SANDY BROWN

Consultants in Acoustics, Noise & Vibration

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West Central Street

Acoustic planning report

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A	23 May 13		Alex Fryer	Robin Hall
B	30 May 13	Plant noise assessment added	Robert Burrell	Richard Muir
C	03 Jun 13	Comments from design team	Robert Burrell	Richard Muir
D	09 Oct 13	Revised based on EHO comments	Alex Fryer	Stephen Stringer
E	11 Oct 13	Minor revision	Alex Fryer	Stephen Stringer

Summary

Sandy Brown Associates LLP (SBA) has been appointed to carry out an environmental noise and vibration survey at West Central Street, London.

The noise survey was performed between Thursday 14 March 2013 and Tuesday 19 March 2013.

The lowest background noise levels measured during the survey were $L_{A90,\ 5min}$ 49 dB during the daytime, $L_{A90,\ 5min}$ 50 dB during the evening and $L_{A90,5min}$ 45 dB at night. Based on the requirements of the London Borough of Camden (LBC) and on the results of the noise survey, all plant 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} 44 dB during the daytime, L_{Aeq} 45 dB during the evening and L_{Aeq} 40 dB during the night.

An assessment of the proposed plant items associated with the development has been carried out. The calculated noise levels at the existing noise sensitive receptors meet the LBC plant noise criteria. Noise egress from the plant proposed for the roof of 16A-18 West Central Street will need to be mitigated so that is in line with the LBC criteria outside the new residential premises proposed as part of the development.

An initial facade sound insulation assessment has been carried out for the residential units to determine the required acoustic performance of the facade, and provide guidance on the ventilation strategy.

Noise ingress to the development has been considered. The sound insulation requirements for the various residential facades range between R_w+C_{tr} 33 dB and R_w+C_{tr} 38 dB. The glazing requirements will generally be achievable using standard double glazed units. High performance acoustically attenuated passive ventilation will be acceptable on some facades, while others will require a whole house mechanical system in order to achieve the ventilation requirements.

A vibration survey was performed on Tuesday 19 March 2013 to establish the impact of vibration from the London Underground Central line that runs close to the site. Tactile vibration levels from underground trains meet the requirements of the LBC.

The re-radiated noise levels from underground trains are predicted to marginally exceed the requirements of LBC on the first Level of residential accommodation in 16A – 18 West Central Street, with noise levels on the upper levels predicted to satisfy the criteria.

Contents

1 Introduction

Sandy Brown Associates LLP (SBA) has been commissioned by City & General New Oxford Street LLP to undertake an environmental noise and vibration survey and assessment in relation to planning for the proposed development at West Central Street, London.

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

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 requirements of the London Borough of Camden (LBC).

Noise measurements of local road traffic and other environmental sources have been used to derive the facade sound insulation 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 conducted to determine whether the proposed development will be adversely affected by tactile vibration and re-radiated noise from underground train movements along the Central line to the north.

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

2 Site description

2.1 The site and its surroundings

The West Central Street development is an existing mixed use block comprising commercial premises, a former nightclub (at ground level) and residential accommodation. The site position is shown highlighted in red in Figure 1. The site is to be redeveloped, maintaining some elements of the existing buildings but demolishing and rebuilding other sections.

New Oxford Street, a busy thoroughfare is located to the north of the site. Museum Street bounds the site to the east. West Central Street, a very quiet road, forms the south and west boundaries.

The London Underground Central line is understood to run to the north of the site, running in both east and west directions underneath New Oxford Street.

