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Technical Report – Acoustic Assessment

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1 Introduction

MLM Acoustics has been commissioned by 13-17 Red Lion Square LLP to assess the impact of noise and vibration at the proposed 13 Red Lion Square development site, London, in respect of the site's suitability for residential development.

This exercise has been undertaken in order to provide an overview of the acoustic environment across the proposed development site, based on the existing sources of noise and vibration affecting the area, such that it can inform the planning of the development.

The assessment has been based on detailed environmental noise and vibration measurements, undertaken across the proposed development site. This report details the results of all noise and vibration surveys undertaken and the resultant acoustic performance requirements of the external building fabric.

The suitability of the site for continued residential development has been assessed, based on the proposed development layout and the measured noise levels. Where the analysis indicates that noise may be a determining factor, mitigation measures have been proposed to ensure satisfactory living conditions are capable of being met.

Whilst every effort has been made to ensure that this report is easily understood, it is technical in nature; a glossary of terms is included in Appendix A to assist the reader.

2 Site Description

The location and extent of the proposed development site is identified in figure 1.

It is proposed to develop the existing 6-storey buildings to provide 13 residential flats. The proposed site is on bound between Red Lion Square to the north and Dane Street to the west. The site is subject to noise arising from traffic movements along the nearby roads, as well as noise arising from general pedestrian and commercial activities in the area.

Figure 1 – Site Location Plan

3 Assessment Criteria

National Planning Policy Framework, 2012

The National Planning Policy Framework (NPPF) [1] published on 27 March 2012 sets out the Government's economic, environmental and social planning policies for England. It attempts to summarise in a single document all previous national planning policy advice. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The NPPF effectively consolidates previous national planning policy advice; it does not introduce new technical guidance that has not already been taken into account in drafting this assessment.

The NPPF sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

Under Section 11; Conserving and enhancing the natural environment, the following is stated:

"The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability"

The document goes on to state:

"Planning policies and decisions should aim to:

- *Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*
- *Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*
- *Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."*

As stated above, this document makes reference to avoiding noise generation from new developments that would adversely impact on health and quality of life. It effectively supersedes PPG24[2], but does not set absolute criteria or offer specific guidance.

[1] Department for Communities and Local Government, March 2012. National Planning Policy Framework. HMSO.
[2] Planning Policy Guidance 24 (1994), Planning and noise, Department of the Environment

Noise Policy Statement for England, 2010

The underlying principles and aims of existing noise policy documents, legislation and guidance are clarified in the Noise Policy Statement for England (NPSE)[3]. The NPSE sets out the 'Long Term Vision' of Government noise policy as follows: *"Promote good health and good quality of life through the effective management of noise within the context of Government policy on sustainable development*'.

The NPSE outlines the following three aims for the effective management and control of environmental, neighbour and neighbourhood noise:

- "*Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life*".

The guidance defines three established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation (WHO):

- "*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 the noise";*
- *"LOAEL (Lowest Observed Adverse Effect Level) – This is the level above which adverse effects on health and quality of life can be detected";* and
- *"SOAEL (Significant Observed Adverse Effect Level) – This is the level above which significant adverse effects on health and quality of life occur""*.

The guidance also states that it is not possible to have a single objective noise-based measure that defines 'Significant Observed Adverse Effect Level (SOAEL)' that is applicable to all sources of noise in all situations and that not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

[3] Department for Environment, Food and Rural Affairs, 2010. Noise Policy Statement for England. DEFRA.

BS8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

BS 8233:2014 *Guidance on sound insulation and noise reduction for buildings* draws on the results of research and experience to provide information on achieving internal acoustic environments appropriate to their functions. The guideline values provided are in terms of an average (L_{Aeq}) level.

The standard advises that, for steady external noise sources, it is desirable for internal ambient noise levels to not exceed the guidance values, as detailed in Table 1 below.

Table 1: BS 8233:2014 Ambient Noise Levels

Activity	**Location**	**07:00 to 23:00**	**23:00 to 07:00**
Resting	Living room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining room	40 dB $L_{Aeq,16hour}$	-
Sleeping	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

BS 8233:2014 goes on to suggest that where development is considered necessary or desirable, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions will still be achieved.

With regard to maximum noise levels, the standard identifies that regular individual noise events (such as passing trains or scheduled aircraft etc.) can cause sleep disturbance. The standard does not provide a guideline design target, but simply goes on to suggest that a guideline value may be set in terms of SEL or $L_{Amax,F}$, depending upon the character and number of events per night. It goes on to suggest that more sporadic noise events could require separate values.

In respect of external noise levels, the guidance in BS 8233:2014 suggests that "*it is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments*".

BS 8233:2014 provides a much more detailed narrative on noise levels in external amenity areas and acknowledges that it may not always be necessary or feasible to ensure that noise levels remain within these guideline values.
In respect of gardens and patios, BS 8233:2014 states;

"…it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable."

BS 8233: 2014 goes on to state, for areas adjoining the strategic transport network:

"*…a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited*".

In respect of balconies, roof gardens and terraces, BS 8233:2014 states, "*Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses; however, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space*".

It is clear from the narrative of BS 8233:2014, that proposed development within noisy environments should be designed to ensure that the recommended internal design standards are achieved, and that noise levels in external amenity areas are designed to effectively control and reduce noise levels, although it acknowledges that in certain circumstances meeting the external design recommendations may not be feasible, or necessary, especially where the provision of such spaces is desirable for other technical, planning or policy reasons.

Residential Amenity – Vibration & Re-Radiated Noise

BS 6472:2008 *Guide to Evaluation of Human Exposure to Vibration in Buildings, Part 1, Vibration Sources Other Than Blasting* describes how to determine the vibration dose value, VDV, from frequency-weighted vibration measurements. The vibration dose value is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop. BS 6472 states that in homes, adverse comment about building vibrations is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception.

