The Grange University Hospital

Emergency Department Extension

Noise Impact Assessment Report

NHS Wales

Project number: 60698871

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Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
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1. Introduction

This Noise Impact Assessment has been prepared in support of a planning application for a proposed extension to the existing Emergency Department at the Grange University Hospital, Cwmbran. An external noise survey has been undertaken at the application site to establish the ambient and background sound climate across the development site. From the results of the survey, recommended plant noise emission limits at the Nearest Noise Sensitive Receptor (NNSR) can be determined and a plant noise assessment can be conducted to make sure the RIBA Stage 3 Building Services design can satisfy these limits.

The survey data is also being used to determine the façade incident noise levels for the new development to inform the façade sound insulation requirements.

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

The full noise survey results are presented in Appendix B.

Unless stated otherwise, all noise levels are sound pressure levels in dB referenced to a pressure of 20 µPa.

2. Site Description

The site is located north of Grange University Hospital main complex in Cwmbran, NP44 8YN. The noise climate of the site is affected by the combination of nearby road noise and plant noise from the main hospital complex, as well as helicopter taking off and landing events associated with the South Wales Air Ambulance operations at the helipad located approximately 25m to the north-east of the proposed extension.

A residential property is located north-west of the proposed site (approximately 80m away) as shown in Figure 1; this is considered to be the NNSR which has been used or setting plant noise emission limits in addition to other on site hospital facilities to which consideration has also been given.

The red line boundary extends further to the south and west to encompass the roof of the existing hospital, the relevant area of development for the purposes of this noise impact assessment is limited to yellow-shaded area shown in Figure 1.

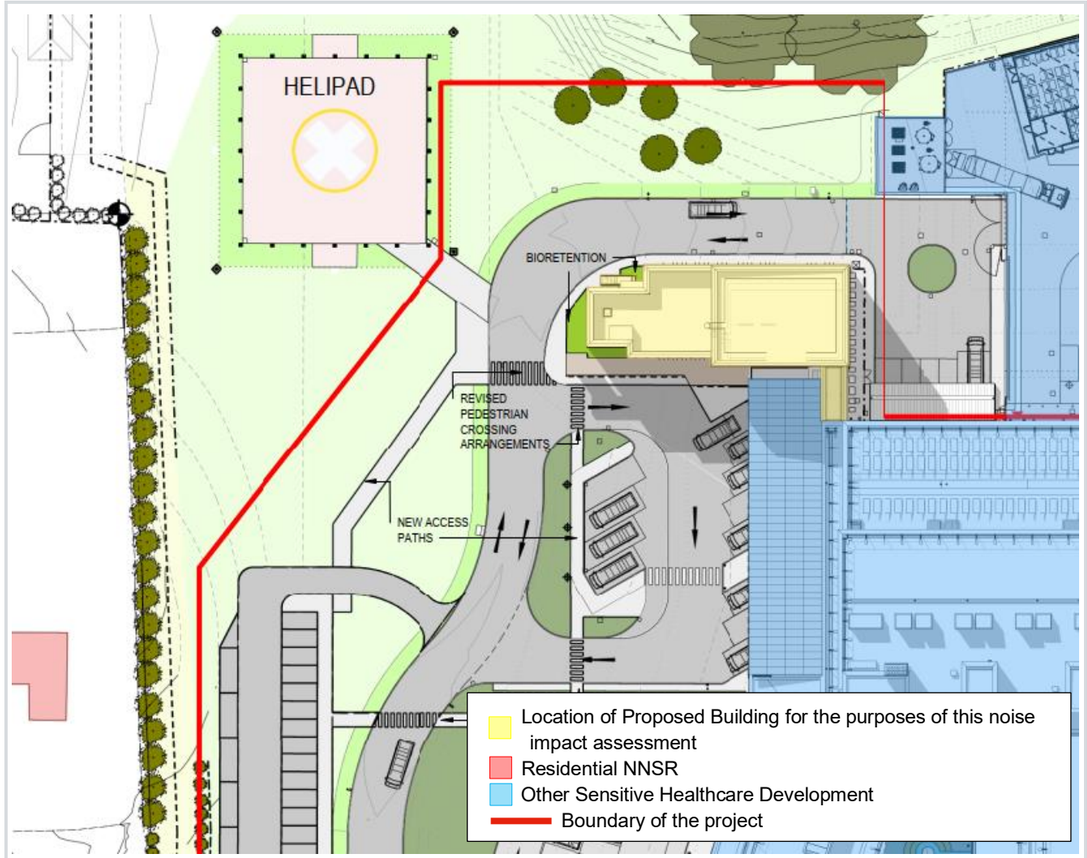


Figure 1. Site Plan and Noise Sensitive Receiver (N.T.S.)

3. External Noise Survey

Measurement Methodology

Long-term unattended noise monitoring stations were set up at position LT1 along the north site boundary and at position LT2 adjacent to the NNSR hours. Noise monitoring at LT1 commenced at 17:30 on the 05/05/2023 and stopped at 13:00 on the 11/05/2023.

Noise monitoring at LT2 commenced at 17:00 on the 05/05/2023 and stopped at 14:00 on the 11/05/2023.