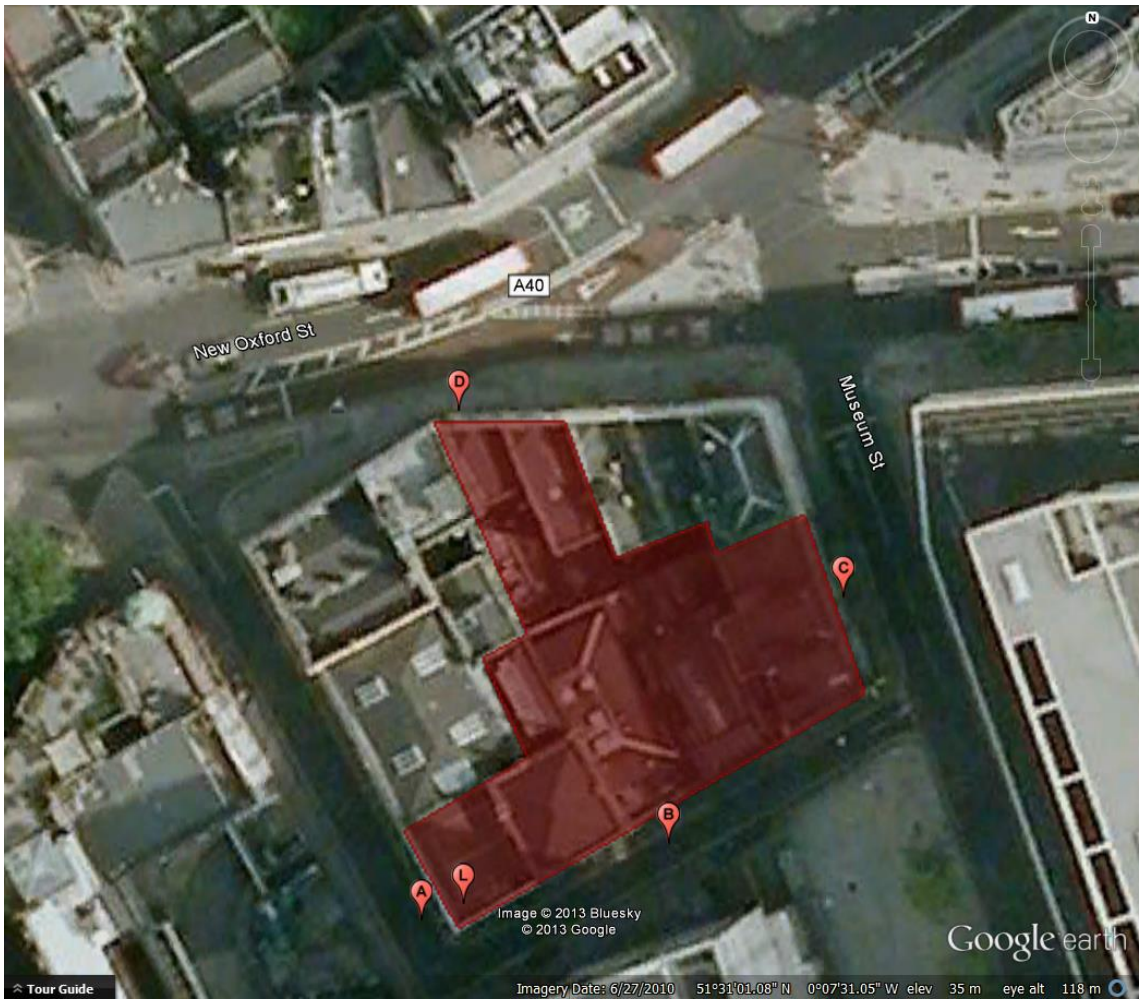


Figure 1 Site and noise measurement positions (source, Google Earth)

2.2 Adjacent premises

The nearest residential premises in relation to the site is a hotel tower (Travelodge) located to the south. Residential premises are also located on the upper floors of the building to the west of the site.

2.3 Development proposals

The south west corner of the site is 16A – 18 West Central Street which currently comprises a disused club at basement and ground levels, with residential accommodation above. The block is to be demolished and replaced with retail space at basement and ground level, office space at first floor level and residential at levels two to four.

The block to the south east of the site is 10 – 12 Museum Street which currently comprises commercial space at ground floor and bed-sits from level 1 and above. This block will be retained and refurbished to form retail at basement and ground level, with residential on levels one to three.

The existing building at 39/41 New Oxford Street will be redeveloped to form a new shop-front, the office accommodation above will remain and is not part of the development proposals.

The existing building at 35/37 New Oxford Street comprises retail at ground floor, with residential accommodation on Levels 1, 2 and 3. This block will remain largely unchanged with the exception of the residential units to the south on Levels 1 and 2 which will be converted into retail units.

3 Method

3.1 Unattended noise measurements

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

The unattended measurements were performed over five minute periods between 12:15 on Thursday 14 March 2013 and 10:45 on Tuesday 19 March 2013.

The unattended noise measurement position used during the survey is indicated in Figure 1, denoted by the letter 'L'. The microphone was positioned a height of 1.5 m above the roof and around 5 m above ground level. Background noise levels at this position were considered to be reasonably representative of the noise levels experienced by the closest noise sensitive properties.

3.2 Attended noise measurements

Attended sample measurements were performed at four locations around the site at ground level. The locations of the attended measurements are shown in Figure 1 as positions 1 to 4. The attended measurements were carried out on Tuesday 19 March 2013, over five minute periods to determine existing noise levels around the site from road traffic, pedestrians and other significant noise sources in the area.

In each case, the microphone was positioned approximately 1.5 m above ground level and 1 m from the facade. All noise levels measured at these positions are considered to be façade levels.

3.3 Vibration survey

Vibration measurements were performed to determine the maximum vibration levels from the passage of London Underground Central line trains which are understood to run to the north of the site. Measurements were also made in the absence of train movements to establish the level of background vibration at the site.

The vibration measurements were performed in the basement of 10-12 Museum Street, towards the south east of the site. Figure 2 shows a basement plan of the south east corner of the site with the measurement position indicated.