BS 6472 contains a methodology for assessing the human response to vibration in terms of either the vibration dose value, or in terms of the acceleration or the peak velocity of the vibration, which is also referred to as peak particle velocity. The advice contained in BS 6472 states that when the vibration is intermittent, as is the case at this site with the only significant potential source of vibration being the tube line in the area, the vibration dose value, or VDV, may be used to assess the potential for impacts.

Appropriately-weighted vibration measurements can be aggregated to derive the vibration dose values. The vibration dose value is a single figure descriptor that represents the cumulative dose of transient vibrations, taking into account the frequency spectrum and duration of each event. The vibration dose value is determined over a 16 hour daytime period or 8 hour night-time period, and the guidance in BS 6472 is set out as follows:

Table 2: Vibration Dose Values ($MS^{-1.75}$) Above Which Various Degrees Of Adverse Comment May Be Expected In Residential Buildings			
Period	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Residential Buildings 16 hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings 8 hour night	0.13	0.26	0.51

The above guidance relates to vibration measured at the point of entry into the human body, which is usually taken to mean the ground surface or at a point mid-span of an upper storey floor, rather than the point of entry into the building, for example, a foundation element.

BS4142:2014 Methods for Rating and Assessing Industrial and Commercial Sound

BS 4142[4] sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and noise sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS 4142 for assessing the effect of sound on residential receptors is to compare the measured or predicted noise level from the source in question, the $L_{Aeq,T}$ 'specific noise level', immediately outside the dwelling with the typical $L_{A90,T}$ background noise level.

Where the noise contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific noise level to obtain the $L_{Ar,Tr}$ 'rating noise level'. The level of uncertainty in noise measurements, data and calculations should also be considered, where necessary.

BS 4142 states: *"The 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"*. An estimation of the impact of the specific noise can be obtained by the difference of the rating noise level and the background noise level and considering the following:

- *"Typically, the greater this difference, the greater the magnitude of the impact."*
- *"A difference of around + 10dB or more is likely to be an indication of a significant adverse impact, depending on the context."*
- *"A difference of around + 5dB is likely to be an indication of an adverse impact, depending on the context."*
- *"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."*

[4] British Standard 4142: 2014: Method for Rating and Assessing Industrial and Commercial Sound. BSI.

For the daytime, the assessment is carried out over a reference time period of 1-hour, but at night-time it is carried out over a 15-minute period. The periods associated with day or night, for the purposes of the Standard, are considered to be between 07:00 to 23:00 and 23:00 to 07:00 respectively.

Camden Borough Council's Local Development Policy DP28

Camden Borough Council's Local Development Framework (Adoption version 2010) contains a local development policy (DP28) with regards to acceptable levels of noise in and vibration for residential developments. The over-riding requirements for residential development are summarised in Table 3 and Table 4, below:

Table 3: DP28 Noise Levels On Residential Streets Adjoining Roads At And Above Which Attenuation Measures Will Be Required

Source	Measurement	Noise Levels
Roads	Noise at 1 metre to a sensitive facade	62 dB $L_{Aeq,12hour}$ (07:00 – 19:00) 57 dB $L_{Aeq,4hour}$ (19:00 – 23:00) 52 dB $L_{Aeq,8hour}$ (23:00 – 07:00)
	Individual noise events several times an hour	>82 dB L_{Amaxr} (S time weighting) (23:00 – 07:00)

Table 4: DP28 Vibration Levels On Residential Sites Adjoining Railways And Roads At Which Planning Permission Will Not Be Granted

Source	Measurement	Vibration Levels Dwellings
Roads & Railways	Vibration inside dwellings	0.2 to 0.4 VDV ms- 1.75 (07:00 – 23:00) 0.13 VDV ms – 1.75 (23:00 – 07:00)
Where dwellings may be affected by ground-borne regenerated noise internally from railway or underground trains within tunnels, noise levels within the rooms should not be greater than 35 dB(A)max.		

In summary, DP28 policy dictates that no application will be recommended for permission without requiring mitigation measures where external noise levels exceed the levels on Table 3; and planning permission will not be granted for residential sites with vibration levels exceed the ones in Table 4.

Regarding plant noise emission, DP28 policy states the following:

Table 5: DP28 Noise Levels from Plant and Machinery At Which Planning Permission Will Not Be Granted

Noise and location measurement	Noise Levels
Noise at 1 metre external to a sensitive facade	5 dB(A)<L_{A90}
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive facade	10 dB(A)<L_{A90}

Summary

In accordance with the guidance contained within BS 8233:2014, BS 4142:2014 and, in accordance with DP28 policy, we would suggest the following internal ambient noise level limits are adopted:

Table 6: Proposed Noise Level Limits		
Location	**07:00 to 23:00**	**23:00 to 07:00**
Bedrooms	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$ & 45 dB $L_{Amax,F}$
Kitchen/Dining Rooms	40 dB $L_{Aeq,16hour}$	-
External Amenity Areas	50 – 55 dB $L_{Aeq,1hour}$	-
Operational noise from Plant	10 dB below typical L_{A90}	10 dB below typical L_{A90}

4 Measurements

The prevailing noise and vibration conditions in the area have been determined by detailed surveys. Noise measurements were conducted over a typical midweek 48 hour period. The noise measurements were undertaken between Wednesday 11 and Friday 13 November 2015. However, due to undesirable weather conditions with high winds during the night of Thursday 12, these data have been discarded. The assessment is based on 24-hours measurements from 23:00 Wednesday 11 to 23.00 Thursday 12. Unattended vibration measurements were also conducted over the same midweek 48 hour period.