A summary of the purpose of each measurement location is given below. The noise levels measured at:

- Location LT1 are considered to be representative of noise levels incident on the façade of the proposed extension, as well as the likely lowest background noise levels across the site and the typical day and night-time noise levels found at the site. The data has been used to inform the sound insulation requirements of the building façade to control the level of noise ingress to appropriate levels.
- Location LT2 is representative of the likely lowest background noise level at the NNSR, and has been used to set noise emission limits for new plant to be installed as part of the development

The equipment at unattended locations LT1 and LT2 has recorded ambient (dB L_{Aeq}), maximum (dB L_{Amax}) and background (dB L_{A90}) noise levels in 15-minute samples with the microphone located at approximately 1.5m above the ground in free-field conditions.

Figure 3 shows long term noise monitoring installation LT1 and LT2.

The equipment used to undertake the measurements are presented in Table 1 below.

Table 1. Noise Measurement Equipment

Location	Equipment	Type	Serial Number
LT1	Integrating Sound Level Meter	Rion NL52	909493
LT2	Integrating Sound Level Meter	Rion NL52	420763

The sound level meters and associated microphones were checked against the calibrator at the beginning and end of each measurement period, in accordance with recommended practice. No significant drift in calibration was observed. The accuracy of the calibrator can be traced to the National Physical Laboratory Standards.

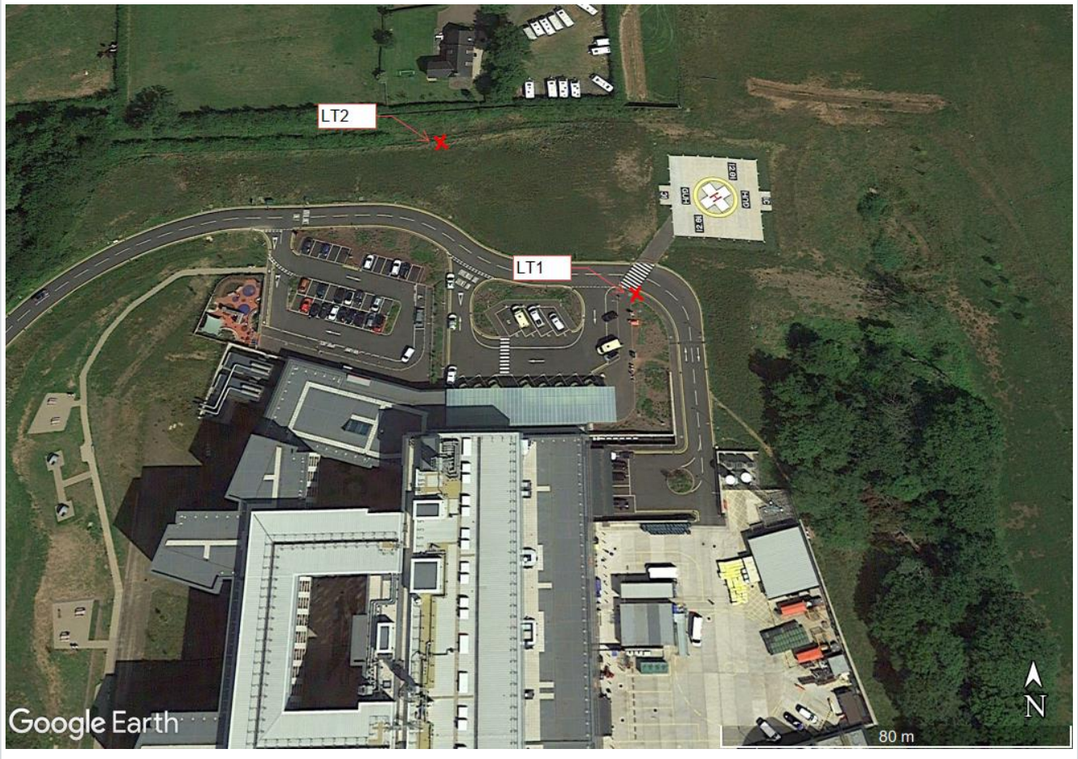


Figure 2. Approximate Measurement Locations (Source: Google Earth)

Figure 3. LT1 (Left) and LT2 (Right) Measurement Setup

4. Measurement Results & Commentary

Table 2 and Table 3 display the results of the external noise survey at LT1 and LT2 respectively. Full results of the long-term noise data are provided as time history plots in Appendix B.

Table 2. Summary of Long-Term Sound Levels at Position LT1

Date	Typical Highest Ambient Level dB $L_{Aeq, 1hour}$ *		Typical Lowest Background Level dB $L_{A90, 15min}$ **	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
05/05/2023***	52	55	39	37
06/05/2023	59	55	45	47
07/05/2023	55	53	42	39
08/05/2023	54	53	43	42
09/05/2023	64	54	47	39
10/05/2023	54	54	41	36
11/05/2023***	79****	n/a	44	n/a

* $L_{Aeq, 1hour}$ which is equivalent continuous sound level of 1 hour monitoring period

** $L_{A90, 15min}$ which is typically the lowest background level over each of the 15-minute monitoring periods (90th percentile of all data)

*** Not a complete data set

**** As reported by the client, a helicopter landed at the helipad at 10:00 on 11/05/2023. This result includes the noise from the helicopter movement from/ to the helipad.

