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Holborn Town Hall.
London.
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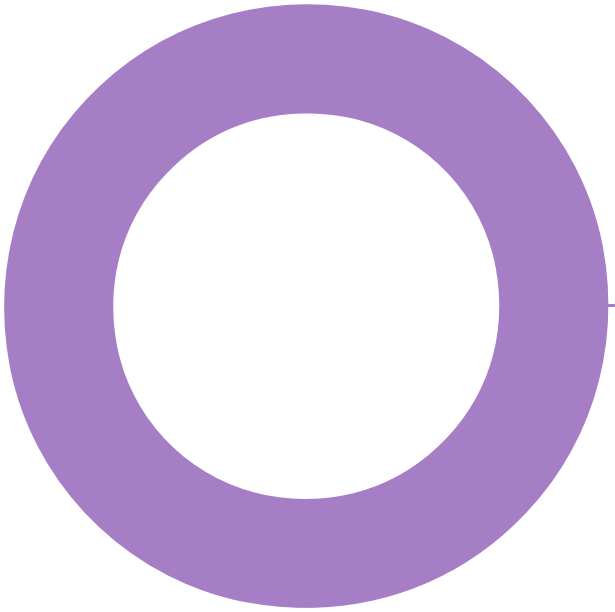
ACOUSTICS
PLANT NOISE ASSESSMENT

REVISION 00 – 12 NOVEMBER 2021



Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
00	12/11/2021	Initial issue	AD	DF/MB	BJ

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Contents.

Executive summary.

There are proposals to refurbish the office spaces within Holborn Town Hall, London. The works will include the installation of new items of building services plant on the roof of the existing building.

Environmental sound survey.

An environmental sound survey was undertaken at the site to establish prevailing acoustic conditions experienced at the site and at nearby noise sensitive receivers. It was noted that the acoustic environment is dominated by existing plant noise from the surrounding office developments.

Results from the survey have been to derive plant noise limits in line with London Borough of Camden requirements.

Control of noise from building services.

A plant noise assessment has been undertaken to the nearest noise sensitive receivers, based on preliminary plant selections, to identify noise control measures that will be required within the design.

To meet the required plant noise limits will require solid screens to be provided, in combination with setting the condensing units to run on ‘low noise’ mode.

On the basis of this assessment, noise from the new building services plant can be controlled through the use of relatively conventional noise control measures. As such, noise should not pose an obstacle in granting planning permission for the refurbishment works.

1. Introduction.

There are proposals to refurbish the office spaces within Holborn Town Hall, London. The works are to include the installation of new items of building services plant on the roof of the existing building to serve the various internal spaces.

An environmental sound survey has been undertaken at the site to establish prevailing background sound levels at the nearest noise sensitive receivers. Data from the survey has been used to set suitable plant noise limits in line with the requirements of the local authority. An acoustic assessment of the preliminary plant selections has been undertaken to set out mitigation measures for the external plant where necessary.

This report has been produced to support the planning application for the scheme and contains a summary of the environmental sound survey and assessments undertaken. A glossary of acoustics terminology is provided in Appendix A.

2. Site description.

Holborn Town Hall is a Grade II listed building located at 193 – 197 High Holborn in London, primarily consisting of offices and surrounded by neighbouring office buildings.

Existing noise sources at the site consist of High Holborn road at the façade to the north, and predominantly existing plant noise from the surrounding buildings to the rear of the building and at roof level. The nearest noise sensitive receivers are identified as the surrounding neighbouring office spaces. These are shown in Figure 1.

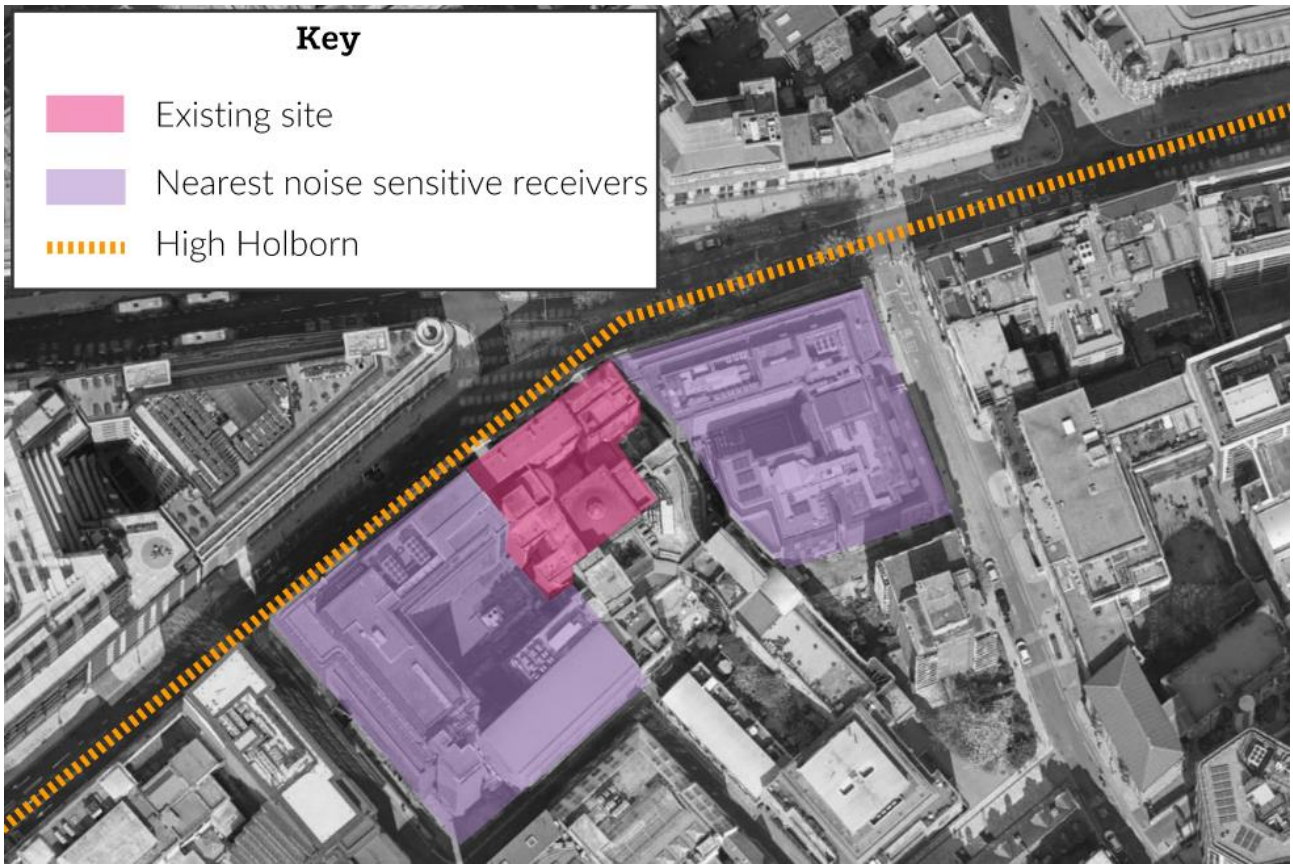


Figure 1 Aerial view of the existing site and surroundings. Image source: Google Images.