Noise Measurements

Noise monitoring was undertaken over sequential five minute periods at each measurement position for the duration of the survey.

All noise measurements were undertaken by a Consultant certified as competent in environmental noise monitoring, and, in accordance with the principles of BS 7445[5].

All acoustic measurement equipment used during the noise survey conformed to Type 1 Specification of British Standard 61672[6]. A full inventory of this equipment is shown in Table 7 below:

Table 7: Inventory Of Noise Measurement Equipment

Item	Make & Model	Serial Number
1 – Sound Level Meter	01dB Duo	10965
1 – Preamplifier	01dB Pre 23	10449
1 – Microphone	Gras 40CD	161799
2 – Sound Level Meter	Rion NA-28	00860027
2 – Preamplifier	Rion NH-23	60027
2 – Microphone	Rion UC-59	04252
3 – Sound Level Meter	Rion NA-28	00370297
3 – Preamplifier	Rion NH-23	60306
3 – Microphone	Rion UC-59	00386
Calibrator	Rion NC-74	34315165

The noise measurement equipment used during the survey was calibrated at the start and end of each measurement. The calibrator used had itself been calibrated by a UKAS accredited calibration laboratory within the twelve months preceding the measurements. No significant drift in calibration was found to have occurred.

The weather conditions during the measurement period considered for the assessment were acceptable for noise measurement, it being dry with very light winds of less than 5m/s.

[5] British Standard 7445: 2003: *Description and measurement of environmental noise*. BSI
[6] British Standard 61672: 2003: *Electroacoustics. Sound level meters*. Part 1 *Specifications*. BSI.

The microphones were fitted with protective windshields for the measurements, which are described in greater detail below.

Measurements were carried at the following locations:

- Position 1 – Noise measurement of exiting noise levels at the façade facing Red Lion Square. A microphone was located at 1m from the northern façade of 13 Red Lion Square existing building, at first floor level. During our time on-site, it was noted that the noise climate was dominated by road traffic movements on Red Lion Square, as well as remote traffic noise from busier streets of the nearby road network; A401 Theobald's Road and A40 Procter Street. Pedestrians, wind in trees and occasional aircrafts were also noted to affect the prevailing noise levels at this position.

- Position 2 – Noise measurement of exiting noise levels at the rear courtyard of the proposed development. A microphone was located at 2m height at the back courtyard of 17 Red Lion Square existing townhouse, under free-field conditions. During our time on-site, it was noted that the prevailing noise climate at this position was dominated by remote road traffic from local road network, occasional car movements within the car park and occasional neighbours' activities noise. It was also noted that remote and continuous noise arising from external air handling units associated to the building current activity affected the monitoring position, as well as noise from a retail unit at the corner of Dane Street and Eagle Street.

- Position 3 – Noise measurement of exiting noise levels at the façade facing Dane Street. A microphone was located at 1m from the western façade of 13 Red Lion Square existing building, at first floor level. During our time on-site, it was noted that the noise climate at this position was dominated by sporadic car movements along Dane Street, as well as affected by remote and continuous noise arising from external air handling units associated the retail unit at the corner of Dane Street and Eagle Street and remote traffic noise from local road network.

Vibration Monitoring

Continuous unattended vibration dose value monitoring was undertaken over a typical midweek period between 11 and 13 November 2015. This exercise was intended to provide hourly vibration dose values within the ground floor of the existing building at 13 Red Lion Square, facilitating calculation of the worst-case daily and nightly VDV values the proposed site is likely to be exposed to and, hence, comparison with the guidance contained in BS 6472 and with the requirements of the Local Authority.

Measurements were undertaken within the existing ground floor, which is understood to be retained as is the case for the rest of floors. .

The transducers were located on hard cement ground and weighted to ensure a good connection with the surrounding area. No vibration was subjectively detected during the time on site.

A full inventory of the monitoring equipment is shown in Table 8 below:

Table 8: Inventory Of Vibration Measurement Equipment		
Item	**Make & Model**	**Serial Number**
1 – Vibration meter	Vibrock V901	747

The vibration meter used was self-calibrating and had been laboratory calibrated within the 12 months preceding the survey, with no drift occurring.

5 Survey Results

Noise Measurements

The measured average noise levels (L_{Aeq}) and typical maximum noise levels (L_{Amax}) at Measurement Positions 1, 2 and 3 over the daytime and night-time periods are detailed in Table 9, below:

Table 9: Measured Daytime & Night-Time L_{Aeq} and L_{Amax} Noise Levels, dB				
Position	**Daytime (07:00 – 23:00 Hours)**		**Night-time (23:00 – 07:00 Hours)**	
	L_{Aeq}	**L_{Amax}**	**L_{Aeq}**	**L_{Amax}**
1	62.3	78.2	56.3	70.2
2	54.9	73.6	47.2	62.2
3	61.3	79.3	55.2	73.2
Please note: the noise levels detailed above for position 1 and 3 were affected by reflections from the façade.				

In order to take into account both the "typical" L_{AFmax} values as well as the contribution of individual events for each position, which may exceed the "typical" L_{AFmax} values, a statistical analysis of the measured L_{AFmax} (23:00 – 07:00) over the measurement period has been undertaken. For the purpose of this exercise, the 90th percentile of the L_{AFmax} noise levels measured at each measurement position has been derived. (The 90th percentile of the L_{max} of all measured data is the L_{max} noise level that was not exceeded for 90% of the measurement time).

The typical background noise levels (L_{A90}) at Measurement Positions 1, 2 and 3 over the daytime and night-time periods are detailed in Table 10 below.