Table 3. Summary of Long-Term Sound Levels at Position LT2

Date	Typical Lowest Background Level dB $L_{A90,\ 15min}$ **	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
05/05/2023***	39	36
06/05/2023	42	38
07/05/2023	41	38
08/05/2023	42	41
09/05/2023	44	37
10/05/2023	38	35
11/05/2023***	39	n/a
The Lowest Level in the survey period	38	35

** $L_{A90,\ 15min}$ which is the typically lowest background level over each of the 15-minute monitoring period (90th percentile of all data)

*** Not complete data set

The octave band values of the typical ambient noise levels measured on site are presented in Table 4. These levels will be used to inform the noise levels incident on the façades of the development.

Table 4. Ambient and Maximum Façade Incident Noise Levels at LT1

Location	Time Period	Index	Octave Band Centre Frequency (Hz)								
			63	125	250	500	1k	2k	4k	8k	dBA
LT1	Typical Daytime (17:15 - 18:15 on 09/05/2023)	dB $L_{eq,\ 1hour}$	64	63	63	61	59	54	49	51	64
	Daytime with helicopter movement (09:45 - 10:45 on 11/05/2023)	dB $L_{eq,\ 1hour}$	77	75	76	76	72	70	68	71	79
	Night-time (04:15 - 05:15 on 07/05/2023)	dB $L_{eq,\ 1hour}$	56	51	49	46	45	49	48	47	55

5. Plant Noise Emission

BS 4142:2014+A1:2019

BS 4142:2014 'Methods for rating and assessing industrial and commercial sound' is of relevance when assessing the potential impact of noise sources relating to existing or proposed industrial/ commercial development.

BS 4142:2014 describes methods for rating and assessing sound of an industrial and/ or commercial nature. In the absence of specific guidance, it is common to apply this assessment method when considering the effects of plant noise on residential receptors and is routinely used to assess the noise impact from plant and equipment of an industrial nature such as condensers, compressors, air handling units and boilers[1]. The method compares the rating level of the sound source under consideration with the background sound level near residential locations. The relevant parameters are as follows:

- *Background sound level* – $L_{A90,T}$ – defined in the standard as the 'A' weighted sound pressure level of the residual noise at the assessment position which is exceeded for 90% of the given time interval, T, measured using time weighting F;
- *Residual sound level* - $L_{Aeq,T}$ - the equivalent continuous 'A' weighted sound pressure level at the assessment position when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound, over a given reference time interval;
- *Specific sound level* – $L_{Aeq,Tr}$ – the equivalent continuous 'A' weighted sound pressure level at the assessment position produced by the specific noise source under consideration over a given reference time interval;
- *Ambient sound level* – $L_{Aeq,T}$ - the equivalent continuous 'A' weighted sound pressure level at the assessment position of the total encompassing sound, over a given reference time interval i.e. the sound level when both the specific and residual sound are present; and
- *Rating level* – $L_{Ar,Tr}$ – the specific sound level plus any adjustment made for the characteristic features of the noise.

The following adjustments can be made to the '*specific sound level*' to account for the characteristic features of the noise:

- Tonality – a penalty of 2 dB is applied for a tone which is just perceptible at the receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible;
- Impulsivity - a penalty of 3 dB is applied for impulsivity which is just perceptible at the receptor, 6 dB where it is clearly perceptible and 9 dB where it is highly perceptible. An impulse is defined as the sudden onset of a sound;
- Intermittency – a penalty of 3 dB can be applied if the intermittency of the specific sound is readily identifiable against the residual acoustic environment at the receptor i.e. it has identifiable on/off conditions; and
- Other sound characteristics – a penalty of 3 dB can be applied where the specific sound features characteristics that are neither tonal or impulsive, but are readily distinctive against the residual acoustic environment.

The *'rating level'* is then compared to the '*background sound level'*; BS 4142:2014 provides the following guidance on assessing the impact:

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context;
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context; and
- 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.

The standard emphasises the importance of taking context into consideration and identifies a range of pertinent factors including:

- The absolute level of the sound;
- The character and level of the '*residual sound'* compared to the character and level of the '*specific sound'*, for example, comparing the frequency spectrum and variation over time; and
- The sensitivity of the receptor.

The standard specifies the '*specific sound level'* as an L_{Aeq} with a one-hour assessment period during the day (07:00-23:00) and a fifteen-minute assessment period at night (23:00-07:00).

Environmental Protection Act 1990

The Environmental Protection Act 1990 (EPA), Part 3 identifies that noise emitted from premises can, at certain levels, be prejudicial to health or give rise to statutory nuisance.

Local Authorities are required to investigate any public complaints of noise and if they are satisfied that a statutory nuisance exists, or is likely to occur or recur, they must serve a noise abatement notice. A notice is served on the person responsible for the nuisance. It requires either the abatement of the nuisance or works to abate the nuisance to be undertaken, or it prohibits or restricts the relevant activity.

[1] BS 4142 Technical Note, The Association of Noise Consultants

In determining if a noise complaint amounts to a statutory nuisance the Local Authority can take account of various guidance documents and existing case law; however, no statutory noise limits exist. Demonstrating the use of 'Best Practicable Means' to minimise noise levels is an accepted defence against a noise abatement notice.