3. Environmental sound survey.

An environmental sound survey was undertaken at the site between Monday 6th September and Monday 13th September 2021 to establish the existing background sound levels at the nearest noise sensitive receivers. The survey consisted of long-term monitoring at two positions at roof level, L1 and L2, which are shown alongside the nearest noise sensitive receivers in Figure 2.

The main sources of noise at both rooftop positions consist of nearby building services plant and aircraft passing by overhead, with distant construction works and road traffic noise making up the background.

The results from the long-term monitoring at the site are summarised in Figure 2. The highest ambient sound levels for day and night ($L_{Aeq,T}$) and typical background sound levels ($L_{A90,15min}$) are presented for each long-term position.

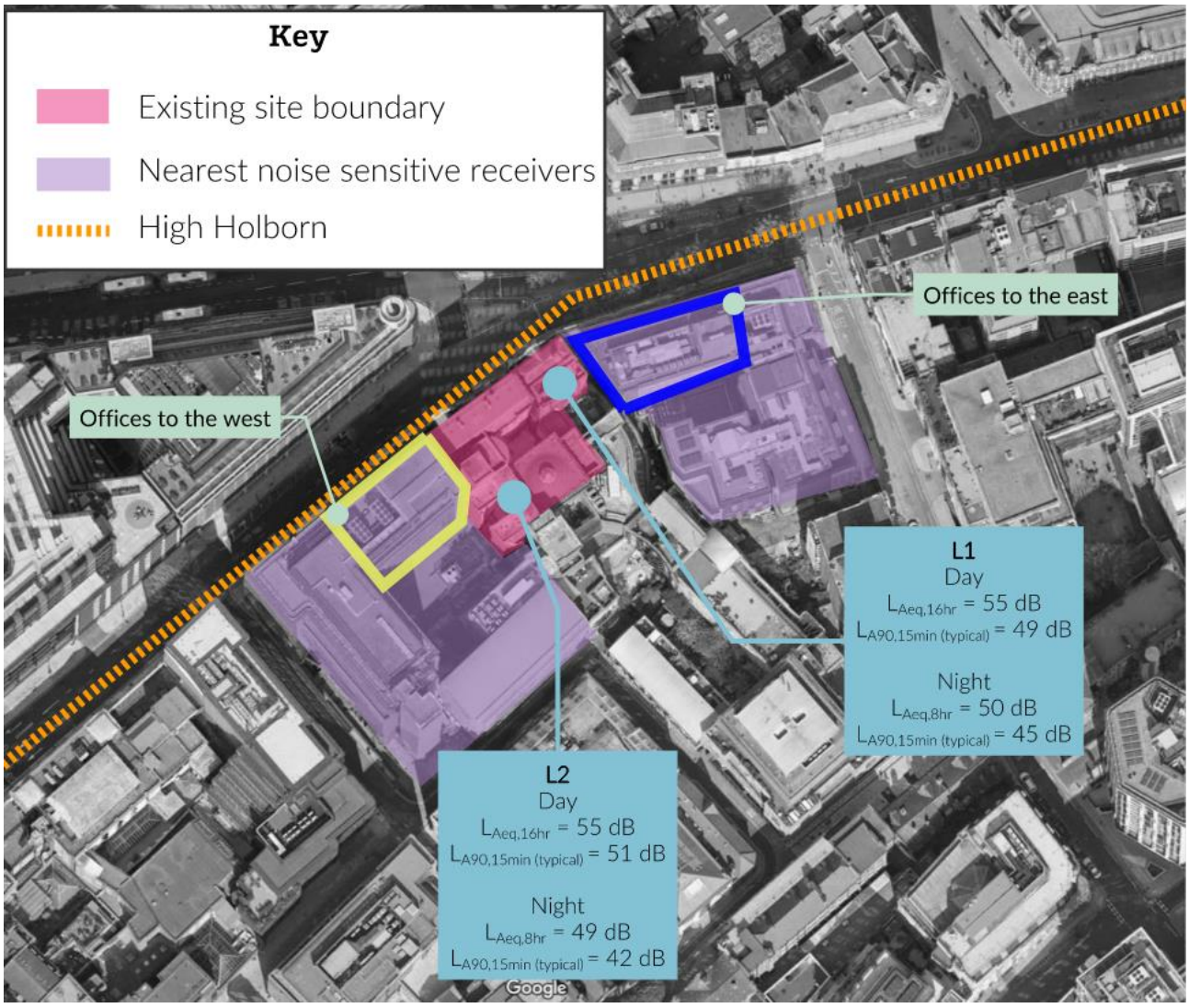


Figure 2 Summary of long-term survey results.

4. Basis of assessment.

4.1 General references.

The assessment has been carried out in accordance with the following policy and guidance:

- National Planning Policy Framework (NPPF, 2021).
- DEFRA Noise Policy Statement for England (NPSfE).
- Camden Local Plan (2017).
- BS 4142:2014 + A1:2019 Methods for rating and assessing industrial and commercial sound.

4.2 Plant noise emissions.

4.2.1 Camden Local Plan: Industrial and Commercial Noise Sources.

Appendix 3 of the Camden Local Plan states the following of new noise generating building services plant:

'Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion.'

Table C: Noise levels applicable to proposed industrial and commercial developments (including plant and machinery)

Existing Noise sensitive receptor	Assessment Location	Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAL (Red)
Dwellings**	Garden used for main amenity (free field) and Outside living or dining or bedroom window (façade)	Day	'Rating level' 10dB* below background	'Rating level' between 9dB below and 5dB above background	'Rating level' greater than 5dB above background
Dwellings**	Outside bedroom window (façade)	Night	'Rating level' 10dB* below background and no events exceeding 57dBL_{Amax}	'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dB L_{Amax}	'Rating level' greater than 5dB above background and/or events exceeding 88dBL_{Amax}

Figure 3 Proposed plant noise rating levels - Table 3 from Appendix 3 of Camden Local Policy (2017).