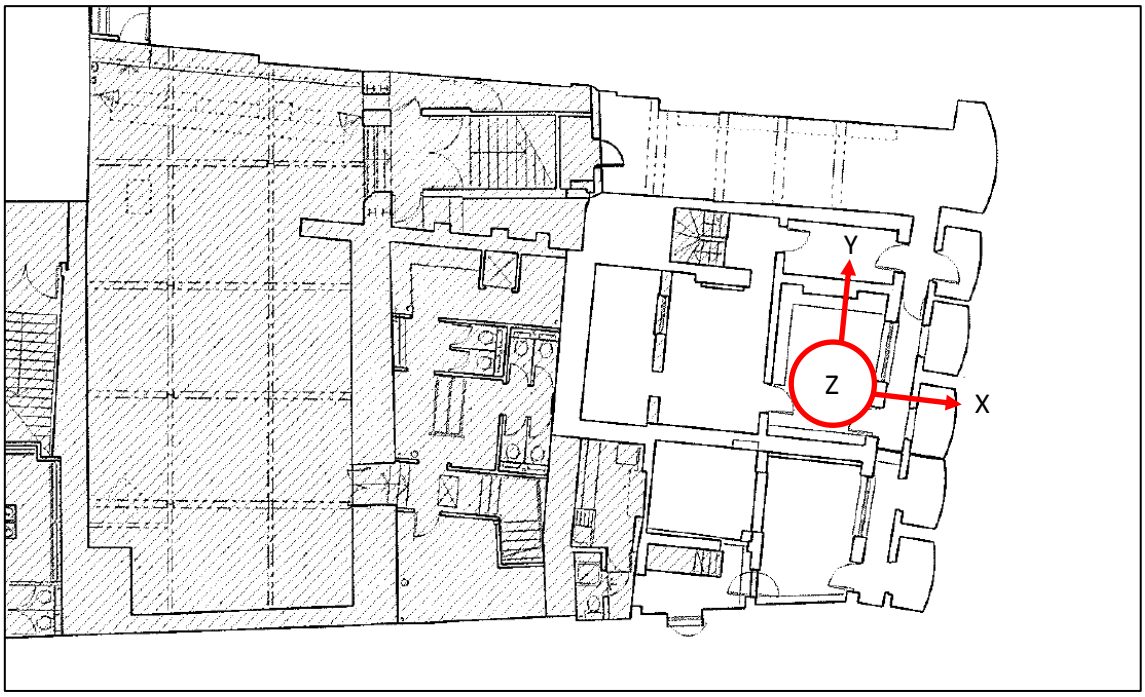


Figure 2 Vibration measurement positions

For the vibration measurements, two accelerometers were set up, one to measure vibration dose values (VDV) and one for one-third octave frequency band slow weighted RMS acceleration. The VDV measurements were taken to establish levels of tactile vibration while the one-third octave frequency band slow weighted RMS acceleration measurements were used to predict re-radiated L_{ASmax} noise.

The measurements were performed on Tuesday 19 March 2013.

The accelerometers were mounted using beeswax.

The VDV measurements were conducted in three perpendicular axes as follows:

- X axis and Y axis - Horizontal vibration approximately perpendicular to the structural geometry of that section of the building layout as shown in Figure 2;
- Z axis - Vertical vibration.

The RMS acceleration measurements were performed in the vertical axis only.

3.4 Equipment and procedure

The unattended noise measurements were performed using a Svantek type 948 sound level meter. The attended noise measurements were performed using a Brüel & Kjær type 2260 sound level meter.

A Brüel & Kjær Type 2260 Investigator with a Type 4370 accelerometer was used to perform the slow weighted RMS acceleration measurements and was calibrated using a type 4294 vibration exciter. A Svantek SVAN948 meter with a Dytran tri-axial accelerometer was used to perform VDV vibration measurements and was calibrated using a type AT01 vibration exciter.

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

Calibration details of the equipment used during the noise surveys are provided in Appendix A.

3.5 Noise indices

The equipment was set to record a continuous series of A-weighted broadband and linear weighted octave band sound pressure levels. Noise indices recorded included the following:

- $L_{Aeq,T}$ The A-weighted equivalent continuous sound pressure level over a period of time, T.
- $L_{Amax,T}$ 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.
- $L_{A90,T}$ 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.*

3.6 Vibration indices

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

- 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.

3.7 Weather conditions

During the attended noise measurements carried out on Tuesday 19 March 2013, the weather was generally dry with no rain. Wind speeds were typically less than 4 m/s.

During the unattended noise measurements between Thursday 14 March 2013 and Tuesday 19 March 2013, weather reports for the area indicated that temperatures varied between -2°C and 9°C. Rain fell on three of the days during this period.

These weather conditions are considered suitable for representative measurements.

4 Measurement results

4.1 Observations

The dominant noise source observed at the unattended noise monitoring position during the installation and removal of the noise monitoring equipment was road traffic on New Oxford Street. Less significant noise sources included road traffic on High Holborn and plant noise.

The dominant noise sources observed at the attended noise monitoring positions were road traffic noise on New Oxford Street, High Holborn and Museum Street. Less significant noise sources included mechanical services, pedestrian movements.

4.2 Unattended noise measurement results

The results of the unattended noise measurements performed at the site are summarised in Table 1 and Table 2. 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.

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

Table 1 Ambient noise levels measured during the survey

Date	Daytime (07:00-19:00) $L_{Aeq,\ 12\ hour}$ (dB)	Evening (19:00-23:00) $L_{Aeq,\ 4\ hour}$ (dB)	Night (23:00-07:00) $L_{Aeq,\ 8\ hour}$ (dB)
Thursday 14 March 2013	-	58	59
Friday 15 March 2013	61	59	61
Saturday 16 March 2013	59	59	58
Sunday 17 March 2013	58	59	57
Monday 18 March 2013	62	61	59

Table 2 Minimum background noise levels measured during the survey

Date	Daytime (07:00-19:00) $L_{A90,\ 5\ min}$ (dB)	Evening (19:00-23:00) $L_{A90,\ 5\ min}$ (dB)	Night (23:00-07:00) $L_{A90,\ 5\ min}$ (dB)
Thursday 14 March 2013	53 *	51	48
Friday 15 March 2013	54	53	50
Saturday 16 March 2013	52	52	47
Sunday 17 March 2013	49	50	45
Monday 18 March 2013	53	52	46
Tuesday 19 March 2013	53 *	-	-

The lowest background noise levels measured during the survey were $L_{A90,\ 5min}$ 49 dB during the daytime, $L_{A90,\ 5min}$ 50 dB during the evening and $L_{A90,5min}$ 45 dB at night.

4.3 Attended noise measurement results

Attended measurements were performed at a number of positions around the site on Tuesday 19 March 2013. The sound pressure levels recorded during these measurements are summarised in Table 3. The dominant noise sources noted during the measurements are also described.

Table 3 Sound pressure levels from attended measurements

Position	Start time	Sound pressure levels (dB)			Dominant noise source
		$L_{Aeq,5min}$	$L_{Amax,5min}$	$L_{A90,5min}$	
A	08:20	63	74	58	Road traffic on New Oxford Street
A	08:25	61	71	55	Road traffic on New Oxford Street
B	08:35	59	71	57	Road traffic on New Oxford Street
C	08:45	65	80	60	Road traffic on High Holborn
D	08:55	71	85	64	Road traffic on New Oxford Street
A	09:05	59	71	55	Road traffic on New Oxford Street
B	09:15	63	82	57	Road traffic on High Holborn
C	09:25	68	91	62	Road traffic on New Oxford Street
D	09:35	72	83	64	Road traffic on New Oxford Street

4.4 Tactile vibration measurements

The vibration dose values from underground train passes measured in the basement of 10-12 Museum Street are given in Table C1 in Appendix C.