Torfaen County Borough Council Local Development Plan (to 2021)

Key elements of Torfaen County Bourgh Council's Borough Wide Policy – BW1 General Policy - Development Proposals are set out below:

All development proposals will be considered favourably providing they comply with the following criteria where they are applicable: -

…

B. Natural Environment

i) The proposal does not result in unacceptable adverse effects in respect of land contamination, instability or subsidence; air, heat, noise or light pollution; landfill gas; water pollution; or flooding, from or to the proposal;.

BREEAM UK New Construction Pol 05 2018

BREEAM is an assessment process that allows credits to be awarded to building developments based on a number of best practice criteria. BREEAM credits are targeted for this development and BREEAM pollution credit Pol 05 specifically relates to noise emission from new plant items and may be awarded where the following criteria are met:

> *"Where there are noise-sensitive areas within the assessed building or noise-sensitive areas within 800 m radius of the assessed site, a noise impact assessment compliant with BS 4142:2014 is commissioned. Noise levels must be measured or determined for:*
>
> ***2.a:** Existing background noise levels:*
> *i. at the nearest or most exposed noise-sensitive development to the proposed assessed site*
> *ii. including existing plant on a building, where the assessed development is an extension to the building*
>
> ***2.b:** Noise rating level from the assessed building.*
>
> ***3** The noise impact assessment must be carried out by a suitably qualified acoustic consultant.*
>
> ***4** The noise level from the assessed building, as measured in the locality of the nearest or most exposed noise-sensitive development, must be at least 5dB lower than the background noise throughout the day and night.*
>
> ***5** If the noise sources from the assessed building are greater than the levels described in criterion 4, measures have been installed to attenuate the noise at its source to a level where it will comply with the criterion."*

Recommended Plant Noise Emission Limits

It is considered that a suitable way of demonstrating compliance with the recommendations given within BS 4142:2014+A1:2019, the Environmental Protection Act and Local Authority Guidance is to control noise emission limits to 5 dB below the typical lowest measured background noise level at the (NNSR), as detailed in the following section. This approach is based on the guidance set out in BS 4142 and is made on the basis that reducing the rating level to below the background noise should result in the plant noise having low impact.

Based on the typical lowest background noise levels and the afore mentioned guidance above, it is recommended that the following noise limits of 5 dB below the existing background levels of long-term monitoring location 2 (LT2) be adopted as summarised in Table 5.

Table 5. Recommended Plant Noise Emission Limit at NNSR

Time Period	Plant Noise Emission Limit, L_{Ar} (dB)
Daytime (07:00 – 23:00)	33
Night-time (23:00 – 07:00)	30

** The above limits should be met at the nearest noise sensitive premises when assessed under free-field conditions.*

The above limits should be met with all plant operating simultaneously at design load. In line with the guidance within British Standard BS 4142, if sources produce any unusual acoustic features associated with tonality, impulsivity, intermittency, or other sound characteristics at any noise sensitive façade, this should be taken into consideration when determining the plant rating noise level.

By meeting the proposed plant noise emission limits at the NNSR it is anticipated that noise emission from the building services plant will be in-line with the requirements set by the Local Development Plan and will suitably reduce the likelihood of adverse noise impacts on occupants of the neighbouring residential premises.

The plant noise assessment shall be undertaken based on the latest proposal of the Building Services as design progresses to set upper limits for each external termination of the individual systems (and any other external plant) such that plant noise is suitably controlled to achieve the noise emission limits at surrounding noise sensitive receptors.

Emergency Plant Noise Emission Limits

Although the Local Authority does not provide guidance on emergency plant noise it is recommended that the emergency plant noise emission limits be set at 10 dB above the underlying background noise levels. The resultant emergency plant noise emission limit is presented in Table 6.

Table 6. Emergency Building Services Plant Noise Emission Limits

Time Period	Emergency Plant Noise Emission Limit (dB L_{Ar})
Daytime (07:00-23:00)	48
Night-time (23:00-07:00)	45

6. Plant Noise Assessment

A plant noise assessment for RIBA Stage 3 Building Services design proposal based on BS 4142:2014 has been undertaken to confirm that the Building Services design is capable of meeting the recommended plant noise emission limits.

Proposed Plant Items

The plant noise assessment has been based on the following plant items being installed as part of the new extension. The sound power levels are largely based on manufacturer's information which is listed in Table 7.

Table 7. Plant Noise Level Data Used in the Prediction (Normal Operation)

Plant Item	No. of Unit	Data Type	Sound Power Level (dB L_w) at each Octave Band Frequency (Hz)								
			63	125	250	500	1k	2k	4k	8k	dB(A)
AHU 1 Fresh Air Intake	1	Manufacturer Data with Fan Correction [1]	83	86	83	78	74	73	72	71	82
AHU 1 Exhaust	1	Manufacturer Data with Fan Correction [1]	83	85	83	83	85	80	74	68	88
AHU 2 Fresh Air Intake	1	Manufacturer Data with Fan Correction [1]	79	86	83	80	75	69	63	55	81
AHU 2 Exhaust	1	Manufacturer Data with Fan Correction [1]	80	84	80	82	83	77	70	62	86

Note 1: Correction for two (2) fans has been applied in this table and the assessment below. 6 dB correction for in duct noise levels has also been applied as per manufacturer's data sheets.