Table 10: Typical Daytime & Night-Time L_{A90} Noise Levels, dB		
Period	**Daytime (07:00 – 23:00)**	**Night-time (23:00 – 07:00)**
Measurement Position 1	57	48
Measurement Position 2	51	44
Measurement Position 3	56	50

Please note that in accordance with the requirements of BS4142:2014, the typical L_{A90} noise levels presented above have been derived following a detailed statistical analysis of the measured noise levels over the relevant daytime and night-time periods. By definition, the lowest L_{A90} is not typical and, therefore, should not be the basis of an assessment in accordance with BS4142:2014. The results of the statistical analysis are detailed in Appendix B.

The measured L_{Aeq}, L_{Amax} and L_{A90} noise levels are presented as time histories and typical L_{Aeq} and L_{Amax} noise levels are presented as spectra in Appendix B.

Vibration Surveys

The measured daytime (07:00 – 23:00) and night-time (23:00 – 07:00) vibration dose value levels are summarised in Table 11 below.

Table 11: Summary Of Vibration Measurement Results, EVDV $MS^{1.75}$

Period	**Axis (maximum levels)**		
	X	**Y**	**Z**
Day – 07:00-23:00	0.021	0.021	0.031
Night – 23:00-07:00	0.018	0.018	0.026

6 Noise Assessment

In order to achieve the required internal ambient noise level limits, the proposed dwellings need to be considered with regard to the level of façade mitigation required in order to achieve internal noise levels of <35 dB(A) in bedrooms and <40 dB(A) in Living room/Kitchens during the day and <30 dB(A) in bedrooms during the night.

The glazing and ventilation elements are typically the weakest acoustic link in the construction of a building facade. Therefore, in order to assess the acoustic performance of the proposed dwellings, it is appropriate in the first instance to explore the level of protection that will be afforded by the performance of the glazing and ventilation elements.

Windows do not reduce noise equally across the entire frequency spectrum, so the frequency content of the sound will influence the overall sound reduction performance of a given window and by extension, the resulting noise levels within the receiving room.

Many glazing manufacturers test their products under laboratory conditions using a typical road traffic noise frequency spectrum source. The resultant measured noise attenuation, in dB, gives a very useful guide to in-situ sound reduction performance of the window for situations where road traffic noise dominates. This performance index is known as the R_{TRA}.

In this instance, given the fact that the existing building is located within a conservation area, it is understood that the existing 4mm glazing is to be retained within the new development. This glazing is predicted to provide a sound insulation performance of 30 dB R_w (26 dB R_{TRA}).

The Building Regulations state that "there shall be adequate means of ventilation for the people in the building" (Approved Document F 2006 of the Building Regulations 2000). Different ventilation strategies and systems may be used to comply with the above requirement.

It is understood in this instance, that mechanical ventilation and heat recovery units are proposed for the proposed development.

In order to determine the worst-case glazing standards required across the site, the predicted façade incident $L_{Aeq,16\ hour}$ daytime and $L_{Aeq,8\ hour}$ night-time noise levels have been used and, accordingly, the required sound reduction performances for the various building facades have been calculated, during both daytime and night-time periods.

As a worst case, the sound reduction performance requirements for the proposed development are driven by meeting the adopted target daytime $L_{Aeq,T}$ internal noise level limits in Living rooms/Kitchens of 40 dBA and the daytime and night-time $L_{Aeq,T}$ internal noise level limit of 35 dBA and 30 dBA in Bedrooms respectively. It should also be noted that the worst case sound reduction performances apply to habitable rooms such as living rooms, dining rooms and bedrooms only. For non-habitable rooms such as kitchens, bathrooms, stairways, halls, landings, lower performance standards would be permissible.

Based upon the provided layout proposals, detailed calculations have been carried out to determine the required worst-case acoustic performances for the external façade elements, in order to provide appropriate internal noise levels in rooms, during both the daytime and night-time periods. The resulting worst-case performance requirements are presented in Table 12, with example specifications provided.

Table 12: Minimum Performance Requirements For Glazing & External Wall Systems						
Example Glazing	**Frequency, Hz**					**R_w (dB)**
	125	**250**	**500**	**1000**	**2000**	
	Sound Reduction Performance, R (dB)					
4 mm single pane glazing	17	20	26	32	33	**30**
Example Walls	**Frequency, Hz**					**R_w (dB)**
	125	**250**	**500**	**1000**	**2000**	
	Sound Reduction Performance, R (dB)					
External Walls – Brick/Block, existing walls to be retained considered to have a minimum sound insulation performance	36	40	41	45	52	46

The above demonstrate that appropriate internal noise levels are entirely achievable through the use of existing façades, when utilising mechanical ventilation systems.

Clearly, other glazing units to the example configurations provided may be suitable. The above analysis is provided to simply demonstrate that a design solution is feasible at the proposed development site, for the purposes of a planning application and is not necessarily for the purposes of detailed design or glazing procurement.

7 Vibration Impact Assessment

Table 13 show the detailed assessment results pertaining to the existing vibration levels at the ground floor of the proposed development, as a worst case.

The figures presented below equate to the worst-case measured daytime and night-time values.

Table 13: Measured Vibration Dose Values At Ground Floor, $MS^{-1.75}$		
Measured VDV		
Axis	Day	Night
X	0.021	0.018
Y	0.021	0.018
Z	0.031	0.026
Probability of Adverse Comment	< low	< low

Table 13 above identifies that the measured existing vibration dose values on the ground floor of the proposed dwellings (which are to be retained) are predicted to be below the range of values that would result in a 'low possibility of adverse comment' in accordance with the guidance presented in BS 6472, and below the levels stated in Camden Borough Council development policy DP28.

In addition to the above, it is noted from the EIA associated with the nearby Crossrail development that ground-borne internal noise levels are, as a worst case, expected to fall within the range 29 – 30 dB L_{max} during normal, future operations. Such levels are not expected to result in disturbance to the future occupants.

