102
Camley Street, London N1C 4PF

Residential Planning Noise & Vibration Report

February 2014

REGENT RENEWAL LTD

SANDY BROWN
Consultants in Acoustics, Noise & Vibration

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102 Camley Street

Residential planning noise and vibration report

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A	19 Feb 14		Shane Sugrue	Robin Hall
B	26 Feb 2014	Minor adjustment	Shane Sugrue	Robin Hall

Summary

Sandy Brown Associates LLP (SBA) has been appointed to carry out an environmental noise and vibration survey at 102 Camley Street, London, N1C 4PF. The survey was performed between 15 January 2014 and 24 January 2014.

The lowest background noise levels measured during the survey were $L_{A90,15}$ 47 dB during the daytime and $L_{A90,15}$ 46 dB at night. Based on the requirements of the London Borough of Camden and on the results of the noise survey, all external plant installed on the site must be designed such that the cumulative noise level at 1 m from the worst affected windows of the nearby noise sensitive premises does not exceed L_{Aeq} 42 dB during the daytime and L_{Aeq} 41 dB during the night.

The average ambient noise levels measured during the survey were $L_{Aeq,16h}$ 64 dB during the daytime and $L_{Aeq,8h}$ 57 dB at night.

An initial facade sound insulation assessment has been carried out to determine the required acoustic performance of the facade, and provide guidance on the ventilation strategy. Based on this assessment high performance acoustic double glazing and mechanical ventilation are recommended to achieve the required indoor ambient noise levels in dwellings.

The east-facing façade of the proposed development, which faces onto railway lines coming from St. Pancras station, has the highest sound insulation requirement. In determining the performance of this façade, the sound reduction provided by winter gardens has been taken into account – ie. the outer and inner leaves of these semi-external spaces can provide the necessary attenuation to achieve the specified internal noise levels. Assuming the winter gardens do not form an integral part of the ventilation strategy for summer overheating, they will be easily designed to provide the necessary sound insulation. Special care should be given to detailing of angle junctions and seals for openable elements.

An initial assessment of potential tactile vibration and re-radiated noise from structure-borne vibration associated with train movements on the adjacent lines out of St. Pancras Station has been carried out. The results of this assessment suggest that vibration levels inside the proposed development will be within the acceptable ranges as set out by the relevant guidance and the London Borough of Camden.

Contents

1 Introduction

Sandy Brown Associates LLP (SBA) has been commissioned by Shaw Corporation to undertake an environmental noise and vibration survey and assessment in relation to planning for the proposed development at 102 Camley Street, London, N1C 4PF.

The purpose of the survey was to establish the existing ambient and background noise levels in the vicinity of the site and nearby noise sensitive premises, as well as the vibration levels affecting the site.

The background noise levels measured during the survey are used as the basis for setting limits for noise emission from proposed building services plant. These limits are set in accordance with the guidance of BS4142: 1997 *Method for rating industrial noise affecting mixed residential and industrial areas* and the requirements of the London Borough of Camden (LBC).

The facade sound insulation has been assessed in order to determine the necessary performance required to achieve appropriate internal noise levels for residences set in accordance with BS8233:1999 *Sound insulation and noise reduction for buildings – Code of Practice*, World Health Organisation and LBC guidelines.

The vibration survey was performed with the objective of assessing the degree to which the proposed development will be affected by tactile vibration (with reference to BS6472:2008 *Evaluation of Human Exposure to Vibration in Buildings – Part 1: Vibration from sources other than blasting*) and re-radiated noise from train movements along the railway tracks adjacent to the site.

This report presents the noise and vibration survey methods, the results of the surveys, a discussion of acceptable limits for noise emission from building services plant and minimum sound insulation requirements for the building envelope. An assessment of tactile vibration and ground-borne noise levels is also provided.

2 Site description

2.1 The site and its surroundings

The site in relation to its surroundings is shown in Figure 1. The site is located 0.5 km north of St. Pancras station and is bounded to the east by the railway lines from the station. Camley street and the Grand Union Canal form the west and south boundaries of the site. To the north is another warehouse site.

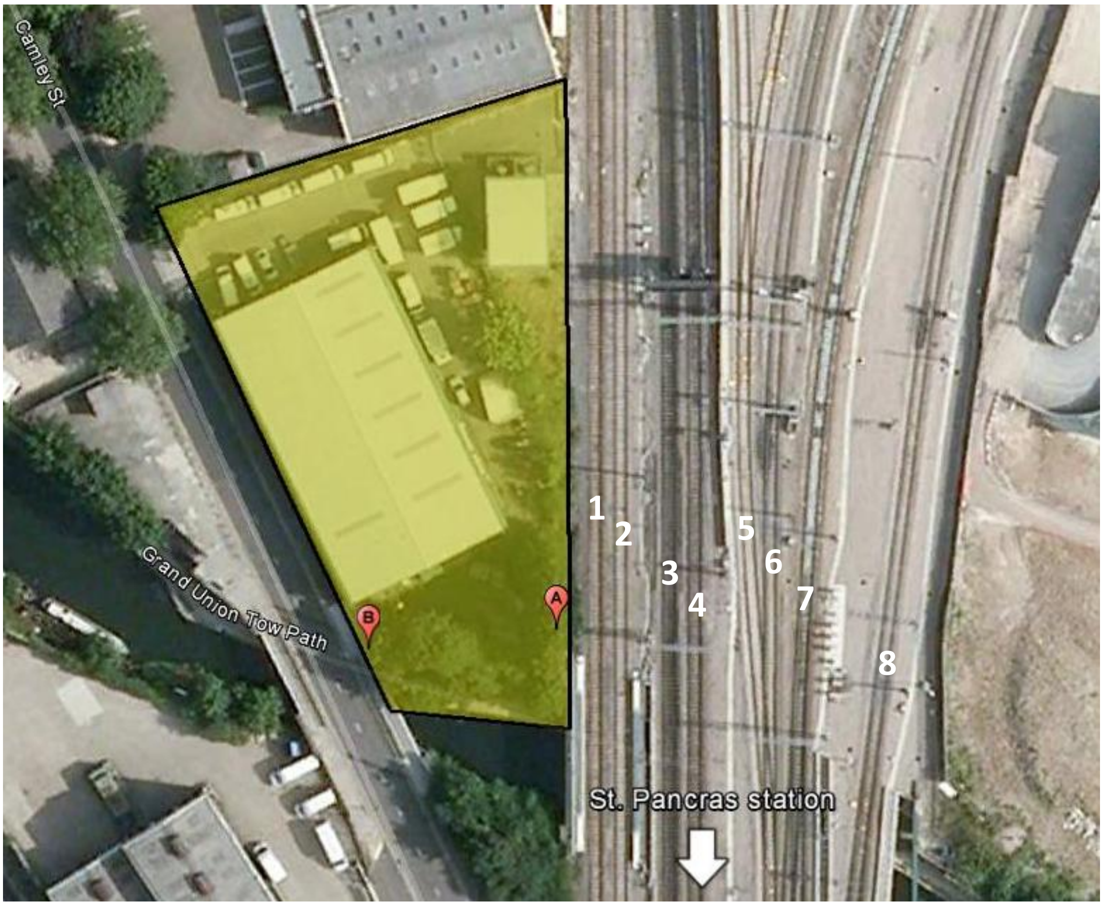


Figure 1 Site and surroundings (courtesy Google, 2014)

2.2 Adjacent premises

The surrounding premises are predominantly light industrial warehouse units similar to that occupying the site itself. The nearest residential premises are 75 m away to the south west, on the other side of the canal. However, it is understood that residential / mixed use developments are also being proposed for the neighbouring 101 and 103 Camley Street sites.