4.5 Re-radiated noise measurements

Ground-borne noise levels within the basement of 10-12 Museum Street have been predicted based on the measured RMS acceleration levels from underground train passes and using the recommended 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.

These predicted re-radiated noise levels are presented in table C2 in Appendix C in terms of L_{ASmax}.

5 Assessment criteria

5.1 LBC local development framework

LBC's Development Policies 2010-2015 document, part of their Local Development Framework, contains planning criteria used to determine applications for planning in the borough.

DP28 of the above document considers noise and vibration. The various criteria from DP 28 are discussed in the relevant sections below.

5.2 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.

5.3 PPG 24

PPG 24 guidance recommends Noise Exposure Categories for assessing the suitability of sites for new residential developments in relation to various types of noise sources, including road and rail traffic, and mixed sources. These are designed to help local planning authorities in their consideration of applications for residential developments near transport related noise sources. PPG 24 has been superseded by the National Planning Policy Framework (NPPF), which provides general guidance stating that the impact of noise needs to be controlled.

However, in DP 28, LBC still require an acoustic report to be provided to ensure compliance with PPG 24. DP28 sets out LBC's interpretation of the PPG 24 standards (presented below) and these are to be used as the basis of the PPG 24 assessment.

Table 4 Interpretation of PPG 24 standards set out in DP 28 (sites adjoining roads)

	Noise level at 1 m external to a sensitive façade (dB)		
	Day (07:00 – 19:00)	Evening (19:00 to 23:00)	Night (23:00 to 07:00)
Noise level above which attenuation measures will be required	62	57	52
Noise level at which planning permission will not be granted	72	72	66*

*In addition to the night time criteria, individual noise events should not exceed L_{ASmax} 82 dB more than several times per hour.

5.4 External noise levels – noise egress

5.4.1 Standard guidance

Standard guidance for assessing 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 areas*.

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.

5.4.2 Local Authority requirements

According to DP28, plant noise limits should be set 5 dB below the existing background noise level, at the nearest noise sensitive premises, over the proposed hours of operation. If the noise contains attention catching features (it is tonal, or has distinct impulses) the noise limit should be set 10 dB below the existing background noise level.

5.4.3 Plant noise limits – noise egress

Based on the above criterion in 5.4.2 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 the noise levels in Table 6.

Table 5 Plant noise limits at the nearest noise sensitive premises

Time of day	Maximum sound pressure level L_{Aeq} outside noise sensitive premises (dB)
Daytime (07:00 - 19:00)	44
Evening (19:00 – 23:00)	45
Night-time (23:00 - 07:00)	40

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.

5.5 Internal noise levels – residential areas noise ingress

5.5.1 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 6.

Table 6 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.

5.5.2 Local Authority requirements

DP28 does not contain any specific criteria for noise levels within dwellings, however it is our experience on other projects in the borough is that internal noise levels meeting the BS8233 Good design range of L_{Aeq} 30 dB are likely to be required in all bedrooms and living rooms.

5.6 Internal noise levels – commercial areas noise ingress

5.6.1 BS 8233: 1999 Sound insulation and noise reduction for buildings – code of practice (BS8233)

For the proposed uses for the development, BS8233 cites the ambient noise levels detailed in Table 7 as appropriate.

Table 7 BS8233 ambient noise level criteria

Criterion	Typical situation	Design range ($L_{Aeq,T}$ dB)	
		Good	Reasonable
Reasonable speech or telephone communications	Department store	50	55
Reasonable acoustic privacy in shared spaces	open plan office	45	50
Reasonable conditions for study & work requiring concentration	cellular office	40	50

5.6.2 Recommended internal noise levels

Further to the information in the table above, the following criteria are deemed to be appropriate for the development with regards to acceptable levels of environmental noise ingress.

- Retail units L_{Aeq} 45-50 dB
- Office L_{Aeq} 40 dB

5.7 Tactile vibration criteria

5.7.1 Standard guidance

Tactile vibration is perceived as mechanical motion. BS6472-1: 2008 *Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration Sources Other Than Blasting* provides procedures for assessing the potential human response to vibration.

Vibration is assessed in terms of the equivalent 'vibration dose value' (VDV) which takes into account the level and duration of vibration.

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

Table 8 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 that offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 hour 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.

5.7.2 Local Authority requirements

DP28 sets out LBC's criteria with regarding to vibration levels in dwellings and offices.

DP 28 advises that vibration levels within residential accommodation should not exceed 0.2 to 0.4 VDV $m/s^{1.75}$ during the daytime and 0.13 VDV $m/s^{1.75}$ during the night time.

Permissible vibration levels for offices and workshops are also given which are in line with the guidance set out in BS 6472-1: 2008.

5.8 Re-radiated noise criteria

5.8.1 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 discusses 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, requires a slow time weighting.

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

5.8.2 Local Authority requirements

DP 28 advises that where dwellings may be affected by ground-borne regenerated noise (eg railways or underground trains within tunnels), noise levels within the rooms should not be greater than 35 dB(A)max. No time weighting is indicated.

6 Plant noise assessment – heat rejection plant

6.1 Proposed plant

It is proposed that a total of five new plant items of heat rejection plant are to be installed on the rooftops of the proposed development. Three Daikin ERLQ008BBV3 units are to be installed on the rooftop of 10-12 Museum Street. One Daikin EMRQ16A unit and one Daikin REYQ8P9 unit are to be installed on the rooftop of 16A-18 West Central Street. The proposed plant units associated with 16A-18 West Central Street are to be located in a plant well that provides screening in all directions. The proposed locations of the units and the location of the worst affected windows are shown in Figure 3.