Accordingly mitigation measures are considered unlikely to be required to control the impact of vibration from underground lines, as existing structural floors are to be retained.

8 Plant Noise Emissions

Noise emission from the building will need to be controlled to achieve acceptable levels of environmental noise when the building has been completed and is in operation.

Plant noise will need to be limited at all neighbouring residential properties. Additional consideration will need to be given to limit noise from external plant breaking back in to noise sensitive parts of the scheme itself.

Noise control strategy

It is anticipated that the Local Authority would require plant noise emission to the surroundings to be limited in accordance with guidance in BS 4142: 2014 "Methods for rating and assessing industrial and commercial sound".

BS 4142:2014 states: *"The 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"*

Considering development policy DP28, it is understood that noise emissions from plant ("rating level") serving the development should be designed to be 10 dBA below the typical existing background level ($L_{A90,T}$), when measured at 1 m from the nearest affected residential façade, during the plant operational hours.

According to BS4142:2014, 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.

Table 14: Proposed Plant Noise Emission limits

Receptors Location	Period	Typical measured Background Noise Level $L_{A90,15min}$ dB(A)	Proposed plant rating level at the nearest noise sensitive receptor dB(A)
Red Lion Square	Day-time (07:00 – 23:00)	57	47
	Nigh-time (23:00 – 07:00)	48	38
Internal Courtyard	Day-time (07:00 – 23:00)	51	41
	Nigh-time (23:00 – 07:00)	44	34
Dane Street	Day-time (07:00 – 23:00)	56	46
	Nigh-time (23:00 – 07:00)	50	40

Practical control measures

Screening of any external plant as well as provision of noise attenuators to items of plant may be necessary to control the transmission of noise and achieve the above criteria as well as to reduce the noise level produced by the plant to a reasonable extend around the footprint of the building itself.

Environmental attenuators and possibly other means of noise mitigation such as acoustic louvers or acoustic screens may be required to control noise emanating from the plantrooms, air intake and discharge points or from externally mounted plant.

9 Conclusion

MLM Acoustics has been commissioned by 13-17 Red Lion Square LLP to undertake an assessment of the impact of noise and vibration at the proposed 13 Red Lion Square development site, London, in respect of the site's suitability for residential development.

This exercise has been undertaken in order to provide an overview of the acoustic environment across the proposed development site, based on the existing sources of noise and vibration affecting the area, such that it can inform the planning of the development.

The assessment has been based on detailed environmental noise and vibration measurements made across the proposed development site.

This report details the results of all noise and vibration surveys undertaken and the worst-case acoustic performance requirements of the various external building fabric elements.

The suitability of the site for residential development has been assessed, based on the development layout proposals and the measured noise levels.

Target noise criteria have been set for all static plant within the proposed development. Providing that the rating noise levels from the building services plant do not exceed the stated noise criteria, whether through the application of noise control techniques or otherwise, the impact of noise from such sources will not adversely affect the amenity of existing noise-sensitive receptors

Subject to the recommendations of this report, it is considered that noise and vibration will not present a constraint to the residential development of this site and planning permission should not, therefore, be refused on this basis.

Appendices

Appendix A: Glossary of Acoustic Terminology
Appendix B: Noise Measurement Results

Appendix A

Appendix A – Glossary Of Acoustic Terminology

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20μPa (20x10-6 Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

Table A1: Typical Sound Levels Found In The Environment	
Sound Level	**Location**
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside factory
100 to 110dB(A)	Burglar alarm at 1m away
110 to 130dB(A)	Jet aircraft on take off
140dB(A)	Threshold of Pain

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

In accordance with logarithmic addition, combining two sources with equal noise levels would result in an increase of 3 dB(A) in the noise level from a single source.

A change of 3 dB(A) is generally regarded as the smallest change in broadband continuous noise which the human ear can detect (although in certain controlled circumstances a change of 1 dB(A) is just perceptible). Therefore, a 2 dB(A) increase would not be normally be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs.

For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10}, the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq}.