3 Method

3.1 Noise survey method

3.1.1 Unattended measurements

A six-day continuous unattended noise survey was undertaken at the site to determine the existing noise levels in the vicinity of the site and nearby noise sensitive premises.

Unattended measurements on the west (track) side of the site were performed over 5-minute periods between 11:57 on 15 January 2014 and 22:22 on 22 January 2014.

The microphone was positioned at the boundary fence, approximately 3 m from the nearest rail line, as shown in Figure 1.

Unattended measurements on the east (street) side of the site were performed over 5-minute periods between 11:35 between 15 January 2014 and 05:15 on 16 January 2014.

The unattended noise measurement positions used during the survey are indicated in Figure 1, denoted by the letters ‘A’ and ‘B’.

Noise levels at these locations were deemed to be reasonably representative of the background noise levels experienced by the nearest noise sensitive premises and of night time maximum noise levels experienced by the site.

3.2 Equipment and procedure

The unattended noise measurements were performed using two Svantek 957 sound level meters.

The vibration measurements were carried out using three Rion PV-87 accelerometers and a Rion DA20 data recorder. The recorded data was then processed to produce VDV and 1/3 octave band RMS acceleration measurements.

Calibration details of the equipment used during the noise and vibration surveys are provided in Appendix A of this report.

The sound and vibration level meters and the respective measurement chains were calibrated at the beginning and end of the measurements using their respective sound level calibrators. No significant calibration deviation occurred.

3.3 Noise and vibration indices

3.3.1 Noise indices

The equipment was set to record a continuous series of broadband sound pressure levels. Noise indices recorded included the following:

- $L_{\mathrm{Aeq},T}$ The A-weighted equivalent continuous sound pressure level over a period of time, T.
- $L_{\mathrm{Amax},T}$ The A-weighted maximum sound pressure level that occurred during a given period. Measured using the fast time weighting in accordance with the requirements of BS 8233 : 1999.
- $L_{\mathrm{ASmax},T}$ The A-weighted maximum sound pressure level that occurred during a given period measured with the slow time weighting.

- $L_{A90,T}$ The A-weighted sound pressure level exceeded for 90% of the measurement period. Indicative of the background noise level.

The L_{A90} is considered most representative of the background noise level for the purposes of complying with any local authority requirements.

Sound pressure level measurements are normally taken with an A-weighting (denoted by a subscript 'A', eg L_{A90} to approximate the frequency response of the human ear.

A more detailed explanation of these quantities can be found in BS7445: Part 1: 2003 *Description and measurement of environmental noise, Part 1. Guide to quantities and procedures.*

3.3.2 Vibration indices

For each measurement period a number of parameters were recorded. The most relevant of these are described below:

- The vibration dose value (VDV) in each of three axes with the appropriate frequency weightings (as defined in BS 6472-1:2008).
- The maximum RMS acceleration levels in each of three axes in one-third-octave bands, measured using the 'slow response' exponential time weighting.

3.4 Weather Conditions

During the attended measurements carried out on 24 January 2014, the weather was generally overcast but no rain occurred.

During the unattended noise measurements between 15 January and 22 January 2014, weather reports for the area indicated that temperatures varied between 1°C at night and 12°C during the day. Wind speed during the survey was typically in the range of 4 m/s and never more than 7.5 m/s.

These weather conditions are considered suitable for obtaining representative measurements.

4 Measurement results

4.1 Observations

The dominant noise sources observed at the site during the survey were trains leaving and arriving St. Pancras Station and construction taking place on the opposite side of the railway lines to the site.

Less significant noise sources included occasional traffic on Camley Street. Announcements from the station were not audible.

4.2 Noise measurement results

4.2.1 Unattended measurement results

The results of the unattended noise measurements performed at the site are summarised in the following tables. A graph showing the results of the unattended measurements is provided in Appendix B of this report.

The day and night time ambient noise levels measured during the unattended survey are presented in Table 1.

Table 1 Ambient noise levels measured during the survey

Date	Daytime (07:00 – 23:00) $L_{Aeq,16h}$ (dB)	Night (23:00 – 07:00) $L_{Aeq,8h}$ (dB)
Wednesday 15 January 2014	-	59
Thursday 16 January 2014	65	60
Friday 17 January 2014	61	55
Saturday 18 January 2014	63	54
Sunday 19 January 2014	62	55
Monday 20 January 2014	66	58
Tuesday 21 January 2014	66	58
Average	64	57

* Measurement not made over full period due to logger start and end time

These levels are below the maximum day and night time façade levels set out by LBC, given in Section 5.2.

The minimum background noise levels measured during the unattended survey are given in Table 2.

Table 2 Minimum background noise levels measured during the survey

Date	Daytime (07:00 – 23:00) $L_{A90,15min}$ (dB)	Night (23:00 – 07:00) $L_{A90,15min}$ (dB)
Wednesday 15 January 2014	49 *	47
Thursday 16 January 2014	49	47
Friday 17 January 2014	48	47
Saturday 18 January 2014	48	46
Sunday 19 January 2014	47	47
Monday 20 January 2014	48	47
Tuesday 21 January 2014	47	46
Wednesday 22 January 2014	47 *	-

* Measurement not made over full period due to logger start and end time

The lowest background noise levels measured during the survey were $L_{A90,15min}$ 47 dB during the daytime and $L_{A90,15min}$ 46 dB at night.

4.3 Vibration measurement results

4.3.1 Tactile vibration measurements

The following table presents the vibration dose values measured at location A. These measurements were performed on 24 January 2014 and are considered representative of the vibration levels to be experienced by the proposed development. The maximum VDVs measured for each of the orthogonal directions are highlighted in red.

Table 3 Vibration dose values measured at location A

Measurement No.	Start time	Duration (min)	No. of events	Track (as labelled in Figure 1)	VDV ($m/s^{1.75}$)		
					X	Y	Z
3	15:29	00:00:23	1	4th	0.004	0.003	0.005
4	15:30	00:00:24	1	3rd	0.004	0.003	0.004
5	15:34	00:00:59	1	6th	0.004	0.004	0.013
6	15:37	00:00:19	1	5th	0.007	0.001	0.004
7	15:43	00:00:59	1	6th	0.003	0.002	0.005
8	15:56	00:00:59	2	6th + 5th	0.003	0.002	0.008
9	15:59	00:00:20	2	3rd + 6th	0.001	0.001	0.005
10	16:00	00:00:29	1	4th	0.001	0.001	0.015
11	16:02	00:00:47	2	3rd + 4th	0.002	0.002	0.013
12	16:02	00:00:31	1	5th	0.002	0.001	0.006
13	16:04	00:00:22	1	4th	0.002	0.001	0.008
14	16:07	00:00:40	1	6th	0.002	0.001	0.007
15	16:09	00:00:59	1	4th	0.002	0.001	0.010
16	16:17	00:00:21	2	3rd + 4th	0.001	0.001	0.004
17	16:19	00:00:33	1	6th	0.001	0.001	0.011
18	16:26	00:00:46	1	4th	0.001	0.001	0.016
19	16:28	00:00:25	1	5th	0.001	0.001	0.004
20	16:29	00:00:56	1	3rd	0.004	0.004	0.006
21	16:30	00:00:21	1	5th	0.004	0.003	0.009
22	16:31	00:00:25	1	4th	0.002	0.002	0.014
23	16:32	00:00:50	1	3rd	0.002	0.002	0.014
24	16:33	00:00:48	1	5th + 6th	0.001	0.001	0.016

4.3.2 Re-radiated noise measurements

Ground-borne noise within the proposed development was predicted using the empirical formula described in '*Guidelines for the Measurement & Assessment of Groundborne Noise and Vibration (2nd Edition)*' published by the Association of Noise Consultants in 2012.