It is noted that the criteria above are given for instances where dwellings are the most affected noise sensitive receivers in the vicinity of the site. However, the nearest noise sensitive receivers to the site consist primarily of offices. While offices are considered to be noise sensitive by the local authority, no limits are provided. Therefore, as offices are not as sensitive to noise as dwellings, this requirement may be considered to be too stringent for less noise sensitive receptors. It is considered that a rating level of 5 dB below the existing background sound levels would be suitable for neighbouring offices and commercial units, while having no significant impact on the acoustic characteristic of the local area.

4.2.2 BS 4142:2014 + A1:2019 Methods for rating and assessing industrial and commercial sound.

The BS 4142:2014 method for assessing noise emissions from new building services plant can be summarised as follows:

- Establish the typical background sound levels of the local acoustic environment over the relevant period.
- Determine the rating levels of plant noise emissions. These include specific noise emissions plus corrections that ought to be applied where noise emissions can be perceived as tonal, impulsive and / or intermittent. If a new type of noise source is to be introduce in a local acoustic environment, a further correction of +3 dB may be applied due to the change in the pre-existing environment.
- Subtract the typical background noise levels from the estimated rating levels, as measured / calculated at the nearest noise sensitive receivers.
- Based on the above levels difference, evaluate the impact of the new building services plant on the nearest noise sensitive receivers considering that:
  - A difference of at least +10 dB is likely to be an indication of a significant adverse impact, depending on context.
  - A difference of around +5 dB is likely to be an indication of adverse impact, depending on context.
  - Where the rating level does not exceed the background noise level, this is an indication of low impact, depending on context.

5. Plant noise assessment.

5.1 Plant noise emission limits.

Table 1 sets out the proposed external noise emission limits for new items of building services plant to be achieved at the nearest noise sensitive receivers

The plant noise limits are based on the typical background sound levels measured during the survey and apply at 1 m from the façade of the nearest noise sensitive receivers, which are the neighbouring offices to either side of the development. The limits applicable to the neighbouring offices to the west of the site are based on the sound levels measured at survey position L1, while the limits which apply at the offices to the east are based on the levels measured at L2.

Table 1 Proposed external plant noise emission limits at the nearest noise sensitive receivers.

Receptor	Period	Typical background sound levels measured, $L_{A90,15min}$ (dB)	Adopted criterion as difference between rating level and background sound level (dB)	Plant rating level limits at the nearest residential premises, L_{ArTr} (dB)
Offices to the east of site	Daytime (07:00 – 23:00)	49	-5	44
Offices to the east of site	Night-time (23:00 – 07:00)	45	-5	40
Offices to the west of site	Daytime (07:00 – 23:00)	51	-5	46
Offices to the west of site	Night-time (23:00 – 07:00)	42	-5	37

5.2 Preliminary plant selections.

The following Daikin condensing units have been preliminarily selected for the refurbishment works:

- 3 no. REYQ8U units
- 1 no. REYQ10U unit
- 4 no. REYQ12U units
- 1 no. REYQ14U unit
- 1 no. RXYSCQ4TV1 unit
- 5 no. RZAG60A units.

The proposed plant layout on the rooftop of Holborn Town Hall is shown in Figure 4.

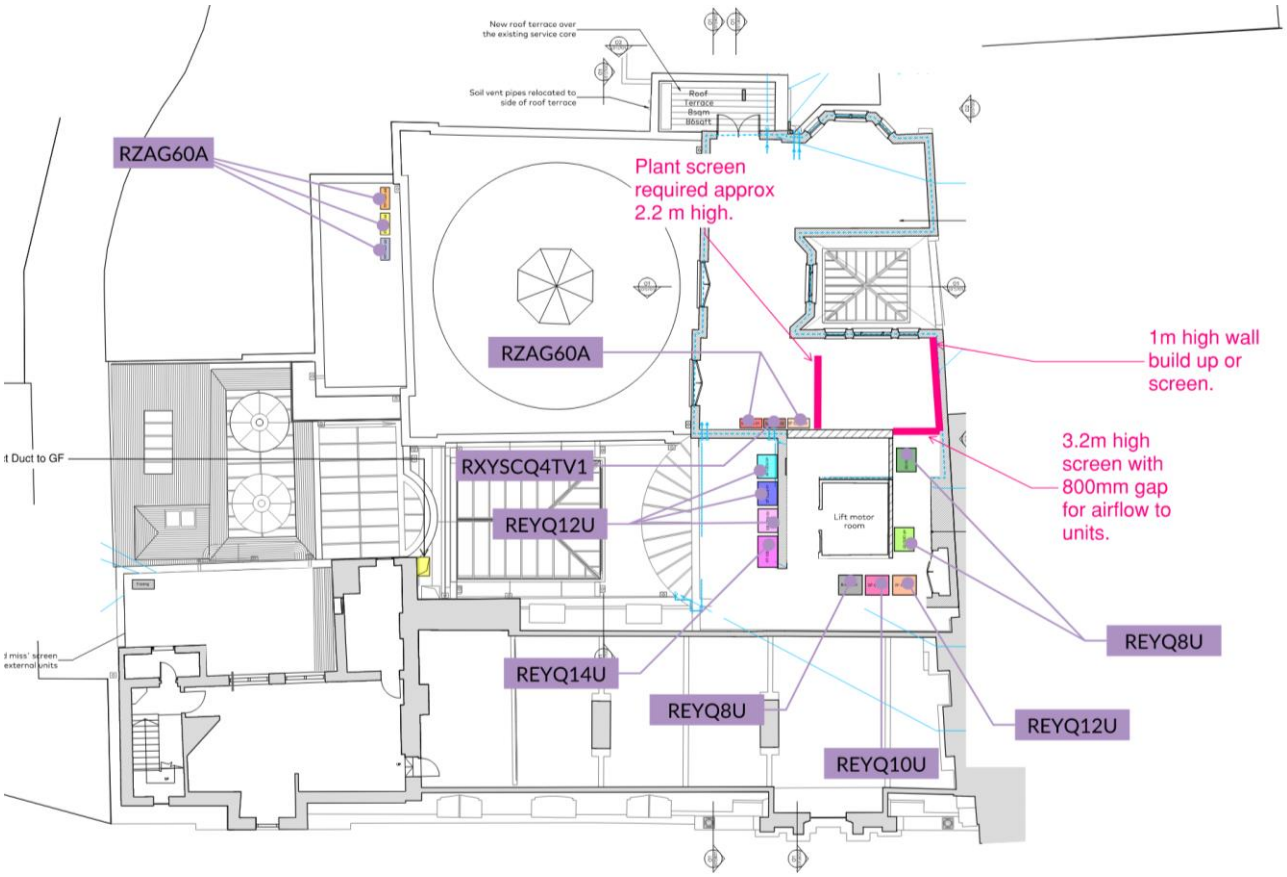


Figure 4 Proposed rooftop plant layout.

