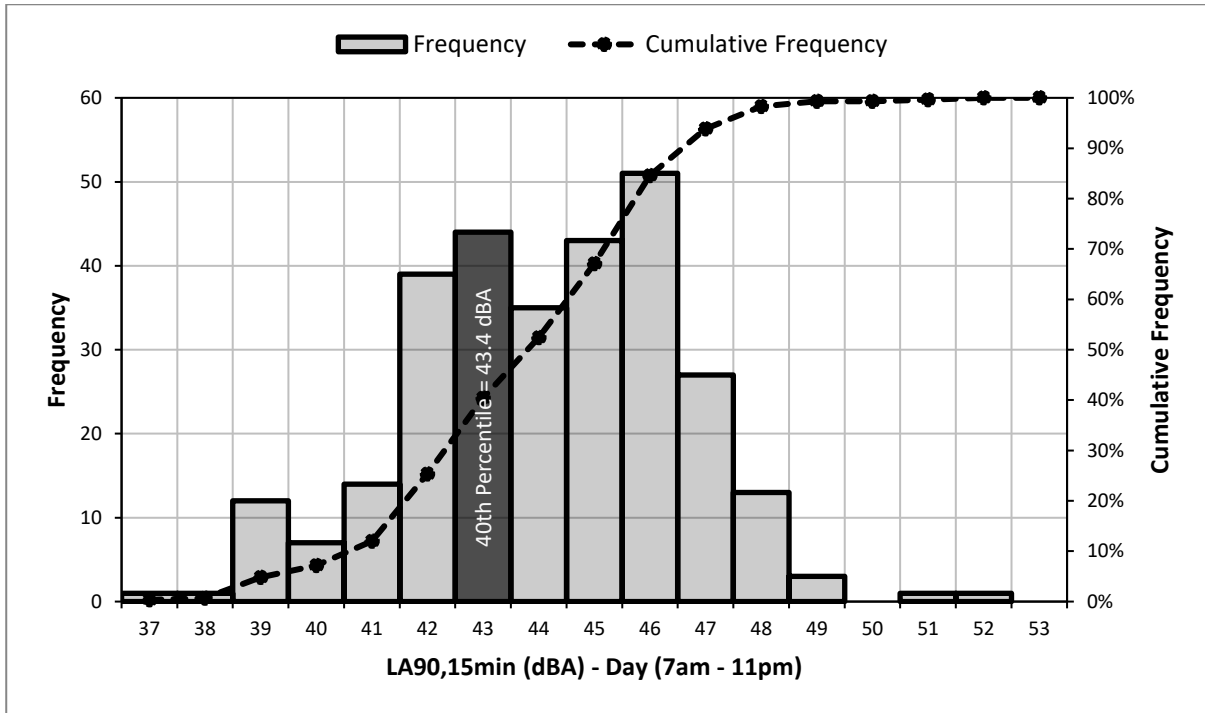


Figure 8: Daytime statistical distribution of background noise levels (LA90,15min) measured at location L1

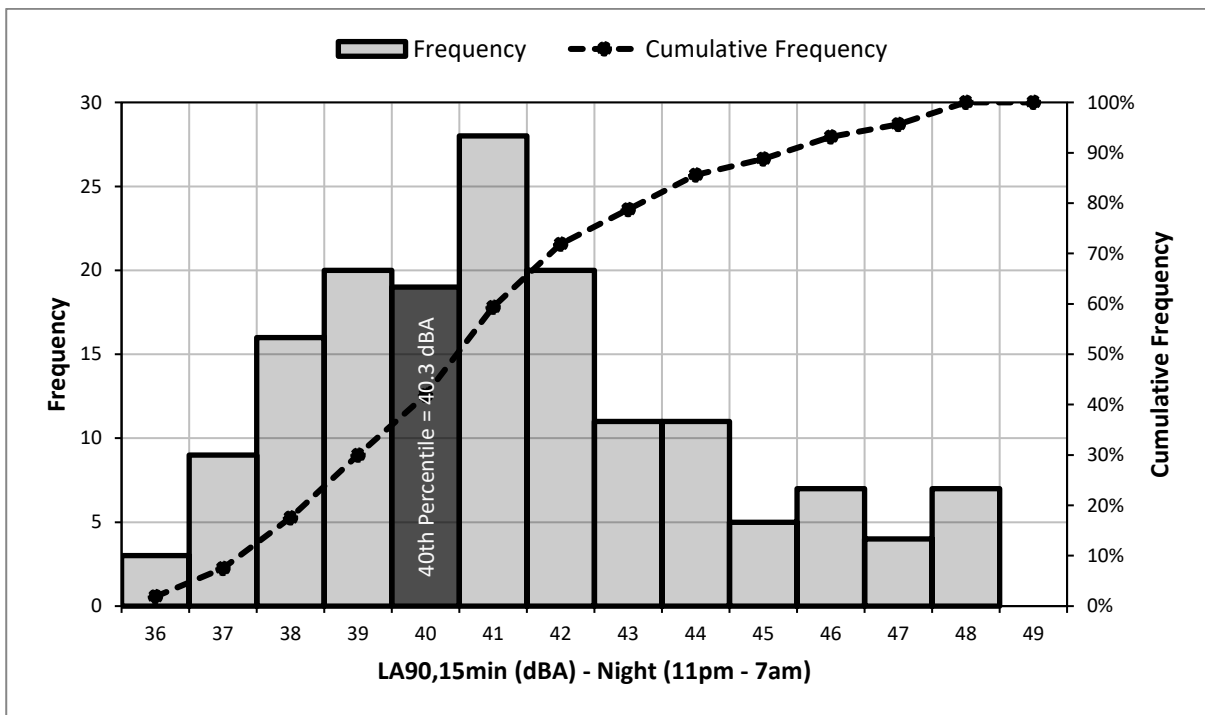


Figure 9: Night-time statistical distribution of background noise levels (LA90,15min) measured at location L1



## 12.0 APPENDIX E

### 12.1 Samsung ASHP - Technical Specification

Samsung - AE140BXYDGG/EU

## 2. Outdoor Units

### 2-6. Sound data

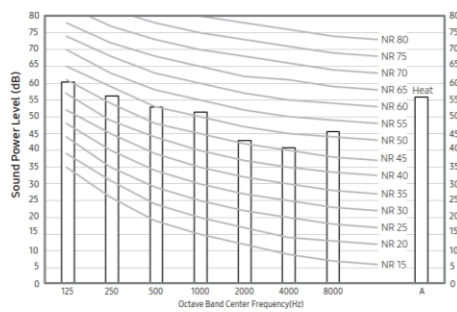
#### Sound Power level

##### NOTE

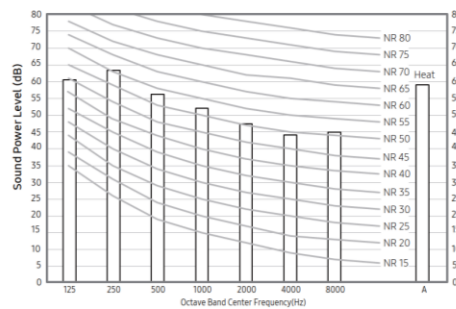
- Specifications may be subject to change without prior notice
  - Sound power level is an absolute value that a sound source generates.
  - dBA = A-weighted sound power level.
  - Reference power : 1pW.
  - Measured according to ISO 3741.

Model	Power (dBA)
AE080BXYDGG/EU	56
AE120BXYDGG/EU	59
AE140BXYDGG/EU	60

4) AE080BXYDGG/EU



5) AE120BXYDGG/EU



6) AE140BXYDGG/EU