The predicted re-radiated noise level, from the vibration measurements at location 'A' are presented in Table 4 in terms of L_{ASmax} as required by BS6472.

Table 4 Predicted re-radiated noise levels from vibration measurements at location A

Measurement No.	Start time	Duration (min)	Measurement axis	L_{ASmax} (dB)
3	15:29	00:00:23	x - horizontal	20
			y - horizontal	21
			z - vertical	21
4	15:30	00:00:24	x - horizontal	16
			y - horizontal	16
			z - vertical	15
5	15:34	00:00:59	x - horizontal	21
			y - horizontal	21
			z - vertical	21
6	15:37	00:00:19	x - horizontal	10
			y - horizontal	12
			z - vertical	11
7	15:43	00:00:59	x - horizontal	14
			y - horizontal	17
			z - vertical	16
8	15:56	00:00:59	x - horizontal	26
			y - horizontal	25
			z - vertical	24
9	15:59	00:00:20	x - horizontal	17
			y - horizontal	19
			z - vertical	19
10	16:00	00:00:29	x - horizontal	24
			y - horizontal	26
			z - vertical	28

Table 4 (cont.) Predicted re-radiated noise levels from vibration measurements at location A

Measurement No.	Start time	Duration (min)	Measurement axis	L_{ASmax} (dB)
11	16:02	00:00:47	x - horizontal	24
			y - horizontal	23
			z - vertical	23
12	16:02	00:00:31	x - horizontal	20
			y - horizontal	22
			z - vertical	21
13	16:04	00:00:22	x - horizontal	21
			y - horizontal	23
			z - vertical	22
14	16:07	00:00:40	x - horizontal	18
			y - horizontal	21
			z - vertical	22
15	16:09	00:00:59	x - horizontal	23
			y - horizontal	26
			z - vertical	26
16	16:17	00:00:21	x - horizontal	16
			y - horizontal	17
			z - vertical	15
17	16:19	00:00:33	x - horizontal	22
			y - horizontal	25
			z - vertical	25
18	16:26	00:00:46	x - horizontal	28
			y - horizontal	29
			z - vertical	30

Table 4 (cont.) Predicted re-radiated noise levels from vibration measurements at location A

Measurement No.	Start time	Duration (min)	Measurement axis	L_{ASmax} (dB)
19	16:28	00:00:25	x - horizontal	22
			y - horizontal	23
			z - vertical	23
20	16:29	00:00:56	x - horizontal	14
			y - horizontal	17
			z - vertical	16
21	16:30	00:00:21	x - horizontal	27
			y - horizontal	27
			z - vertical	26
22	16:31	00:00:25	x - horizontal	28
			y - horizontal	30
			z - vertical	31
23	16:32	00:00:50	x - horizontal	23
			y - horizontal	24
			z - vertical	23
24	16:33	00:00:48	x - horizontal	26
			y - horizontal	28
			z - vertical	28

5 Assessment criteria

5.1 NPPF and NPSE

The National Planning Policy Framework (NPPF) sets out the government planning requirements, and supersedes previous guidance notes such as PPG24. No specific noise criteria are set out in the NPPF, or in the Noise Policy Statement for England (NPSE) to which it refers.

The NPPF states:

'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.'*

The NPSE states that its aims are as follows:

'Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *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.'*

As such, although neither of these documents sets out specific acoustic criteria for new residential development, the requirement to control both the effect of existing noise on the new development and the effect of noise from the development on the surroundings needs to be considered.

5.2 External noise levels – noise egress

5.2.1 Standard guidance

Standard guidance for noise emission from proposed new items of building services plant etc is given in BS4142: 1997 *Method for rating industrial noise affecting mixed residential and industrial area*s.

BS4142 provides a method for assessing noise from items such as building services plant against the existing background noise levels at the nearest noise sensitive receptors to assess the risk of complaints occurring.

BS4142 suggests that if the rating noise level is 10 dB or more higher than the existing background noise level, complaints are likely. If the rating level is 5 dB above the existing background noise level, it is considered of marginal significance. If the rating level is 10 dB or more below the existing background noise level, this is considered a positive indication that complaints are unlikely.

If the noise contains 'attention catching features' such as tones, bangs etc, these limits should be reduced by a further 5 dB.

5.2.2 *Local Authority requirements*

The requirements of Camden Borough Council are set out below:

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90

On this basis, all external plant installed at the site must be designed such that the cumulative noise level at the nearest noise sensitive receiver is not less than 5 dB below the lowest measured background noise level ($L_{A90,15min}$), unless it contains tones or impulsive sound.

5.3 Internal noise levels – noise ingress

5.3.1 *Standard guidance*

Guidance on acceptable internal noise levels in residential dwellings is given in BS8233 *Sound insulation and noise reduction for buildings – Code of Practice*, and is also provided by the World Health Organisation. The guidance given by BS8233 and WHO is shown in Table 5.

Table 5 Internal noise criteria for sleeping/resting

Internal space	Design range, L_{Aeq} (dB)		
	BS8233 "Reasonable"[1]	BS8233 "Good"[1]	WHO
Living rooms	40	30	30/35[2]
Bedrooms[3]	35	30	30[2]

[1] The design range given in BS8233 refers to criterion for "reasonable resting/sleeping conditions" in both living rooms and bedrooms. No time periods are specified.

[2] WHO does not differentiate between different types of living spaces, but recommends L_{Aeq} 30 dB in relation to sleep disturbance and L_{Aeq} 35 dB in relation to speech intelligibility. WHO provides a 16 hour time base when referring to speech intelligibility and an 8 hour time base when referring to sleep disturbance.

[3] BS8233 indicates that individual noise events should not normally exceed L_{Amax} 45 dB during night time, which is broadly in line with the guidance given by the WHO. However, Section 3.4 of the WHO guidelines suggests that good sleep will not generally be affected if internal levels of L_{Amax} 45 dB are not exceeded more than 10-15 times per night.

5.3.2 Local Authority requirements

The London Borough of Camden requirements regarding façade levels for developments adjoining rail and road are given below:

Table A: Noise levels on residential sites adjoining railways and roads at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Sites adjoining railways	Sites adjoining roads
Noise at 1 metre external to a sensitive façade	Day	0700-1900	74 dB L_{Aeq},12h	72 dB L_{Aeq},12h
Noise at 1 metre external to a sensitive façade	Evening	1900-2300	74 dB L_{Aeq},4h	72 dB L_{Aeq},4h
Noise at 1 metre external to a sensitive façade	Night	2300-0700	66 dB L_{Aeq},8h	66 dB L_{Aeq},8h

The following assessment is driven by condition 3 in Table A.

Table B: Noise levels on residential streets adjoining railways and roads at and above which attenuation measures will be required

Noise description and location of measurement	**Period**	**Time**	**Sites adjoining railways**	**Sites adjoining roads**
Noise at 1 metre external to a sensitive façade	Day	0700-1900	65 dB $_{LAeq'}$12h	62 dB $_{LAeq'}$12h
Noise at 1 metre external to a sensitive façade	Evening	1900-2300	60 dB $_{LAeq'}$4h	57 dB $_{LAeq'}$4h
Noise at 1 metre external to a sensitive façade	Night	2300-0700	55 dB $_{LAeq'}$1h	52 dB $_{LAeq'}$1h
Individual noise events several times an hour	Night	2300-0700	>82dB L_{Amax} (S time weighting)	>82dB L_{Amax} (S time weighting)

The following assessment is driven by condition 3 in Table B.