5.3 Manufacturers' plant noise data.

Plant noise data provided by the manufacturer for the preliminary plant selections used in this assessment is set out in Table 2. The manufacturers' data below is for the preliminary selections on heating mode, where provided, giving a worst-case in terms of noise levels from the operating plant.

Table 2 Manufacturers' sound power level data for proposed plant operating on heating mode.

Plant items	Sound power level per octave band centre frequency, Hz (dB)								Manufacturers' sound power level (dBA)
	63	125	250	500	1k	2k	4k	8k	
REYQ8U	88	81	79	78	71	68	64	59	78
REYQ10U	87	82	79	78	72	71	68	61	79
REYQ12U	91	85	83	81	76	75	76	73	84
REYQ14U	88	83	80	80	75	71	70	69	81
RXYSCQ4TV1	-*	71	67	67	64	56	49	44	68
RZAG60A	68	66	63	63	59	52	48	39	64

*63 Hz data not provided by the manufacturer.

The sound power level spectra used to assess the noise levels from the condensing units operating on 'low-noise' mode is presented in Table 3 below. This is based on data provided by the manufacturer.

Table 3 Sound power level spectra for condensing units operating in 'low noise' mode.

Plant items	Sound power level per octave band centre frequency, Hz (dB)								Manufacturers' sound power level (dBA)
	63	125	250	500	1k	2k	4k	8k	
REYQ8U	87	74	65	71	70	70	59	60	75
REYQ10U	90	75	71	70	72	70	65	62	76
REYQ12U	89	75	72	72	71	71	66	66	77
REYQ14U	76	75	75	72	64	66	63	61	74

5.4 Mitigation measures.

The following noise mitigation measures have been included in the design:

- Two solid acoustic screens between the plant around the lift motor room and the neighbouring offices to the south-west. Locations of the screens are shown in Figure 4.
  - The screen to the units south of the lift room should be 2.2 m in height.
  - The screen to the large condensing units east of the lift room should be 3.2 m in height. This screen will require an 800 mm gap at the bottom to allow airflow to the units.
- A 1 m high wall build up or screen along the perimeter of the south-western sides of the roof edge to the neighbouring offices. This will provide screening at low level where the 800 mm air gap is required in the 3.2 m screen.
- Both screens should be imperforate and have a minimum mass per unit area of 15 kg/m^2. Class A sound absorbent treatment should be provided on the plant side of each screen.
- All condensing units are to operate on a low-noise mode, providing a 3 – 7 dB reduction in noise while the units are running.

5.5 Predicted plant noise levels.

Noise levels from the various condensing units and heat pumps have been calculated to 1 m from the façade of the nearest noise sensitive receiver. The following has been accounted for within the calculations:

- Attenuation due to distance, based upon point source propagation over a distance of 10 – 15 m to the nearest receiver.
- Screening losses provided by the plant screens and existing buildings such as the lift motor room.
- All condensing units operating on an available low-noise mode.

No feature penalties, as defined within BS 4142 have been applied. This is on the basis that the plant noise data provided by the manufacturers does not indicate any obvious tonality, the plant is understood to be operating constantly throughout its use (not intermittent) and is not considered to be an impulsive source.

It is understood that the plant will only be operational during daytime office hours between 07:00 and 23:00. Therefore, this assessment is based on achieving the daytime plant noise limits only.

The predicted rating levels at the nearest receiver, inclusive of mitigation, are presented in Table 4.

Table 4 Results of the plant noise assessment.

Receiver	Predicted plant rating level at 1 m from the façade of the nearest noise sensitive receiver, $L_{Ar,Tr}$ (dB)	Rating level limits at 1 m from the façade of the nearest noise sensitive receiver, $L_{Ar,Tr}$ (dB)	Difference (dB)
Offices to the east of site	41	44	-3
Offices to the west of site	46	46	0

The calculations demonstrate that the rating level of new building services plant noise are compliant with the rating level limits at both receivers.

On the basis of this assessment, it is considered that external plant noise emissions should not pose an obstacle in the granting of planning permission for the refurbishment works.

Appendix A – Glossary of acoustic terminology.

Sound
Sound is produced by mechanical vibration of a surface, which sets up rapid pressure fluctuations in the surrounding air.

Sound pressure
Sound Pressure is the force (N) of sound on a surface area (m^2) perpendicular to the direction of the sound. The SI-units for Sound Pressure are Nm^{-2} or Pa (Pascal).

Sound is measured with microphones responding proportionally to the sound pressure – p. The power is proportional to the square of the sound pressure.

Sound pressure level
The human ear has an approximately logarithmic response to sound pressure over a very large dynamic range. The lowest audible sound pressure approximately 2 x 10^{-5} Pa (2 ten billionths of an atmosphere, threshold of audibility) and the highest is approximately 200 Pa (threshold of pain).

It is therefore convenient to express the sound pressure as a logarithmic decibel scale related to this lowest human audible sound, where:

$$L_p = 10 \log\left(\frac{p^2}{p_{ref}^2}\right) = 10 \log\left(\frac{p}{p_{ref}}\right)^2 = 20 \log\left(\frac{p}{p_{ref}}\right)$$

Where: L_p *= sound pressure level (dB)*

p *= sound pressure (Pa)*

p_{ref} *= 2 x* 10^{-5} *– reference sound pressure (Pa)*

In accordance with the logarithmic scale, doubling the sound pressure level gives an increase of 6 dB.

Decibel (dB)
The decibel is the unit used to quantify sound pressure levels as well as sound intensity and power levels.

In accordance with the logarithmic scale, an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pa). Subjectively, this increase would correspond to a doubling of the perceived loudness of the sound.

Frequency
The rate at which the pressure fluctuations occur determines the pitch or frequency of the sound. The frequency is expressed in Hertz (Hz) or cycles per second.

Octave and third octave bands
An octave is the interval between two points where the frequency at the second point is twice the frequency of the first.

There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz. Third octave bands provide a fine resolution by dividing each octave band into three bands. For example, third octave bands would be 160 Hz, 250 Hz and 315 Hz for the same 250 Hz octave band.