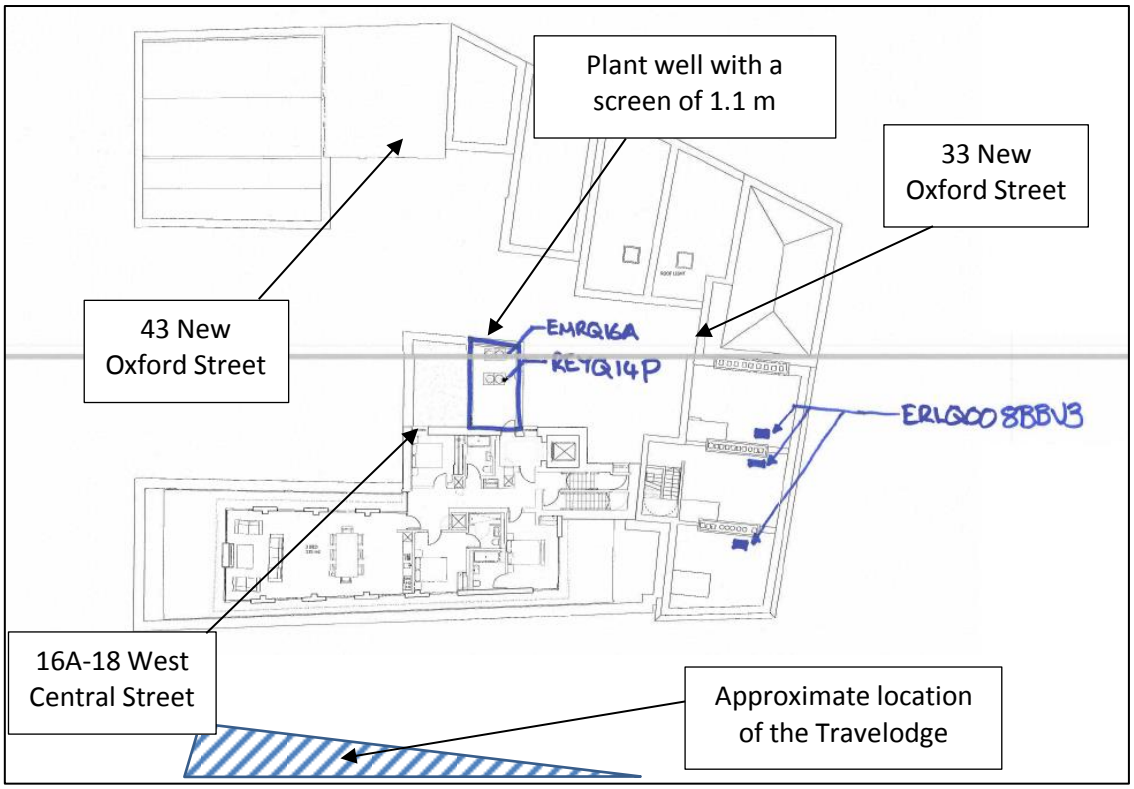


Figure 3 Plan showing the proposed plant and locations of the worst affected receptors

The manufacturer's sound pressure level data for the plant items are given in Table 9.

Table 9 Manufacturer's sound pressure level data 1 m horizontally from the unit and 1.5 m above ground level

Condenser model	Octave band pressure level (dB)								(A)
	63	125	250	500	1k	2k	4k	8k	
Daikin EMRQ16A	67	64	63	60	59	54	46	43	63
Daikin REYQ14P	66	64	63	59	56	53	46	43	62
Daikin ERQ008BBV3	46	49	49	48	46	39	34	27	50

It is assumed that the proposed units may operate at any time during the day or night, seven days a week.

6.2 Calculation to existing noise sensitive receptors

Calculations have been undertaken to establish the level of noise egress for the worst affected windows of 43 New Oxford Street, 33 New Oxford Street and the Travelodge Hotel as shown in Figure 3 which are existing noise sensitive premises. There are other noise sensitive receptors in the area; however, the noise levels at these receptors will be lower than those at 43 New Oxford Street, 33 New Oxford Street and the Travelodge Hotel.

The calculations take into account distance attenuation, reflections, barrier attenuation (where the direct line of sight between the proposed plants to the receiver is obscured), and a facade correction. It is assumed that the plant will run continuously.

The three plant items on 10-12 Museum Street are assumed to be located at a distance of 30 m from the worst affect window of 43 New Oxford Street, 5 - 11 m from the worst affected window at 33 New Oxford Street and 30 m from the worst affect window of the Travelodge. It is assumed there is no visual obstruction between these plant items and the receptors at 43 New Oxford Street and the Travelodge, but that the nearest window of 33 New Oxford Street is visually screened from these sources.

The two plant items on 16A-18 West Central Street are assumed to be located at a distance of 15 m from the worst affected window of 43 New Oxford Street, 15 m from the worst affected window of 33 New Oxford Street, and 28 m from the worst affected window of the Travelodge. It is assumed there is visual obstruction between these plant items and 43 New Oxford Street and 33 New Oxford Street but no visual obstruction between these plant items and the worst affected window of the Travelodge.

The calculated A-weighted noise level at the worst affected windows of 43 New Oxford Street, 33 New Oxford Street and the Travelodge, with all plant running is 34 dB, 34 dB and 40 dB respectively. At all three locations the noise from all plant running meets the LBC's plant noise criteria for day, evening and night time periods. The calculations used are given in Appendix D.

6.3 Calculation to proposed noise sensitive receptors

6.3.1 General

Noise egress from the new plant outside the noise sensitive premises that will be formed as part of the development proposals has also been assessed, the calculations are given in Appendix D.