5.4 Tactile vibration criteria

Tactile vibration is that which is perceived as mechanical motion. The current standard for residential and office environments, *BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration Sources Other Than Blasting',* classifies the severity of tactile vibration according to the probability of adverse comment from occupants and by building function.

5.4.1 Vibration dose value

As the vibration is intermittent, it is assessed in terms of the equivalent "vibration dose value". This relates the level of vibration to the duration of vibration. The vibration dose value (VDV) can be used to assess the severity of intermittent sources of tactile vibration such as vehicle pass-by based on a 16 hour daily and 8 hour nightly dose.

For information, the BS6472-1: 2008 assessment table is reproduced below:

Table 6: BS6472-1: 2008 tactile vibration assessment criteria

Vibration dose values ($m/s^{1.75}$) above which might result in various degrees of adverse comment within residential buildings.			
Place	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential building 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Note: For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 hr day.

It is important to note that people exhibit wide variations of vibration tolerance. Specific values are dependent upon social and cultural factors, psychological attitudes and expected degree of intrusion.

It is recommended that residential properties within the development should at least achieve the VDV values for 'Low probability of adverse comment'.

5.4.2 RMS acceleration

In assessing tactile vibration it can also be useful to consider the guidance of the previous standard BS6472: 1992: '*Guide* to *evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)'.* This document provided a series of RMS acceleration curves outlining thresholds at which the probability of adverse comments is low for various situations including residential and commercial. The base curve ('Curve 1') is often regarded as the threshold of human perception. If measured vibration levels are found to be less than 'Curve 1', then this is a reasonable indication that adverse comment is unlikely. Although the BS6472: 1992 standard has been withdrawn and superseded by BS6472-1: 2008, it still provides an indication of the satisfactory magnitudes of building vibration.

5.5 Re-radiated noise criteria

5.5.1 Standard guidance

There is currently no international or British Standard which provides guidance on assessing the impact of ground-borne noise from railways on the occupants of a building. The Association of Noise Consultants (ANC) guidelines '*Measurement and assessment of ground-borne noise and vibration*', 2nd edition published in 2012, is generally used as the basis of assessments such as this.

This document also provides discussion on the relevant research that has been carried out, and a summary of typically adopted criteria.

The most relevant items are set out below:

- The American Public Transit Association (APTA) guidelines recommend criteria of between 30 and 40 dB(A) depending on the density and type of residential properties. They do not define where within a building these apply, or the time response that should be used.
- The Federal Transit Administration (FTA) of the US Department of Transportation, recommends limits for maximum pass-by levels of 35 dB(A) for frequent events (more than 70 events per day) and 43 dB(A) for infrequent events.
- London Underground Limited has studied the relationship between ground-borne noise levels and complaint thresholds. This was used to define a complaint threshold of 40 dB L_{Amax}.
- The ANC guidelines also note that Local Authority guidelines for ground-borne noise were published in London and the South East, and state a limit of 35 dB L_{Amax}.

In all of the above examples, the time constant is not defined, with the exception of the Local Authority guidelines in London and the South East, which is defined as having a fast time weighting.

It should be noted that most of this research relates to residential accommodation, and is aimed at providing good sleeping / resting conditions.

5.5.2 Local Authority requirements

The London Borough of Camden requirements regarding vibration dose values are given below:

Vibration description and location of measurement	**Period**	**Time**	**Vibration levels**
Vibration inside critical areas such as a hospital operating theatre	Day, evening and night	0000-2400	0.1 VDV ms-1.75
Vibration inside dwellings	Day and evening	0700-2300	0.2 to 0.4 VDV ms-1.75

6 Plant noise limits – noise egress

Based on the criteria set out in section 5.2 and the measurement results, the cumulative noise level resulting from the operation of all new plant at 1 m from the most affected windows of the nearest noise sensitive premises should not exceed 10 dB below the minimum external noise level. These limits are set out in Table 7.

Table 7 Plant noise limits at the nearest noise sensitive premises

Time of day	Maximum sound pressure level at noise sensitive premises (L_{Aeq} dB)
Daytime (07:00 - 23:00)	42
Night-time (23:00 - 07:00)	41

As previously stated, if the proposed plant noise contains attention catching features (such as tonal elements, whines, whistles, bangs etc), the plant should be designed to achieve a limit 5 dB below those set out above.

At this stage, no detailed information is available in relation to the proposed installation of building services plant, and this will need to be assessed in detail as the design progresses. However, all plant items will be designed to achieve the plant noise limits set out above.

The required attenuation measures will depend on the type and location of the plant items, but typical measures include in-duct attenuation, acoustic enclosures or screens, and acoustic louvres.

7 Facade sound insulation – noise ingress

This section discusses internal noise level criteria and assesses the required facade sound insulation performance. In principle, the required facade specification depends on two factors – the external noise levels at the site, and the internal noise criteria.

The following assessment is based on achieving the internal noise levels recommended in BS8233 which are set out in Section 5.3.

7.1 External noise levels

The measured noise levels have been used to predict the external façade noise levels around the building as given in Table 8 and Figure 2. The values have been calculated using the environmental noise prediction software CadnaA and the measured results of the noise survey, and are considered to represent the worst case scenario.

Table 8 Predicted external facade noise levels

Location	Predicted sound pressure levels (dB)	
	$L_{Aeq,5min}$	$L_{AFmax,5min}$
	55	71
	58	74
	63	86
	67	89
	73	95

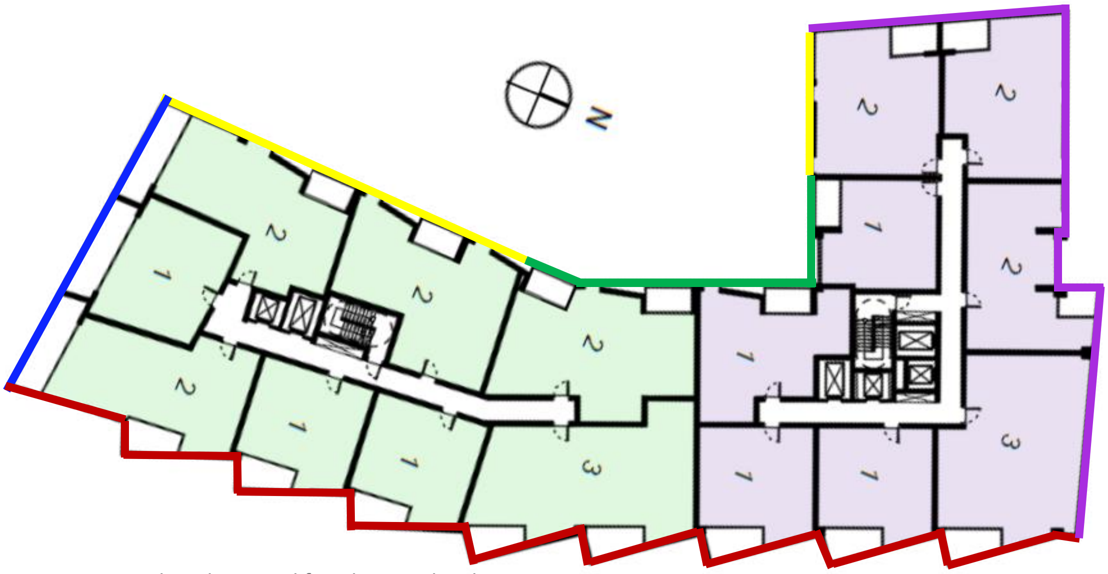


Figure 2 Predicted external facade noise levels

7.2 Facade sound insulation

To achieve the internal noise criteria given in Section 5.3 for bedrooms and other living areas, the minimum facade sound insulation requirements have been determined based on the predicted external noise levels at each facade given above.