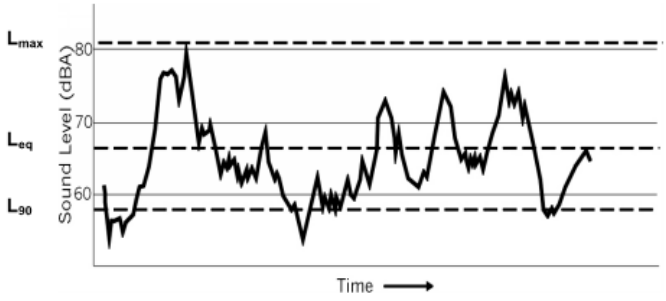
A-Weighting
The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequency than to low frequencies within the range. This is the basis of the A-weighting. This is a correction term applied to the frequency range in order to mimic the

sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies.

An A weighted value would be written as dB(A), or including A within the parameter term.

Noise units
In order to assess environmental noise, measurements are carried out by sampling over specific periods of time, such as five minutes, the statistically determined results being used to quantify various aspects of the noise.

The figure below shows an example of sound level varying with time. Because of this time variation, the same period of noise can be described by several different levels. The most common of these are described below.



$L_{eq,T}$
The $L_{eq,T}$ is a parameter defined as the equivalent continuous sound pressure level over a defined time period 'T'. It is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal.

The $L_{eq,T}$ can be thought of as an 'average' sound pressure level over a given time period (although it is not an arithmetic average). Typically the $L_{eq,T}$ will be an A-weighted noise level in dB(A) and is commonly used to describe all types of environmental noise sources.

$L_{90,T}$
The L90,T is a parameter defined as the sound pressure level exceeded for 90% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe the prevailing background noise level.

$L_{max,T}$
The $L_{max,T}$ is a parameter defined as the maximum noise level measured during the specified period 'T'.

Specific Noise Level, $L_{Aeq,Tr}$
This is the equivalent continuous A-weighted sound pressure level at the assessment position due to a specific noise source operating over a given time interval.

Free Field
A measurement taken in the free field is at least 3 m from reflecting vertical surfaces and 1.2 m from the ground.

Appendix B – Environment sound survey details.

Methodology.

Environmental sound survey.

Measurements were undertaken in accordance with BS 7445:2003 *Description and measurement of environmental noise.*

Weather conditions.

The weather conditions during the long-term measurements were appropriate for environmental sound measurements, with cloudy or partly cloudy sky and little to no rain or strong winds.

Equipment.

The equipment used during the survey is detailed in Table 5. All equipment was calibrated at the start and end of the survey and no significant drift was recorded during the measurements.

Table 5 Equipment used for the environmental sound survey.

Location	Component	Manufacturer	Model	Serial Number	Date of calibration	Calibration certificate
Measurements at location L1	Sound Level Meter	Rion	NL-52	01276555	26/06/2020	UCRT20/1561
	Microphone	Rion	UC-59	12612	26/06/2020	UCRT20/1561
	Pre-amp	Rion	NH-25	76774	26/06/2020	UCRT20/1561
	Acoustic Calibrator	Rion	NC - 74	34172704	12/08/2021	UCRT21/1986
Measurements at location L2	Sound Level Meter	Rion	NL - 32	01161938	24/09/2020	UCRT20/1918
	Microphone	Rion	UC-53A	311043	24/09/2020	UCRT20/1918
	Pre-amp	Rion	NH-21	21976	24/09/2020	UCRT20/1918
	Acoustic Calibrator	Rion	NC - 74	34172704	12/08/2021	UCRT21/1986

Results.

Long-term monitoring.

A summary of the ambient sound levels measured at L1 and L2 during the survey are presented in Table 6 and Table 7, respectively. The results of the unattended measurements have been calculated into daytime ($L_{Aeq,16hr}$) and night-time ($L_{Aeq,8hr}$) equivalent levels.

Time histories of the L_{Aeq} and L_{A90} from the unattended measurements recorded at positions L1 and L2 throughout the survey period are then shown in Figure 5 and Figure 6.

Table 6 Ambient sound pressure levels measured (dB) at position L1 - northern rooftop.

Date	Ambient sound pressure levels measured (dB) at position L1 - Northern rooftop	
	Day Time (07:00 - 23:00) $L_{Aeq, 16hr}$	Night Time (23:00 - 07:00) $L_{Aeq, 8hr}$
06/09/2021	53	49
07/09/2021	54	50
08/09/2021	55	49
09/09/2021	55	49
10/09/2021	53	48
11/09/2021	52	48
12/09/2021	50	-

Table 7 Ambient sound pressure levels measured (dB) at position L2 - southern rooftop.

Date	Ambient sound pressure levels measured (dB) at position L2 - Southern rooftop	
	Day Time (07:00 - 23:00) $L_{Aeq, 16hr}$	Night Time (23:00 - 07:00) $L_{Aeq, 8hr}$
06/09/2021	54	49
07/09/2021	54	49
08/09/2021	55	48
09/09/2021	55	49
10/09/2021	54	48
11/09/2021	54	48
12/09/2021	54	49
13/09/2021	55	-