The intended layout of the Air Handling Units (AHUs) in L3 plant room is shown in Figure 4.

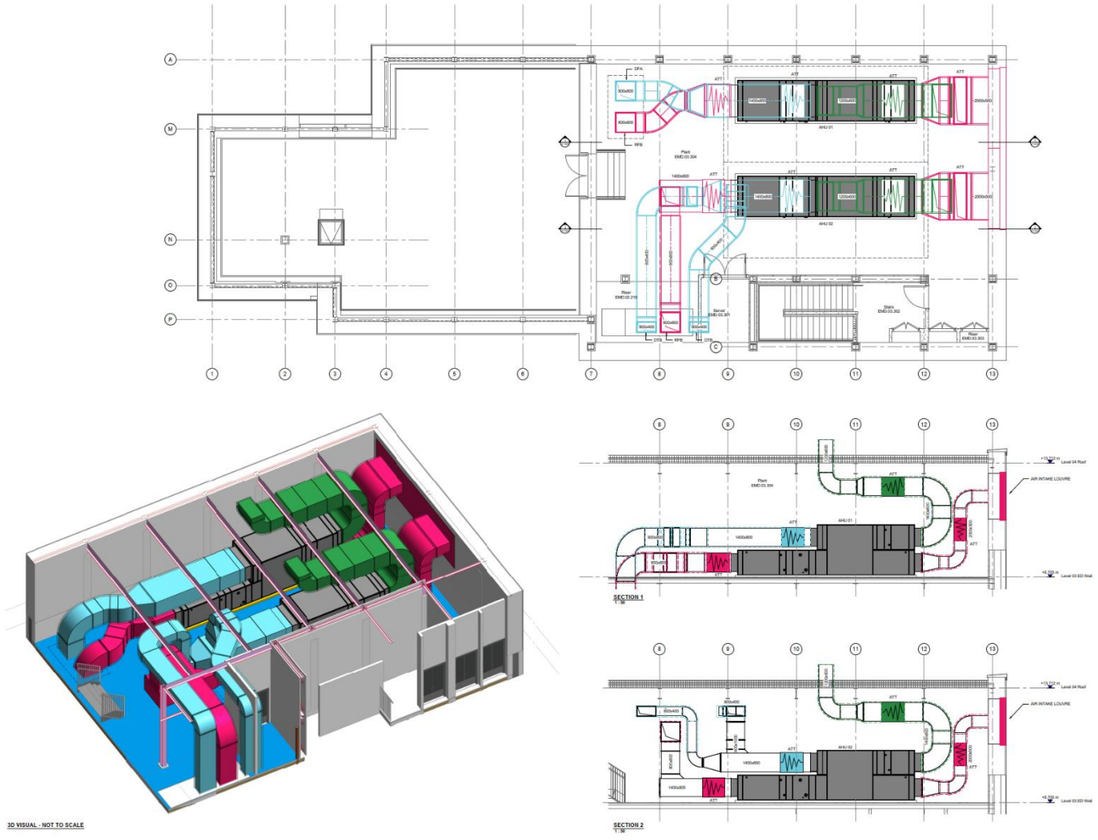


Figure 4 L3 Mechanical Ventilation Layout (N.T.S.)

Technical Assumptions

The following technical assumptions have been made for the assessment:

- Two AHUs are running simultaneously in 24 hours.
- The dominant noise breakout from the AHUs to the external area closest to the NNSR is the exhaust louvres, since no direct and indirect transmission paths are identified from intake louvres to the NNSR.
- The process of calculation for this assessment is outlined in Section 4.10.4 – "Noise propagation to outdoors" in CIBSE Guide B4:2016 – "Noise and vibration control for building services systems".
- Max. penalty of tonality according to BS 4142 (+6 dB) is applied.
- The exhaust terminations of AHUs face upwards – the direct transmission paths to the NNSR have an approximate 90 degree offset to the centre line of exhaust terminations.
- A 0.9m length silencer is installed to both the intake/ exhaust airduct as shown in the Mechanical Ventilation Layout in Figure 4. The Dynamic Insertion Loss of this silencer in octave bands are listed in Table 8.
- The approximate horizontal distance from each exhaust louvre to the NNSR is obtained from Architect's master layout plan as shown in Figure 5.