Based on the predicted external façade levels and the internal noise criteria, the required facade sound insulation performance is determined by the night time criterion of L_{AFmax} 45 dB to achieve the BS8233 ‘Good’ standard.

The minimum façade sound insulation performances required to meet BS8233 ‘Good’ are given in Table 9.

Table 9 Facade sound insulation performance requirements

Facade	Overall sound insulation performance R'_w+C_{tr} (dB)	
	BS8233 'Good'	BS8233 'Reasonable'
	26	21
	29	24
	41	36
	44	39
	50	45

8 Facade specification

8.1 Glazing and ventilation strategy

The following table sets out some examples of glazing build ups and ventilation strategies that could be employed to achieve the required sound insulation performance for the various elevations.

Table 10 Example glazing configurations and ventilation strategies

Sound insulation R_w+C_{tr} (dB)	Example glazing configuration	Ventilation Strategy
≤10	6 mm/12 mm/6 mm	Open windows
10-15	6 mm/12 mm/6 mm	Limited open area opening windows
15-29	6 mm/12 mm/6 mm	Attenuated passive ventilation (eg, trickle vents)
30-32	6.4 mm/12 mm/6 mm	Attenuated passive ventilation
33-35	6.4 mm/12 mm/10 mm	High performance acoustically attenuated passive ventilation
36-38	12.8 mm/12 mm/10 mm	Mechanical ventilation (eg, whole house ventilation)
39-41	12.8 mm/20 mm/10 mm	Mechanical ventilation (eg, whole house ventilation)
42-44	This represents a very high sound insulation performance. The highest performance typically achievable using double glazing is around R_w+C_{tr} 42 dB (16.8 mm/20 mm/16.8 mm). For higher performances, a substantial façade construction, limited glazing area, and mechanical ventilation is likely to be required.	

The attenuation of sound provided by an open window is typically in the region of 10 to 15 dB when located in a solid facade, depending on the open area. As such, where the required facade sound insulation performance is less than R_w +C_{tr} 10 dB, it is likely that opening windows can be used whilst achieving the necessary internal noise levels.

There are no areas where the necessary facade sound insulation is low enough to allow windows to be an integral part of the ventilation strategy.

8.2 Airborne sound insulation requirements

The east-facing façade, which is primarily composed of glazed elements and overlooks the railway lines, has a notably high airborne sound insulation performance requirement.

The balconies on this side of the building are described as winter gardens. As such, they are essentially enclosed glazed spaces with small areas of openable glazing. The internal air quality requirements for the building determine that adequate mechanical ventilation, heating and cooling systems will be provided. It is thus reasonable to assume that openings in the façade, including winter gardens and balconies, are not required to be open for the purposes of ventilation.

On this basis the required sound insulation performance of the facade has been determined by taking into account the sound reduction provided by both the outer and the inner glazing of winter garden, as shown in Figure 3.

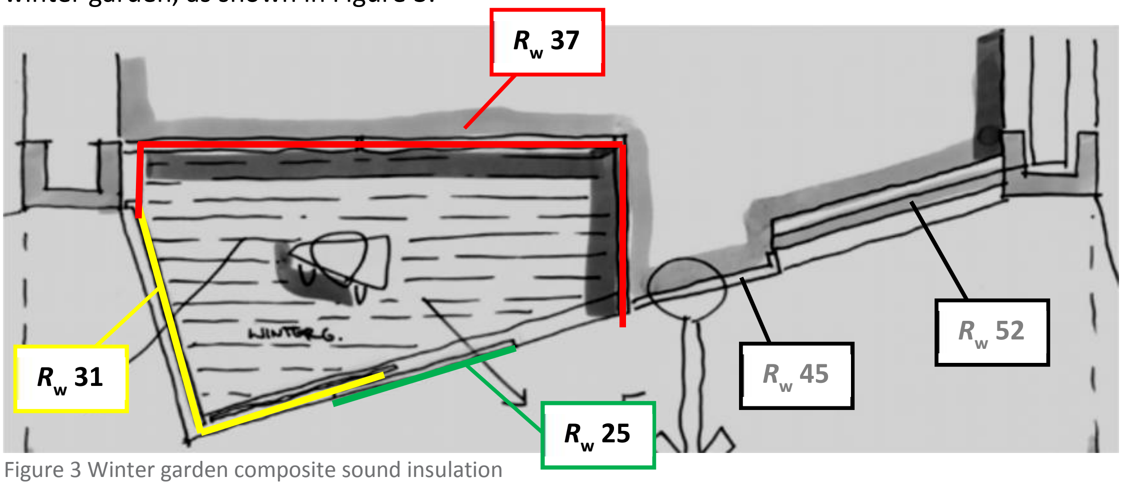


Figure 3 Winter garden composite sound insulation

The various elements of the façade system will be designed to meet the octave frequency band performances set out in Table 11.

Table 11 Octave band sound insulation performance requirements

	Octave centre frequency (Hz)						
Façade element	125	250	500	1k	2k	4k	R_w
Solid masonry	36	41	46	56	65	-	52
Fixed Glazing	35	38	44	42	47	59	45
Sliding door – inside WG*	26	27	34	40	38	-	37
Sliding window – outside WG*	19	21	25	25	24	30	25
Glass balustrade – outside WG*	20	22	28	32	33	-	31

*WG = Winter garden

Based on these performances and the worst-case noise levels recorded at site during the survey, the following internal ambient noise levels are predicted.

Values are given where the exterior window of winter garden is fully open, half open and closed. It is reasonable to assume that where good sleeping / resting conditions are required the outer window and inner sliding door would remain closed. Levels which meet the respective L_{Aeq} and L_{AFmax} criteria are given in red.

Table 12 Predicted internal noise levels

Scenario	Predicted sound pressure levels (dB)	
	$L_{Aeq,5min}$	$L_{AFmax,5min}$
Closed	20	43
Half-open	29	52
Open	31	55

In calculating the composite sound insulation performance of the winter gardens it has also been confirmed that the LBC requirement of L_{Aeq} 55 dB at 1 m from the building façade is achieved when the outer glazing is closed.

8.3 Guidance on façade construction

The sound insulation of the facade is dependent on the mass of the layers and the depth of the cavity between the layers. To achieve the sound insulation performance requirement for fixed glazing, there needs to be a balance between the mass and cavity depth. Increasing the mass of the external glazing will reduce the cavity size required and vice versa.

One option is to use a heavy, high performance acoustic glazing unit on the outside and a secondary glazing pane inside. Using a laminated double glazed external unit selected to achieve a sound insulation performance of R_w ≥45 dB, a 100 mm cavity and an inner laminated single glazing unit with a thickness of c.8 mm. Based on the Pilkington Optiphon systems, an example glazing configuration that achieves R_w ≥45 dB is 8.8 mm glass, 16 mm argon-filled cavity and 12.8 mm glass and would have a surface mass of approximately 50 kg/m^2.

Another option is a lighter external glazing unit but requires a heavier internal glazing unit. Using a laminated double glazed external unit selected to achieve a sound insulation performance of R_w ≥35 dB, a 200 mm cavity and an inner laminated double glazed unit that achieves a sound insulation performance of R_w ≥35 dB would be required. Based on the Pilkington Optiphon systems, an example glazing configuration that achieves R_w ≥35 dB is 6 mm glass, 16 mm argon-filled cavity and 4 mm glass and would have a surface mass of approximately 25 kg/m^2.