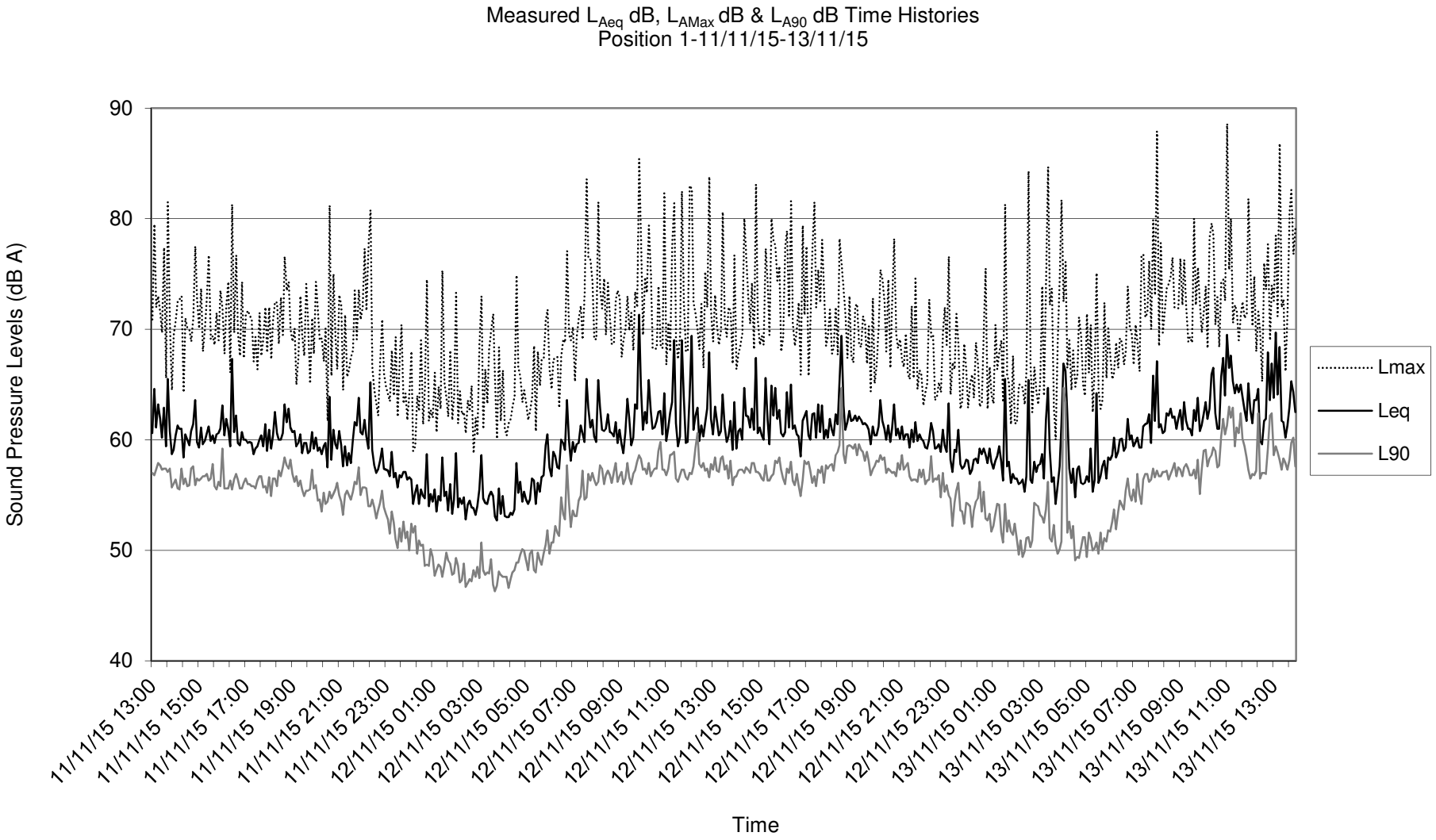
This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3 dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows represent changes of 1 dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

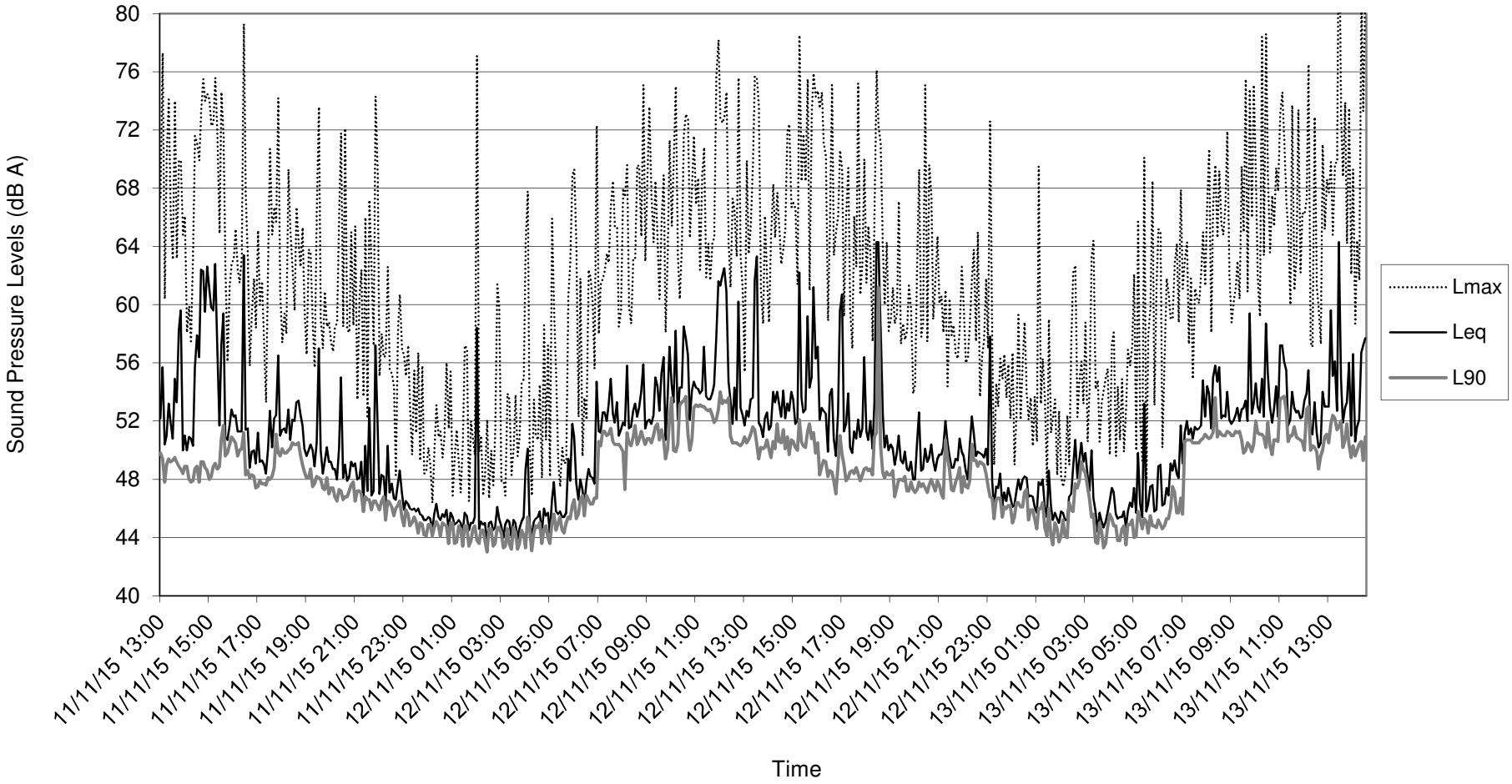
Note that the time constant and the period of the noise measurement should be specified. For example, BS 4142 specifies background noise measurement periods of 15 minutes during the day and night. The noise levels are commonly symbolised as $L_{A90,1hour}$ dB and $L_{A90,5mins}$ dB. The noise measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.