Table 8 Dynamic Insertion Loss of AHU's Intake/ Exhaust Silencer

	Dynamic Insertion Loss (10m/s, in dB) at each Octave Band Frequency (Hz)								
	63	125	250	500	1k	2k	4k	8k	Approximate Length
All AHU Fresh Air Intakes/ Exhausts	3	5	8	13	14	11	9	6	0.9m

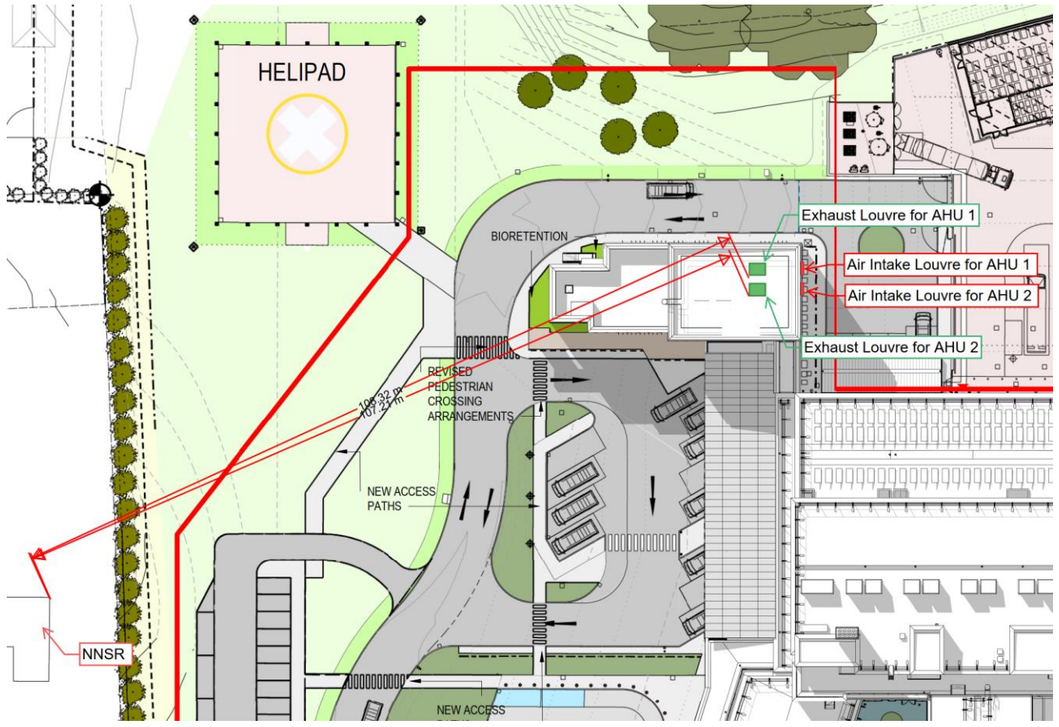


Figure 5 Approximate Horizontal Distance from Exhaust Louvre to NNSR (N.T.S.)

Assessment Result

The resultant predicted SPL at the NNSR from the Plant are summarised in Table 9. This demonstates the recommended plant noise limits are achieved during any time period, and indicates the proposals are fully in line with the requirements set by policy and legislation. Therefore, it should not result in adverse impacts of noise to the NNSR's.

Table 9 Predicted SPL at NNSR from the Plant

	1/1 Octave Band Mid-frequency							dB(A)
	63	125	250	500	1000	2000	4000	
Predicted SPL from AHU 1, dB	36	36	28	23	0	<0	<0	
Predicted SPL from AHU 2, dB	33	35	25	22	0	<0	<0	
Resultant predicted SPL from all AHUs, dB	38	39	30	26	0	<0	<0	27

Appendix A Glossary of Acoustic Terminology

Sound

This is a description of the physical phenomena of the transmission of energy through gaseous or liquid media via rapid fluctuations in pressure.

Sound Pressure Level

This is the basic measure of how much sound there is at a given location. It is a measure of the size of the pressure fluctuations in the air that we perceive as sound.

Sound Pressure Level is expressed in decibels with a reference level of 20 mPa (Lp in dB re 20 mPa).

Sound Power Level

This is the total amount of sound produced by a source. It cannot be measured directly but it can be calculated from Sound Pressure Level measurements in known conditions. It can be used to predict the Sound Pressure Level at any point.

Sound Power Level is expressed in decibels with a reference level of 1 pW (L_W in dB re 1 pW). In the US a reference of 100 fW is sometimes used.

L_p L_{pA} (or L_A)

The instantaneous sound pressure level (L_p).

The A-weighted instantaneous sound pressure level (L_{pA} or L_A).

This is the root mean square size of the pressure fluctuations in the air. This level can fluctuate wildly even for seemingly steady sounds. To make sound level meters easier to read the values on the display are smoothed or damped out. This is effectively done by taking a rolling average of the previous 0.125 s (FAST time constant) or the previous 1 s (SLOW time constant).

L_{max} L_{Amax}

The (A-weighted) maximum instantaneous sound pressure level (L_{Amax}).

$L_{Aeq,T}$

The A-weighted equivalent continuous sound pressure level over period, T.

This is effectively the average sound pressure level over a given period. As the decibel is a logarithmic quantity the L_{eq} is not a simple arithmetic mean value.

The L_{eq} is calculated from the raw sound pressure data. It is not appropriate to include a reference to the FAST and SLOW time constants in the notation.

L_{Ar}

Plant rating level as defined under British Standard BS4142:2014.