In both cases it is recommended that the glazing is fully sealed and the reveal between the cavity be lined with a ≥25 mm sound absorbent product such as Lamaphon WRX sound absorbing reveal liners (http://www.siderise.co.uk) or a 25 mm thick open celled acoustic foam.

The internal plasterboard linings should be formed using two layers of dense plasterboard or other material materials that would have with a combined surface mass of ≥21 kg/m^2. The cavity behind the plasterboard should contain a minimum of 50 mm acoustic insulation (i.e. mineral fibre or Rockwool).

8.3.1 Flanking via the facade interface details

As the sound insulation requirements are very high, good workmanship in the detailing of the façade is essential to its acoustic performance.

Mullions, transoms and seals around openings are likely to be the weakest elements in the overall facade construction. The interface details required to maintain the sound insulation performance will be dependent on the structural elements. The detailing will be designed such that the composite facade sound insulation performances are not lower than those set out in Table 9.

It is recommended that the gaps between the structural angles and the external glazing are kept to a minimum and that any gaps are filled with a flexible sealant. Depending on the surface density of the structural angles, internal layers of plasterboard may be required to enhance the details.

Flanking sound transmission via these elements will need to be re-assessed during detailed design, once the structural requirements have been confirmed. It is recommended that laboratory testing be carried out prior to installation on site to confirm that the facade elements achieve the performances set out in Table 11. Testing should be carried out in accordance with BSENISO 10140-2 *Acoustics. Laboratory measurement of sound insulation of building elements. Measurement of airborne sound insulation.*

The facade sub-contractor shall provide certificates of testing; confirming the proposed facade construction, including mullion penetrations at floor slab locations, meets the acoustic performance values given in Table 11.

A representative sample of the mullion and transom details should be included within the recommended laboratory sound insulation tests.

9 Vibration assessment

9.1 Tactile vibration

9.1.1 Vibration dose value

BS6472 states that the assessment should be based on the axis along which the highest vibration dose value (VDV) is measured. At measurement location 'A' the highest vibration dose value was measured on the Z-axis.

Published timetables indicate that approximately 760 trains pass on the tracks between 07:00 – 23:00. At night, between 23:00 – 07:00, the number of trains operating along this line is expected to be approximately 120 trains.

Based on the maximum vibration values from Table 3 and on the number of trains passing on the tracks between 07:00 – 23:00 and 23:00 – 07:00, the equivalent vibration dose values over a 16 hour day and an 8 hour night are given in the following table.

Table 13 Equivalent vibration dose values

Location	Maximum VDV measured ($m/s^{1.75}$)	Equivalent VDV ($m/s^{1.75}$)	
		Daytime (07:00 – 23:00)	Night time (23:00 – 07:00)
$VDV_{b(x)}$ (vertical)	0.007	0.02	0.03
$VDV_{b(y)}$ (vertical)	0.004	0.04	0.02
VDV_d (horizontal)	0.016	0.10	0.08

By comparing the calculated day and night time vibration dose values above with the assessment table given in Section 5.4 of this report, it can be seen that the predicted vibration dose values during the daytime and night periods are lower than the threshold of the 'low probability of adverse comment' category and are within the requirements set out by LBC.

Levels experienced may vary depending on the type of train and position of the future buildings. However, if the measured vibration levels are below the lowest BS6472 threshold, a significant increase in the number of trains would be required for the threshold to be exceeded. Tactile vibration due to trains is therefore not considered to be problematic at this site.

9.1.2 RMS acceleration

Figure 4 shows the measured and predicted maximum acceleration levels measured on the existing ground slab. Empirically derived corrections have been used to provide a transfer function between the measured and the predicted levels, as well as amplification by floor resonances.

For all measurements of train events, the measured maximum vibration levels are within BS6472: 1992 'Curve 1'.

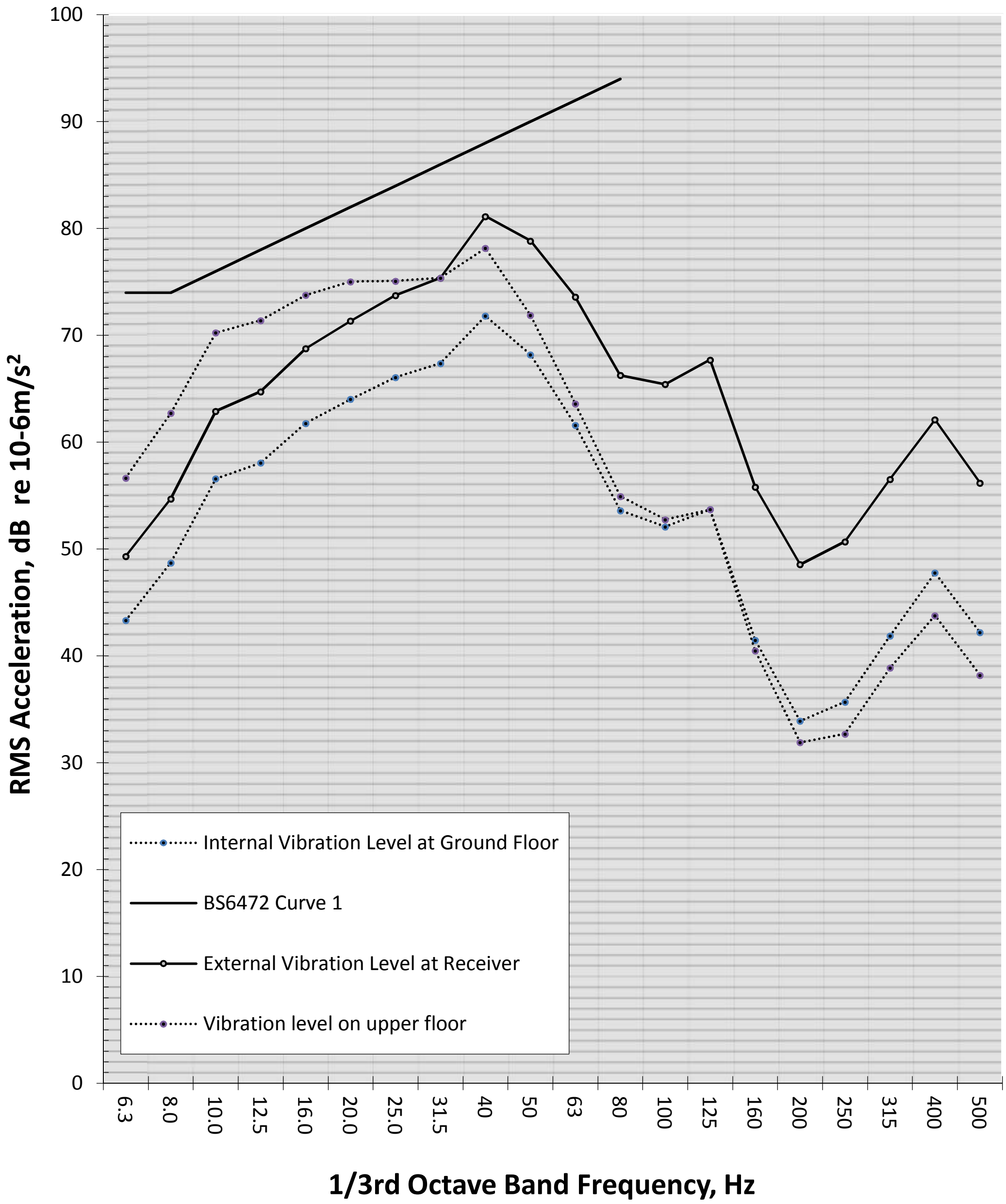


Figure 4 Measured and predicted RMS acceleration

9.1.3 Re-radiated noise

During the ground-borne noise measurements, approximately 26 individual train events were observed. The highest predicted L_{ASmax} level for all of these events was 31 dB