6.3.2 16A-18 West Central Street roof plant

The two plant items on 16A-18 West Central Street roof are located around 5 m from the closest noise sensitive window on the north elevation of 16A-18 West Central Street. It is assumed there is no visual obstruction between the plant and the receptor point.

The calculated A-weighted noise level at the closest window to the plant on the north elevation with all plant running is 56 dB thus exceeding the LBC's noise criteria.

In order to comply with the requirements of the Local Authority, noise egress from plant in this area will need to be reduced by 16 dB. It is proposed to put these two items of plant in acoustic enclosures to reduce noise egress from these units. The datasheet for the proposed acoustic enclosure is presented in Appendix E.

With the 16A-18 West Central Street plant house in acoustic enclosures, the calculated A-weighted noise level at the closest window to the plant on the north elevation with all plant running is 27 dB thus meeting the LBC's criteria. The noise levels at the existing noise sensitive premises (see Section 6.2) would also be lower although it should be noted that they are already compliant with the Local Authority criteria without attenuation.

6.3.3 10 – 12 Museum Street roof plant

The three plant items on 10-12 Museum Street are located around 10 – 15 m from the closest noise sensitive window of 16A-18 West Central Street (east elevation). It is assumed there is no visual obstruction between these plant items and the receptor. The calculated A-weighted noise level at the closest window to the plant on the east elevation with all plant running is 36 dB, thus achieving the LBC's noise criteria.

7 Plant noise assessment - substation

A new substation is proposed as part of the development, located at ground floor level to the south of the site facing onto Museum Street. The substation is directly above non-sensitive retail space, horizontally adjacent to non-sensitive retail/back of house areas and below proposed new office space.

As part of the installation the transformers and connecting services will be appropriately vibration isolated from the surrounding structure thus mitigating any structure borne noise/vibration issues.

Appropriate attenuation measures will be incorporated as the design develops such that any residual noise breakout is compliant with the LBC planning requirements.

8 PPG 24 assessment

This section discusses the noise levels at the site in line with the LBC's interpretation of the PPG 24 assessment criteria as set out in DP 28.

The noise levels presented in Table 1 are the free field noise levels measured during the unattended noise logging survey. The noise measurements were conducted in the south west corner of the site where residential accommodation is proposed to be located. The arithmetic average of the noise levels measured during the day, evening and night are summarised below:

- Average daytime noise level - L_{Aeq} 60 dB
- Average evening noise level - L_{Aeq} 59 dB
- Average night time noise level - L_{Aeq} 59 dB

The assessment criteria set out in DP 28 refers to a noise level at 1 m external to a noise sensitive facade. As such a correction (+3dB) has been applied to these levels to derive a façade noise level. These façade noise levels are summarised below:

- Average daytime noise level - L_{Aeq} 63 dB
- Average evening noise level - L_{Aeq} 62 dB
- Average night time noise level - L_{Aeq} 62 dB

Comparing the noise levels above to the criteria set out in Table 4, external noise levels at the site are below the level at which planning permission should not be granted, although attenuation measures will need to be provided as part of the design.

9 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 BS 8233 "good" internal noise criteria given in section 5.5.1 for residential bedrooms and other residential living areas.

There are no planning requirements for the internal noise levels in the retail and entrance lobbies. The sound insulation requirements of these spaces will depend on their intended use.

9.1 External noise levels

The noise levels provided in Table 1 and Table 3 have been used to assess noise ingress. On this basis, the predicted external façade noise levels at the various elevations of the proposed development are shown in Figure 4 and Figure 5.