Appendix B

Appendix B – Noise Measurement Results



Measured L_{Aeq} dB, L_{AMax} dB & L_{A90} dB Time Histories
Position 2-11/11/15-13/11/15



Measured L_{Aeq} dB, L_{AMax} dB & L_{A90} dB Time Histories
Position 3-11/11/15-13/11/15

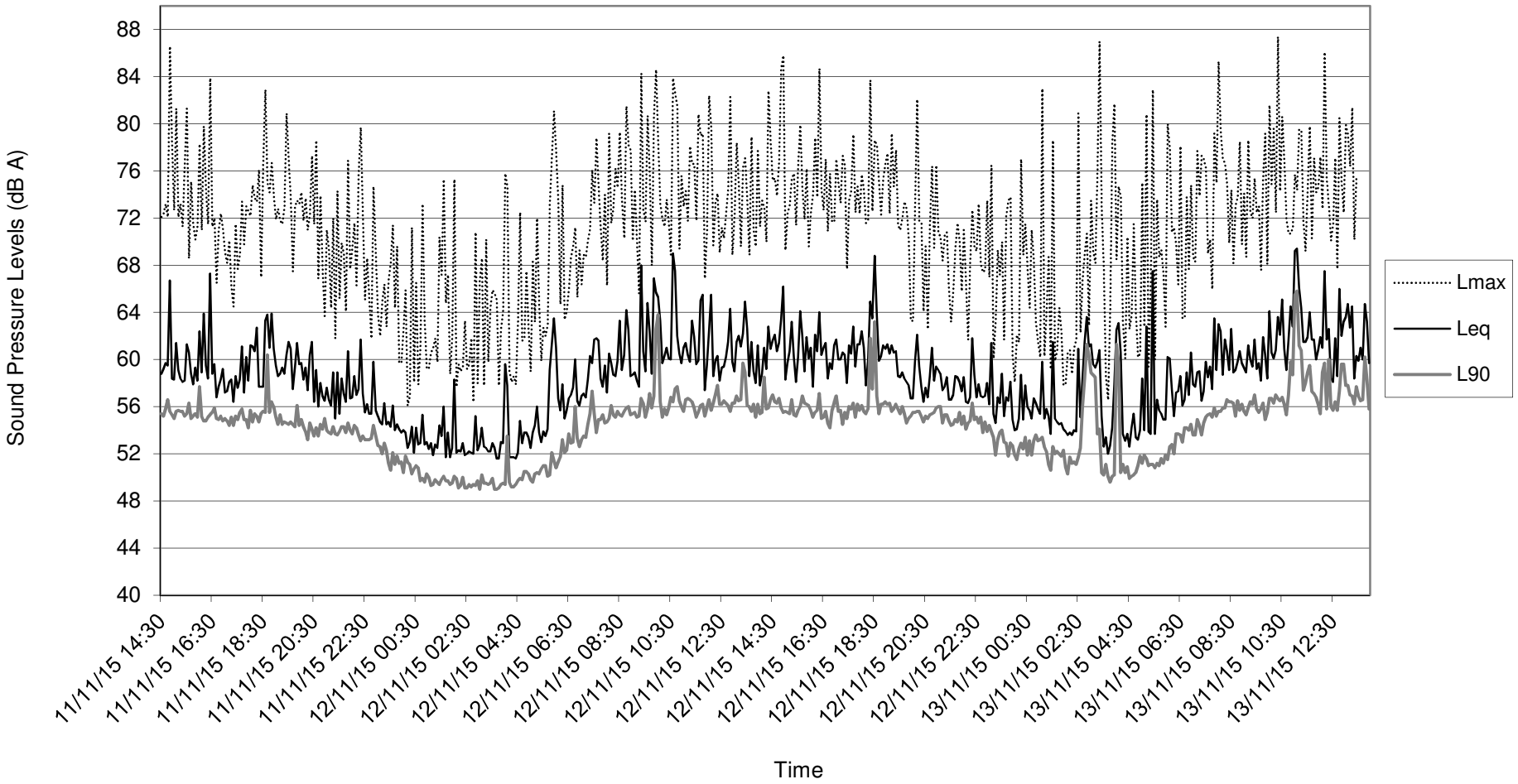
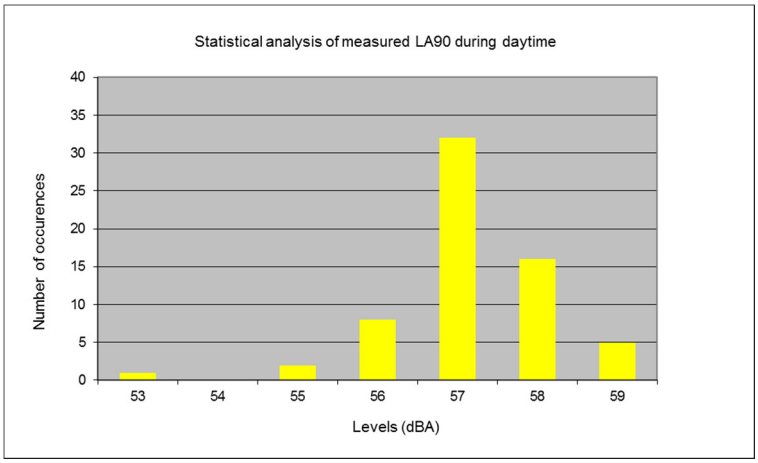