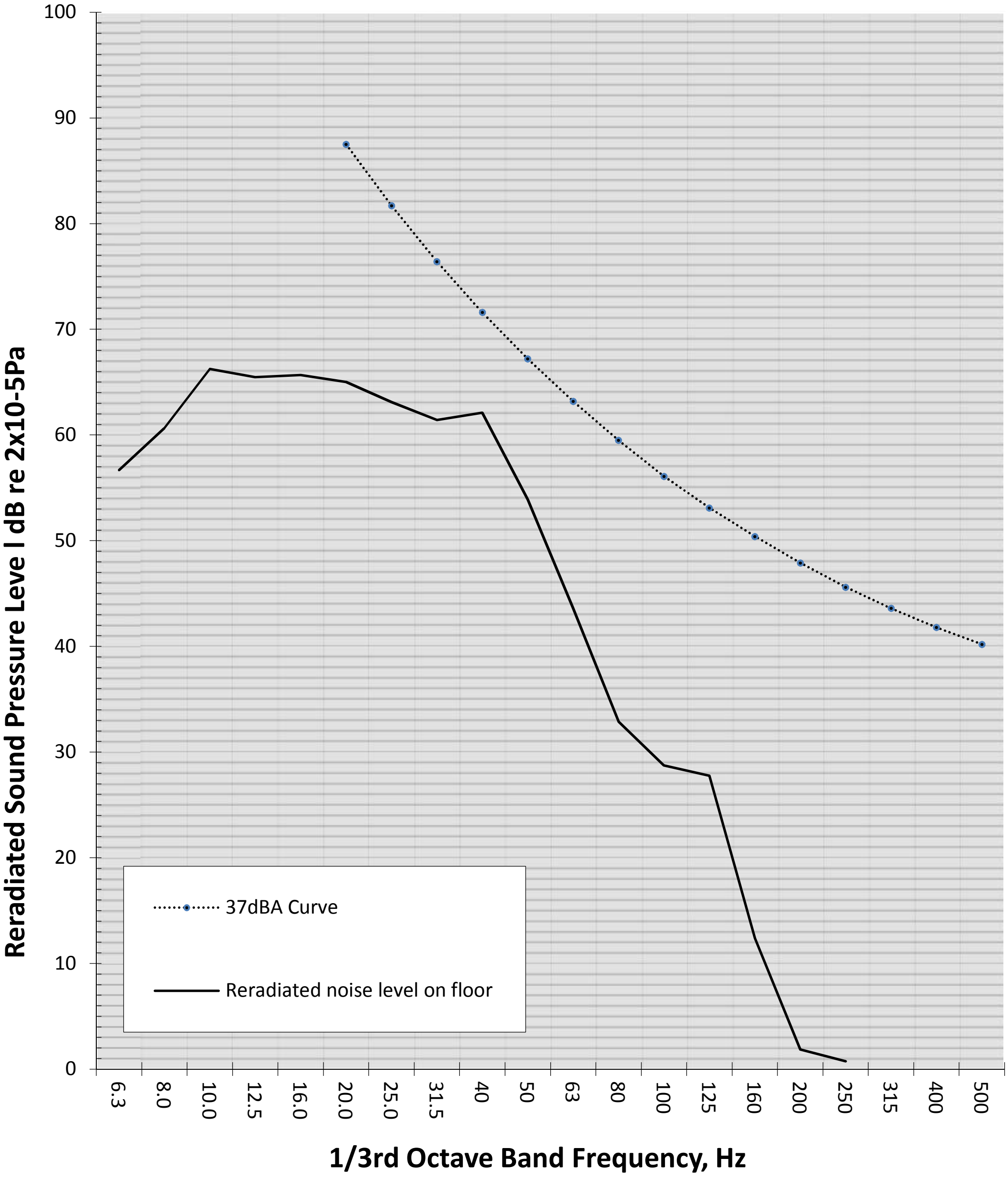


Figure 5 Predicted re-radiated sound pressure level

Of the train passes captured during the survey period, all of the measured levels were significantly lower than the criteria.

On this basis, ground-borne noise in the proposed residences is unlikely to result in adverse comment. As the predicted values are for worst case ground floor conditions, noise levels from this source are expected to be even lower at upper floor levels.

10 Conclusion

The minimum measured background noise levels were $L_{A90,5min}$ 47 dB during the day, and $L_{A90,5min}$ 46 dB during the night. On the basis of the guidance set out in BS4142 the relevant plant noise limits at the worst affected existing noise sensitive premises would be L_{Aeq} 37 dB during the day and L_{Aeq} 36 dB during the night. These limits are cumulative, and apply with all plant operating under normal conditions. If plant items contain tonal or attention catching features, the limits will be 5 dB more stringent than those set out above.

In order to achieve the relevant internal noise limits in bedrooms and living spaces, it will be necessary to use high performance acoustic double glazing in combination with high performance mechanical ventilation. It has been assumed that openable elements of the façade are not a core part of the ventilation strategy. On facades facing the rail lines out of St. Pancras, the sound reduction provided by winter gardens has been taken into account to determine the necessary performances.

Tactile vibration and structure borne noise are not considered to be an issue at this site.

Appendix A

Equipment calibration information

Table A1 Equipment calibration data

Equipment description	Type/serial number	Manufacturer	Calibration expiry	Calibration certification number
Sound level meter	SVAN957/12327	Svantek	23 Oct 15	1310490
Microphone	ACO7052H/43273	Svantek	23 Oct 15	1310490
Calibrator	SV30A/7451	Svantek	23 Oct 15	1310484
Sound level meter	SVAN957/12326	Svantek	15 Dec 15	1312599
Microphone	AC07052H/36733	Svantek	15 Dec 15	1312599
Calibrator	SV12L/13571	Svantek	15 Dec 15	1312592
Accelerometer	PV-87/33827	Rion	27 Aug 15	1309405SUP
Accelerometer	PV-87/33828	Rion	27 Aug 15	1309406SUP
Accelerometer	PV-87/33829	Rion	27 Aug 15	1309407SUP
Signal Recorder	DA-20/10870889	Rion	27 Aug 15	1308369
Vibration calibrator	AT01/3015	APT	27 Aug 15	TCRT13/1306