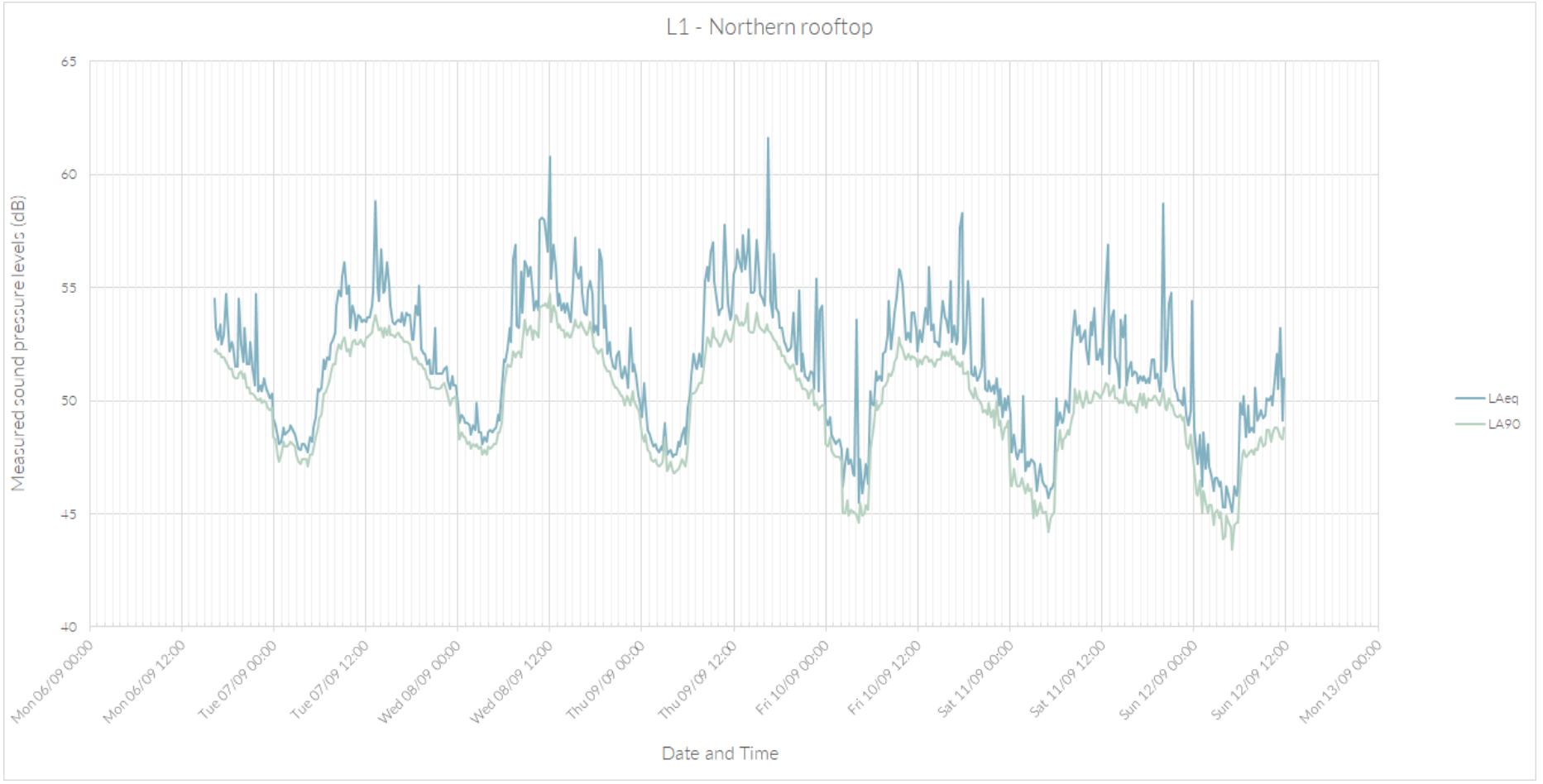


Figure 5 Time-history of unattended sound monitoring results at position L1.

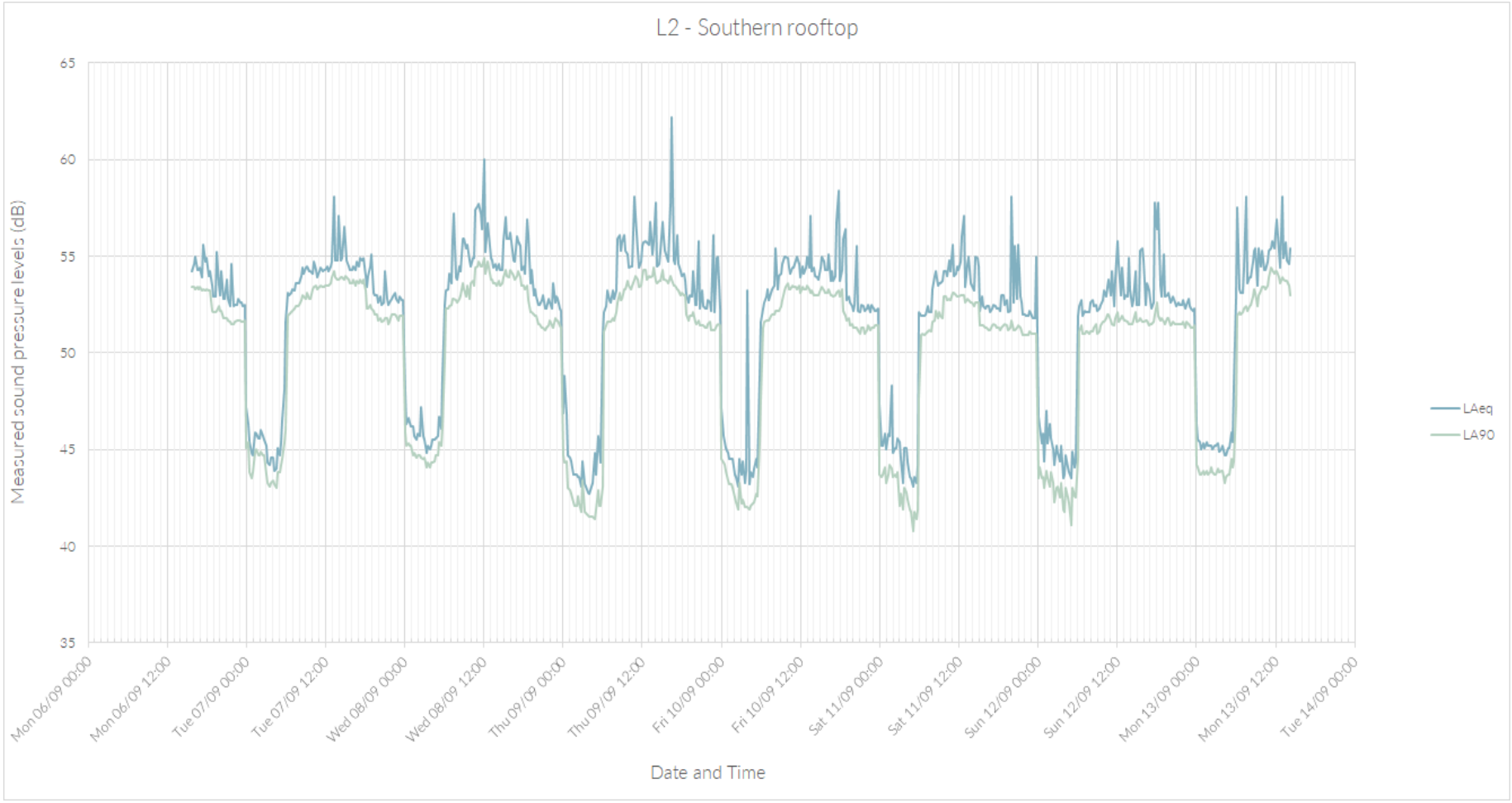


Figure 6 Time-history of unattended sound monitoring results at position L2.

Background sound levels.