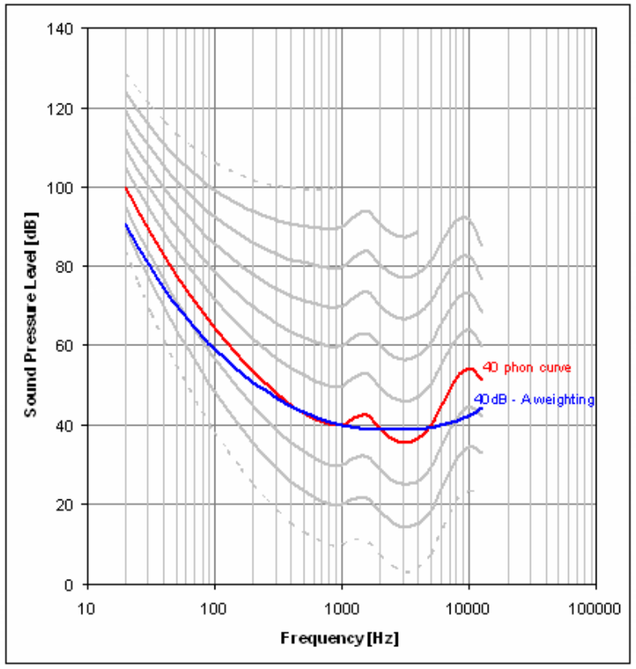
This is the specific sound level generated by the plant items inclusive of any adjustment for the characteristic features of the source.

A-Weighting

The human ear does not sense all frequencies of sound equally. Our sensitivity is at a maximum at around 2 kHz and steadily decreases above and below. Below 20 Hz and above about 20 kHz we can't hear at all.

Within its operating limits a precision measurement microphone measures all frequencies the same so the output it produces does not reflect what we would actually hear. The A-weighting is an electronic filter that matches the response of a sound level meter to that of the human ear. When A-weighted the Sound Pressure Level L_p becomes L_{pA} (or L_A) and the Sound Power Level L_W becomes L_{WA}.

It used to be common to identify that a level was A-weighted by writing dB(A) or dBA instead of dB. These terms are now obsolete and should not be used as they conflict with other, non-acoustic, uses of decibels.



Percentiles

To describe the time-varying character of environmental noise, statistical noise descriptors were developed:

L_{A10} is the A-weighted sound level equalled or exceeded during only 10% of the measurement time. The L_{A10} provides a good measure of the maximum sound levels caused by intermittent or intrusive noise.

L_{A50} is the A-weighted sound level that is equalled or exceeded 50% of the measurement time period; it represents the median sound level.

L_{A90} is the A-weighted sound level equalled or exceeded 90% of the time. Since this represents 'most' of the time, L_{A90} generally has been adopted as a good measure of the ambient baseline noise of the measurement site. Therefore, the baseline noise is defined as L_{A90} of the overall background nois