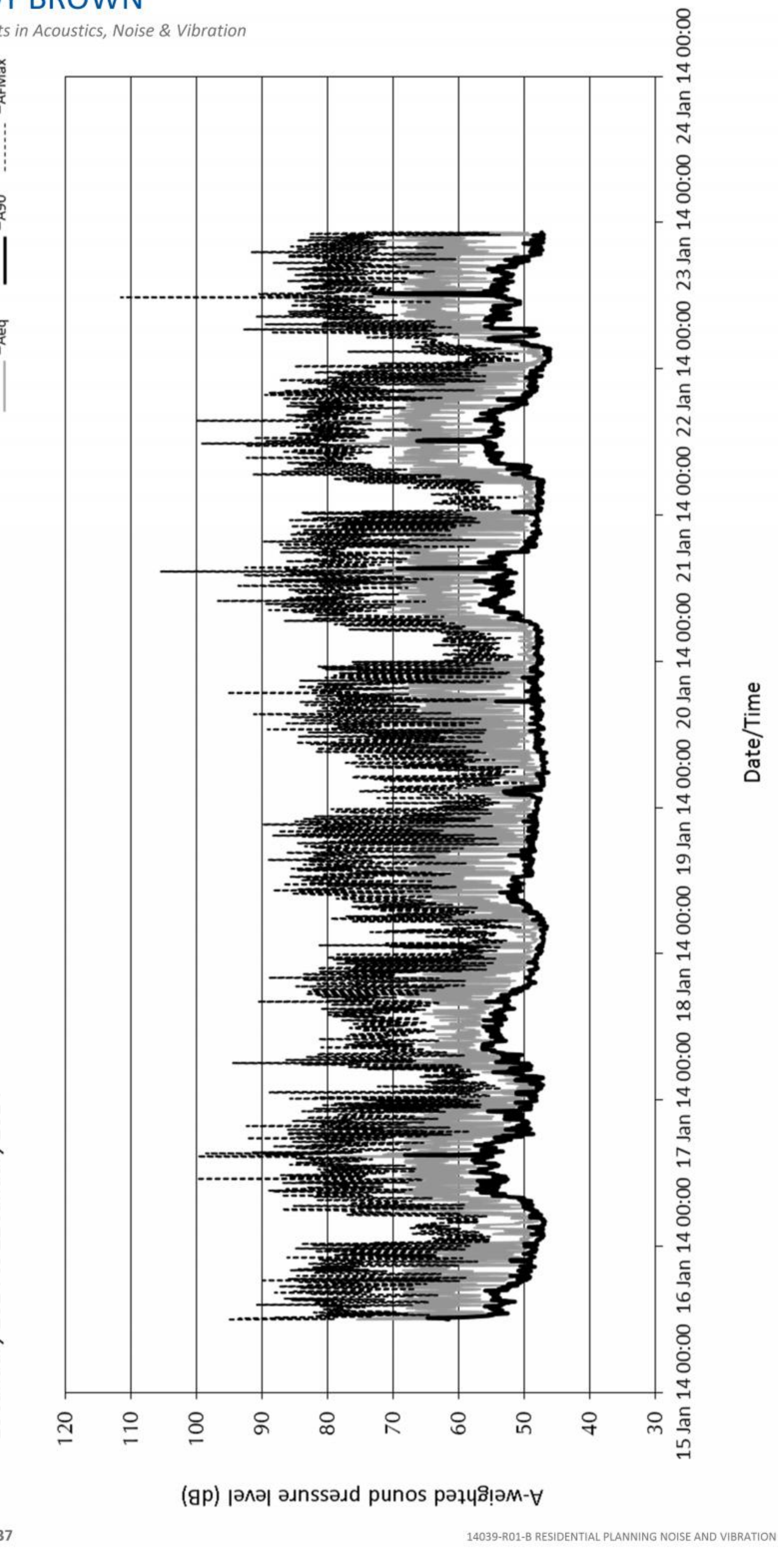
The calibration certificates for the sound level meters stated above are available upon request.

Calibration of the sound level meters used for the measurements is traceable to national standards. The sound level meters and the respective measurement chains were calibrated at the beginning and end of the measurements using their respective sound level calibrators. No significant calibration deviation occurred.

Appendix B

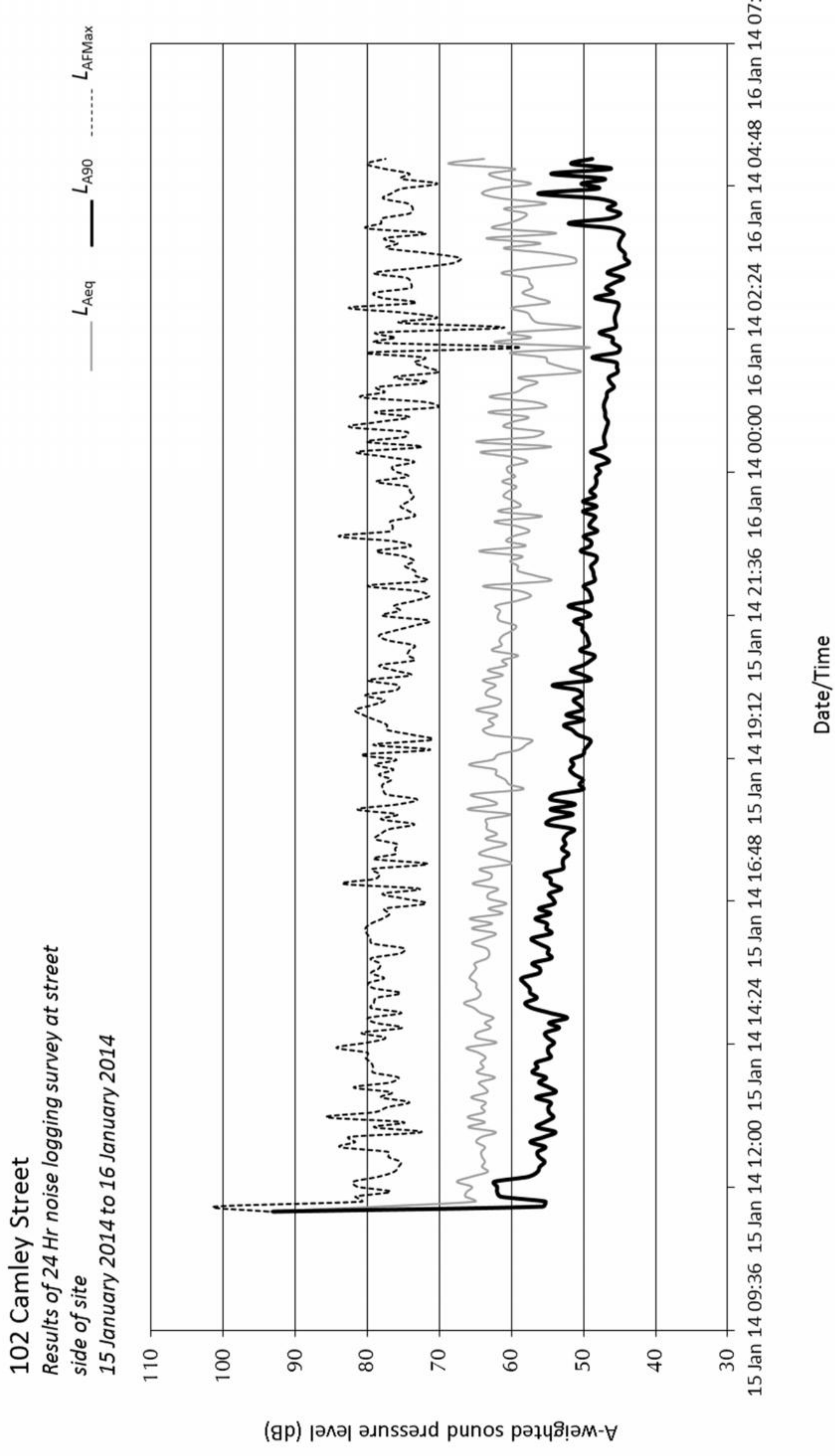
Results of unattended measurements at Location 'A'

102 Camley Street
Results of noise logging survey at 'B'
15 January 2014 to 22 January 2014



Appendix C

Results of unattended measurements at Location 'B'


102 Camley Street
Results of 24 Hr noise logging survey at street side of site
15 January 2014 to 16 January 2014
L_{Aeq}
L_{A90}
L_{AFMax}
A-weighted sound pressure level (dB)
110
100
90
80
70
60
50
40
30
15 Jan 14 09:36
15 Jan 14 12:00
15 Jan 14 14:24
15 Jan 14 16:48
15 Jan 14 19:12
15 Jan 14 21:36
16 Jan 14 00:00
16 Jan 14 02:24
16 Jan 14 04:48
16 Jan 14 07:12
Date/Time