In line with the requirements of BS 4142, in order to *"quantify what is typical during particular time periods"*, statistical analysis of the measured background sound levels ($L_{A90,15min}$) has been undertaken. The periods of interest have been taken as daytime (07:00 – 23:00) and night-time (23:00 – 07:00). T

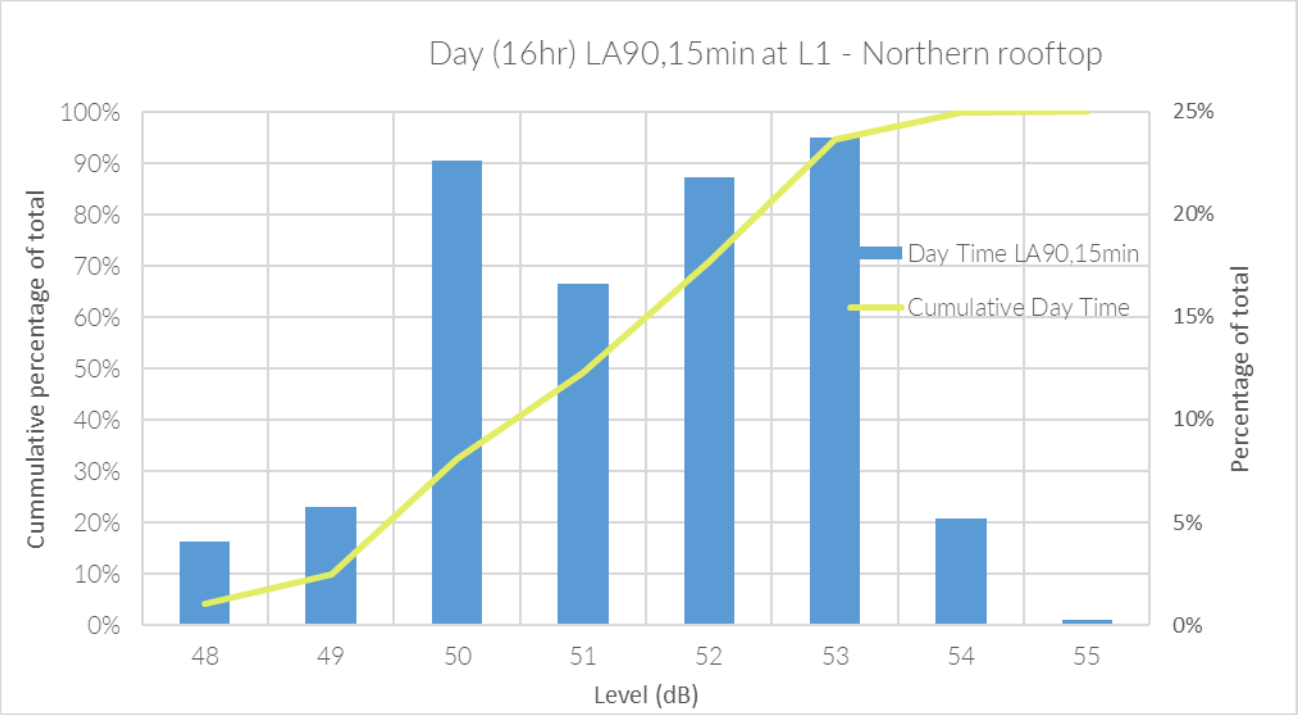


Figure 7 Background sound pressure levels measured during the day at L1 - Northern rooftop.

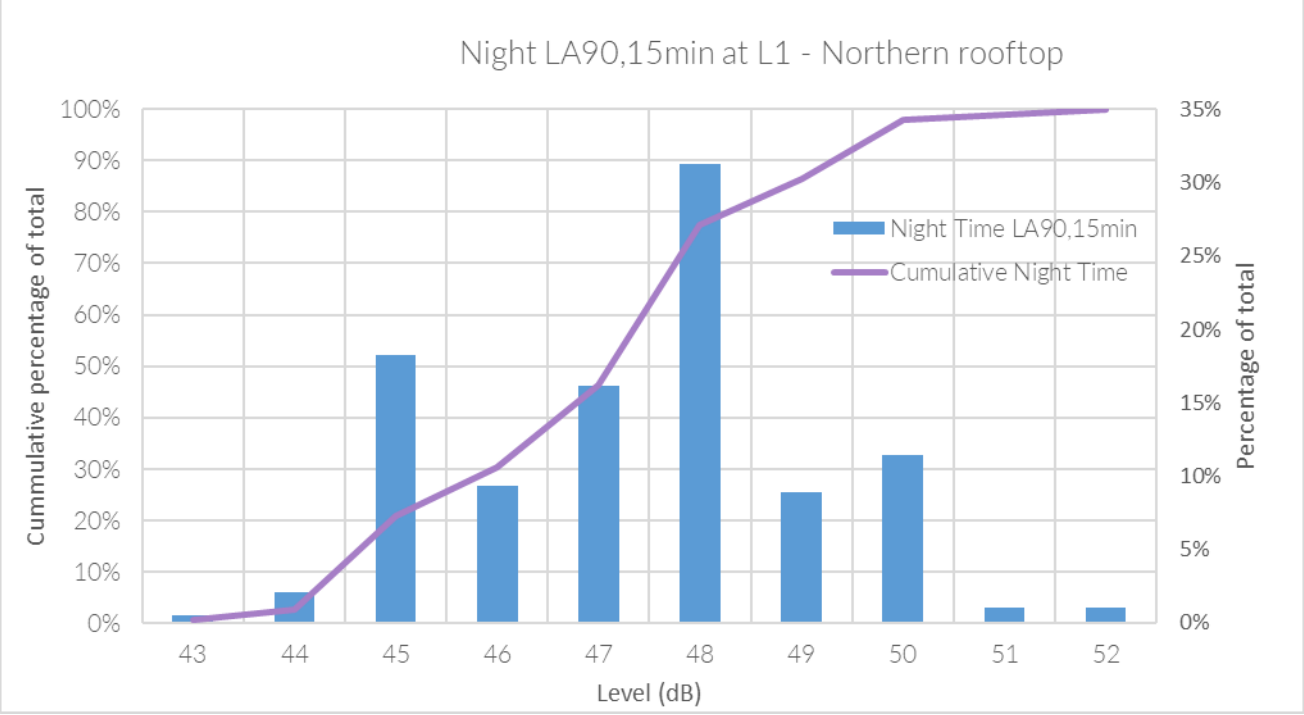


Figure 8 Background sound pressure levels measured during the night at L1 - Northern rooftop.