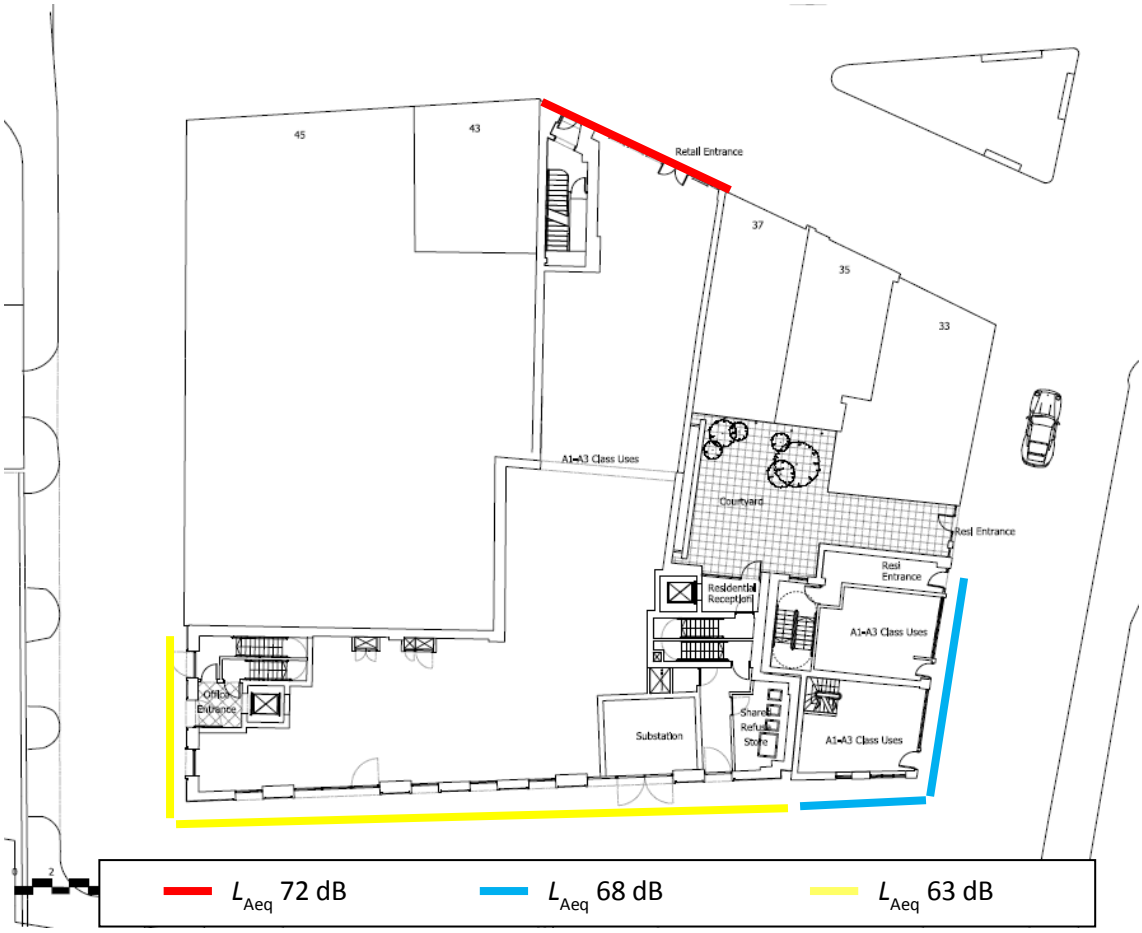


Figure 4 External noise levels – Ground floor level

Figure 5 External noise levels – upper levels

9.2 Facade sound insulation

To achieve the internal noise criteria given in section 5.5 and 5.6 minimum facade sound insulation requirements have been determined, based on the external noise levels at each facade stated in section 9.1.

9.2.1 Red façade

Noise levels on the red façade are predicted to be around L_{Aeq} 72 dB. This noise level occurs only on the New Oxford Street ground floor retail unit. The minimum facade sound insulation requirement of this facade is R_w+C_{tr} 27 dB.

9.2.2 Blue facades

Noise levels on the blue facades are predicted to be around L_{Aeq} 68 dB. This noise level occurs on the block to the south east corner of the site that is to be refurbished (10-12 Museum Street).

The minimum facade sound insulation of any retail units on the blue elevations is $R_W + C_{tr}$ 23 dB.

The minimum facade sound insulation of any residential units on the blue elevations is $R_W + C_{tr}$ 38 dB.

9.2.3 Yellow facades

Noise levels on the yellow facades (solid and dotted) are predicted to be around L_{Aeq} 63 dB. This noise level occurs on new build section of the development (16A – 18 West Central Street).

The minimum facade sound insulation requirement for retail units on the yellow elevations is $R_W + C_{tr}$ 18 dB.

The minimum facade sound insulation requirement for office units on the yellow elevations is $R_W + C_{tr}$ 23 dB.

There are two facade performance requirements for the residential units on the yellow elevations. For the majority of the facades, those indicated with a solid yellow line on in Figure 4 and Figure 5, a minimum façade sound insulation performance of $R_W + C_{tr}$ 33 dB is required. On the west elevation, denoted with a dashed yellow line, an enhanced sound insulation performance is required to provide protection against L_{AFmax} noise levels. The minimum sound insulation performance on the yellow dashed facade is $R_W + C_{tr}$ 36 dB.

9.3 Guidance on facade construction, glazing, and ventilation strategy

Table 10 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
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)

It is generally accepted that the 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, only where the required facade sound insulation performance is less than R_w+C_{tr} 10 dB can opening windows be used whilst achieving the necessary internal noise levels. Due to the external noise levels on this site, a means of ventilation other than openable windows needs to be considered.

The performance required by each element will depend on the construction of the solid elements, the glazing specification, the relative areas of the solid and glazed elements, and the ventilation strategy (including the acoustic performance of the trickle ventilators and the number of ventilators required to serve individual rooms, if applicable). As the design progresses, a more detailed facade sound insulation assessment will need to be performed, taking into account the factors listed above, to ensure that the internal ambient noise levels are met.

The block to the south east corner of the site that is to be refurbished (10-12 Museum Street) has sliding sash windows. If sliding sash windows are to be retained due to heritage requirements, then it should be noted that it is likely that even with a high performance sliding sash window, an additional secondary glazed pane will be required in order to achieve the sound minimum sound insulation requirement of R_W +C_{tr} 38 dB on the blue facades.

10 Vibration assessment

10.1 General

Vibration measurements were carried out to assess how levels of vibration and re-radiated noise at the site due to the nearby London Underground Central line affect the proposed development.

The Central line is understood to run to the north of the site (see Figure 6). The measurements and predictions set out in sections 10.2 and 10.3 are based on measurements conducted in the basement of 10-12 Museum Street. Levels of vibration are likely to be higher to the north of the site, ie at 35/37 New Oxford Street (however only minimal redevelopment is proposed to this part of the site, see section 2.3).