Table B1: Summary Of Background Noise Measurement Results		
Position	**Period**	**L_{A90} Noise Level, dB**
1	Minimum 15-min - Day	53
	Minimum 15-min - Night	47
	Mode ($L_{Aeq,16hr}$) Day	58
	Mode ($L_{Aeq,8hr}$) Night	48
	Typical 15-min - Day	57
	Typical 15-min - Night	48

Since the most frequently occurring (or modal) measured noise levels were found to be equivalent to the typical levels detailed above, the levels selected are considered to constitute a reasonable value and, therefore, are considered appropriately robust in this instance.



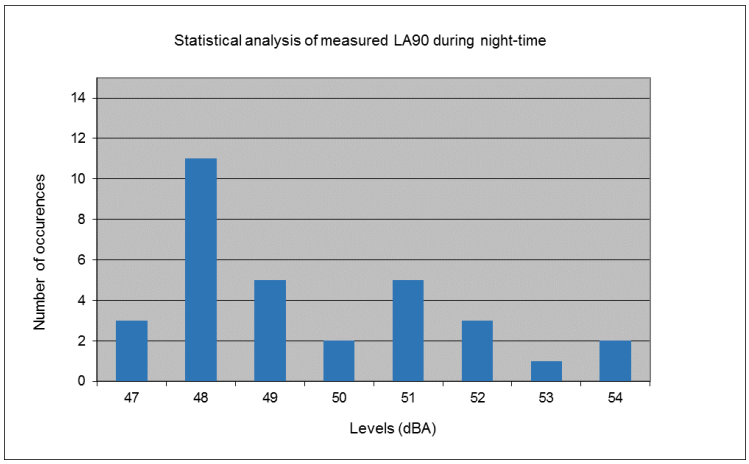
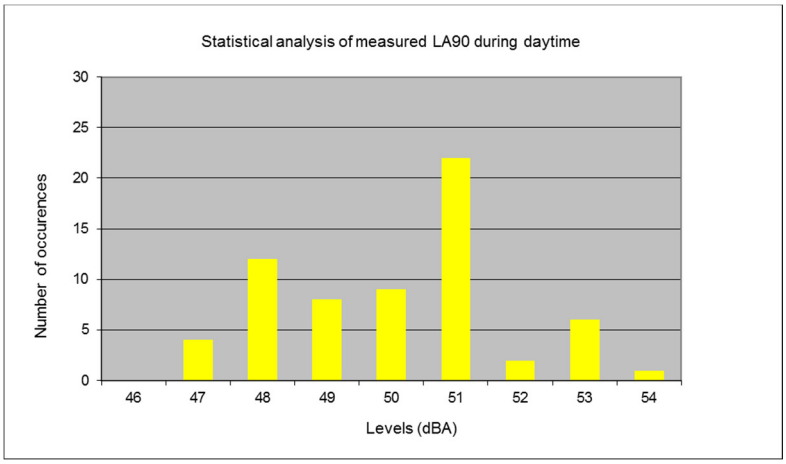


Table B2: Summary Of Background Noise Measurement Results		
Position	**Period**	**L_{A90} Noise Level, dB**
2	Minimum 15-min - Day	47
	Minimum 15-min - Night	44
	Mode ($L_{Aeq,16hr}$) Day	51
	Mode ($L_{Aeq,8hr}$) Night	44
	Typical 15-min - Day	51
	Typical 15-min - Night	44

Since the most frequently occurring (or modal) measured noise levels were found to be equivalent to the typical levels detailed above, the levels selected are considered to constitute a reasonable value and, therefore, are considered appropriately robust in this instance.



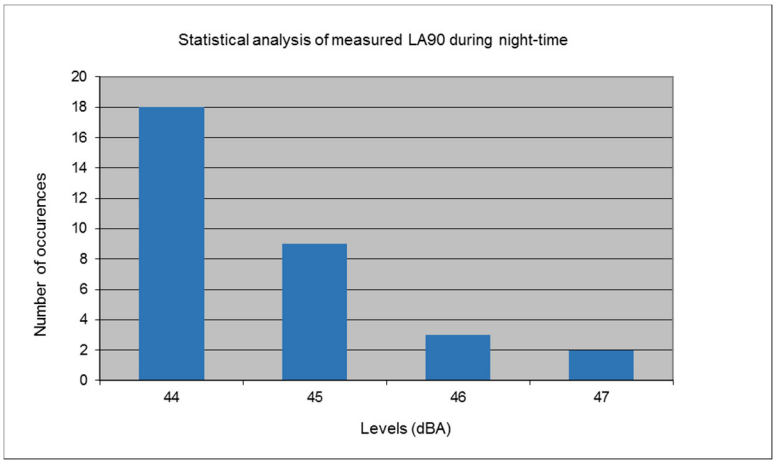


Table B3: Summary Of Background Noise Measurement Results		
Position	**Period**	**L_{A90} Noise Level, dB**
3	Minimum 15-min - Day	53.0
	Minimum 15-min - Night	49.0
	Mode ($L_{Aeq,16hr}$) Day	55.0
	Mode ($L_{Aeq,8hr}$) Night	51.0
	Typical 15-min - Day	56.0
	Typical 15-min - Night	50.0

Since the most frequently occurring (or modal) measured noise levels were found to be equivalent to the typical levels detailed above, the levels selected are considered to constitute a reasonable value and, therefore, are considered appropriately robust in this instance.