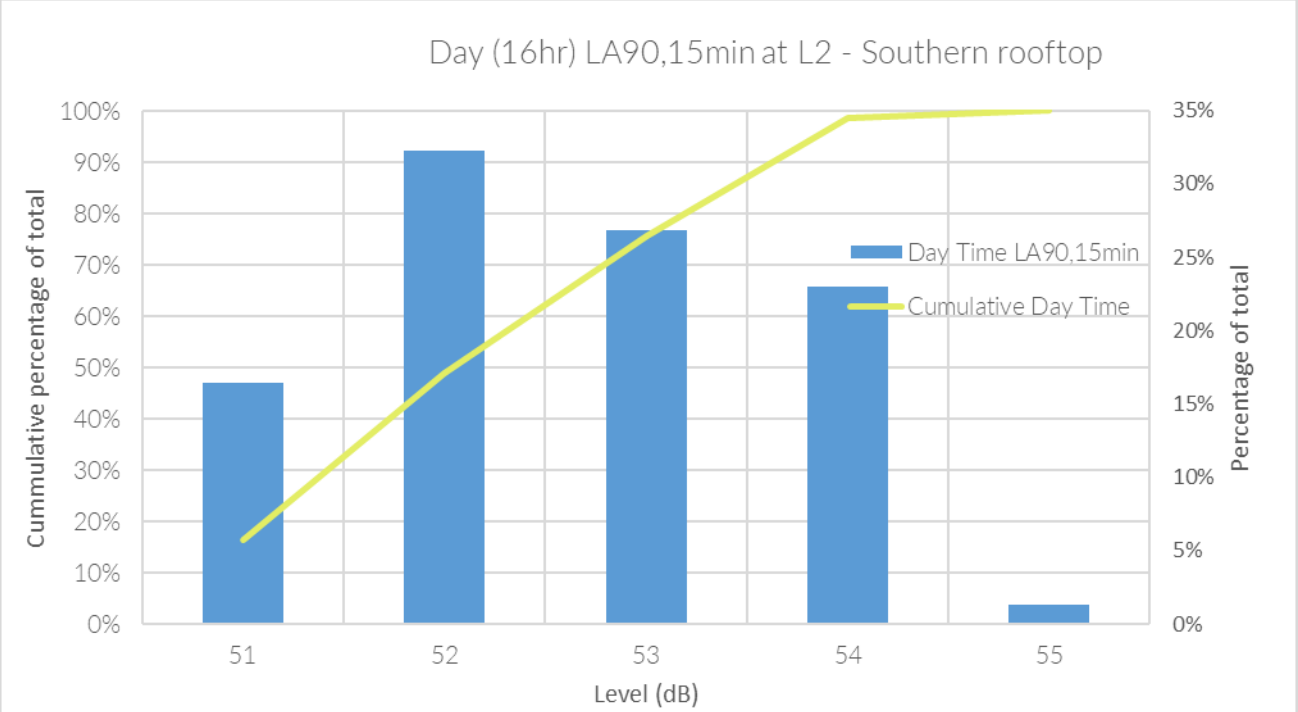


Figure 9 Background sound pressure levels measured during the day at L2 - Southern rooftop.

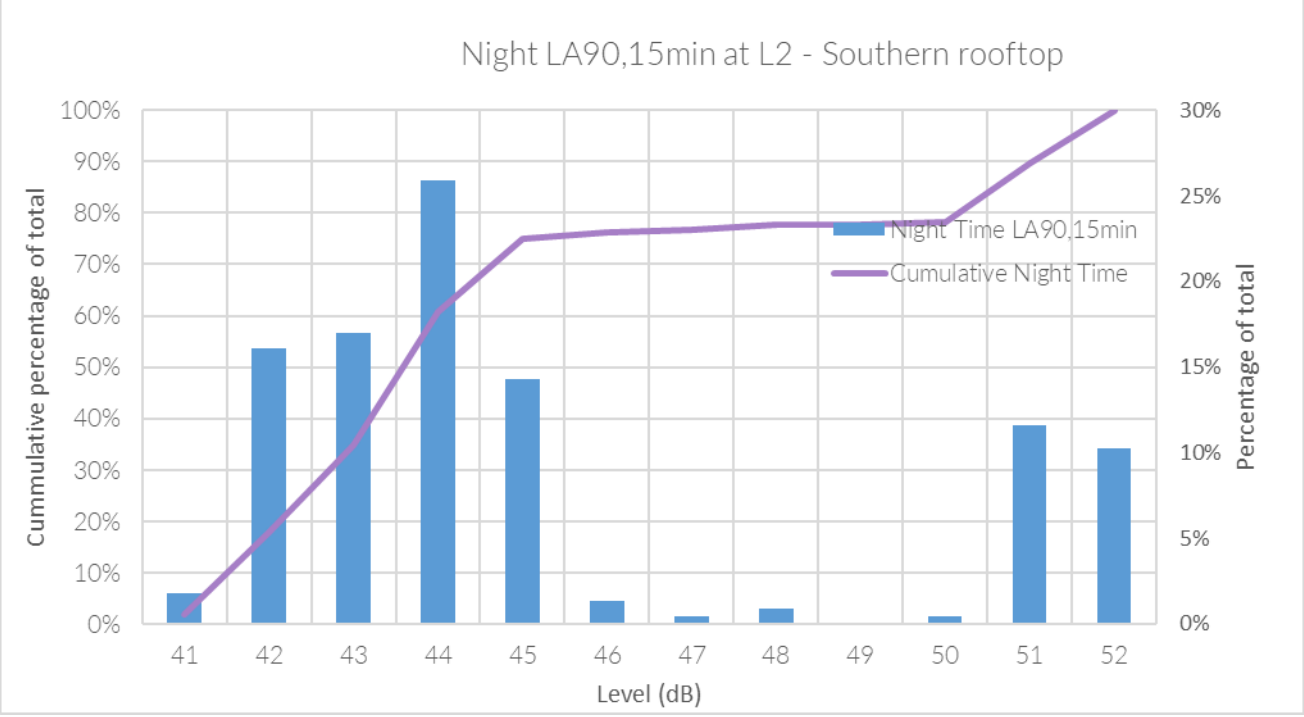


Figure 10 Background sound pressure levels measured during the survey during the night at L2 - Southern rooftop.

From the above statistical analysis charts, and the time history charts included in Figure 5 and Figure 6, the following background sound levels have been determined representative for the periods of interest for each measurement position and corresponding receptors.

Table 8 Typical background sound levels measured at each monitoring position.

Position	Period	Typical background sound levels dB $L_{A90,15min}$
L1	Daytime (07:00 – 23:00)	49
	Night-time (23:00 – 07:00)	45
L2	Daytime (07:00 – 23:00)	51
	Night-time (23:00 – 07:00)	42

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