Appendix B Long Term Time History Plots

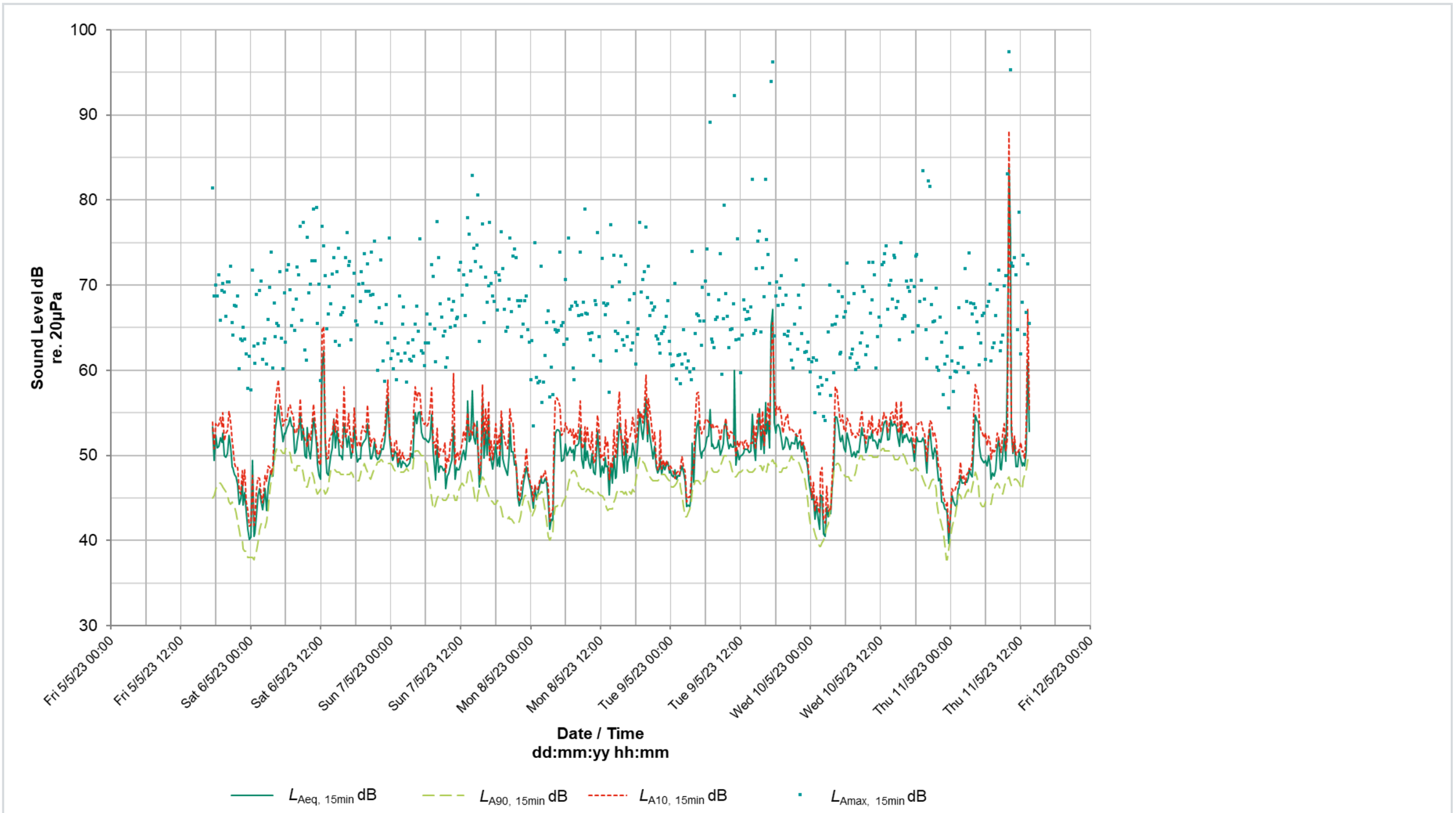


Figure 6. LT1 Measurement Results

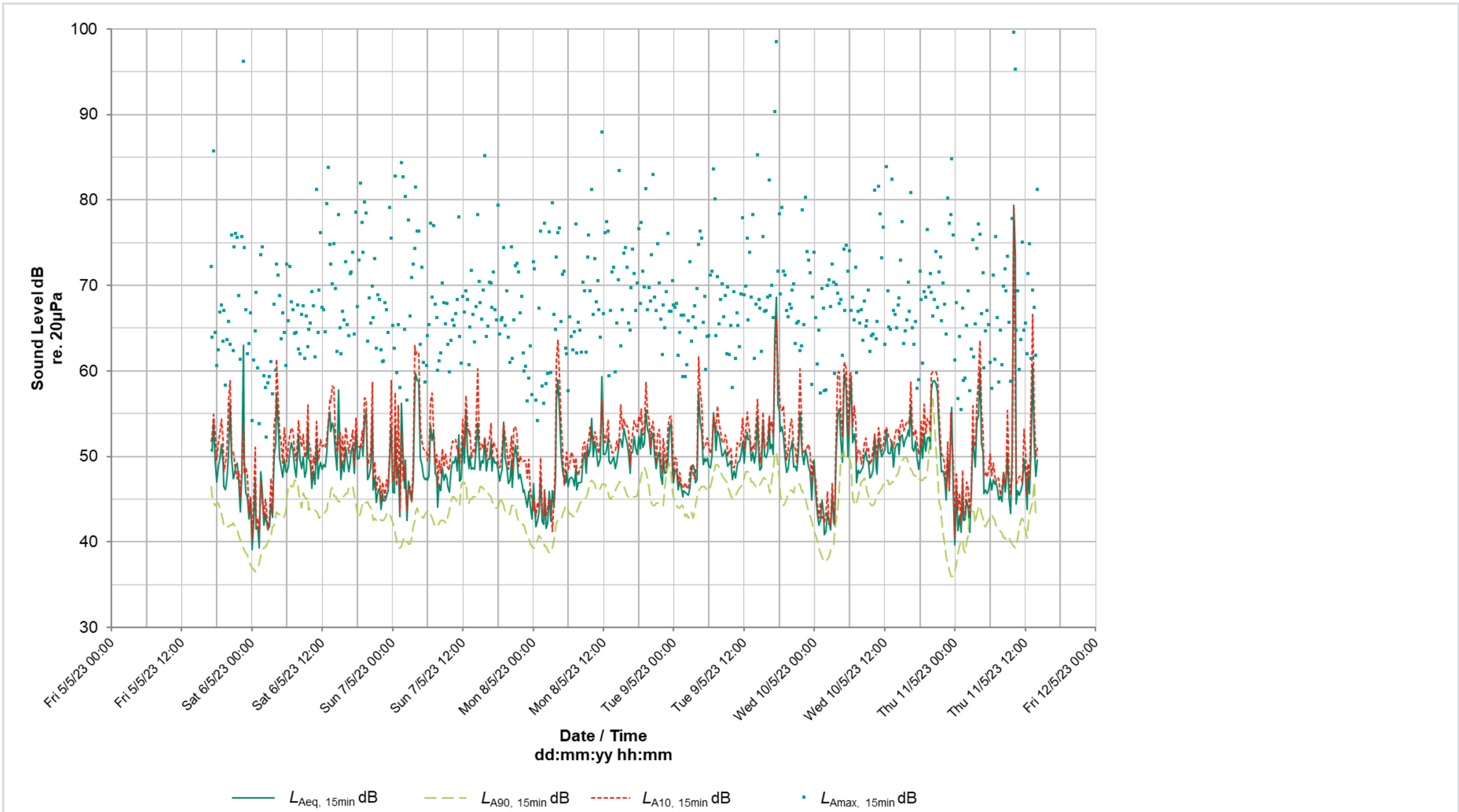


Figure 7. LT2 Measurement Results

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