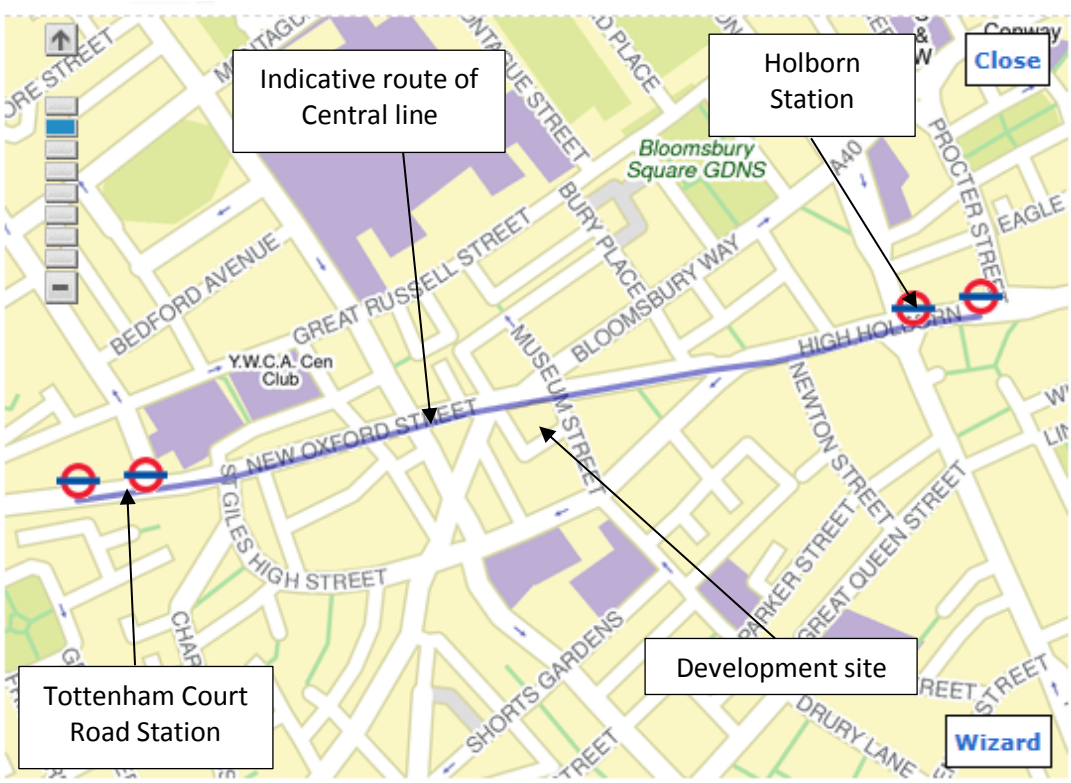


Figure 6 Indicative route of London Underground Central line (source: TFL)

10.2 Tactile vibration

BS6472 states that the assessment should be based on the axis along which the highest vibration dose value (VDV) is measured.

It is understood that approximately 60 London Underground Central line trains per hour pass by the site during the day (30 in an easterly direction, 30 in a westerly direction). This will result in approximately 960 trains passing 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 240 trains.

Based on the maximum vibration value from Table C1 and on the predicted 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 Table 11.

Table 11 Equivalent vibration dose values

Maximum VDV measured ($m/s^{1.75}$)	Equivalent VDV ($m/s^{1.75}$)	
	Daytime (07:00 – 23:00)	Night time (23:00 – 07:00)
0.0061	0.034	0.024

By comparing the calculated day and night time vibration dose values in Table 11 with the guidance in section 5.7 of this report, it can be seen that the predicted vibration dose values during the daytime and night time periods are lower than the threshold of the 'low probability of adverse comment' category.

The above predictions represent the expected VDV levels at basement level, with lower values being expected further up the building. As such tactile vibration due to trains is therefore not considered to be problematic at this site.

10.3 Re-radiated noise

10.3.1 10 – 12 Museum Street

Ground-borne noise levels within the basement of 10-12 Museum Street have been predicted using the measured RMS acceleration levels and the recommended 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.

These predicted re-radiated noise levels in the basement are presented in Table C2 in Appendix C in terms of L_{ASmax}. The arithmetic average of all the predicted re-radiated noise levels for train events is L_{ASmax} 42 dB, with individual events reaching up to L_{ASmax} 45 dB.

Losses via the building structure will result in lower levels of re-radiated noise on the upper floors. Corrections as set-out in the *'Transportation noise reference book' by Paul Nelson* have been used to establish the predicted radiated noise level on Level 1 of the building which is the first residential floor. It is predicted the average re-radiated noise level from underground train movements will be L_{ASmax} 36 dB, with some events reaching up to L_{ASmax} 39 dB.

The levels of re-radiated noise within the residential accommodation of 10-12 Museum Street are predicted to be above LBC's criteria of L_{ASmax} 35 dB.

One method of reducing re-radiated noise is to structurally isolate the building at basement/ground floor level by means of elastomeric pads or metal springs in such a way that the sensitive areas of the building are fully de-coupled from the vibration in the ground. This part of the development site at 10-12 Museum Street is an existing residential building that is to be refurbished and it is impractical to isolate the building from vibration in this way.

The alternative would be to de-couple habitable areas of the building from the structure itself. This would involve creating an isolated 'box in box' construction for each noise sensitive space, comprising walls that are independent from the structure, a resiliently mounted ceiling and a resilient mounted floor (ie on elastomers/springs).

Providing an isolated box in box construction for each habitable area would require considerable space and therefore significantly reduce floor to ceiling heights and overall net internal floor area. It is therefore considered to be impractical to adopt such an approach for the part of the development site at 10-12 Museum Street.

Consequently, it would be necessary to accept a relaxation in the LBC criteria for structure-borne noise from underground trains within such spaces.

10.3.2 16A – 18 West Central Street

The ground-borne noise levels predicted for the basement of 10-12 Museum Street have been used as the basis of predicting noise levels on the residential floors of 16A – 18 West Central Street.

The predicted re-radiated noise levels in the basement of 10-12 Museum Street are presented in table D2 in Appendix D in terms of L_{ASmax}. The arithmetic average of all the predicted re-radiated noise levels for train events is L_{ASmax} 42 dB, with individual events reaching up to L_{ASmax} 45 dB.

Losses via the building structure will result in lower levels of re-radiated noise on the upper floors. Corrections as set-out in the *'Transportation noise reference book' by Paul Nelson* have been used to establish the predicted radiated noise level on Level 2 of the building which is the first residential floor. It is predicted the average re-radiated noise level from underground train movements will be L_{ASmax} 33 dB, with some events reaching up to L_{ASmax} 36 dB. Noise levels on Level 3 and above are predicted meet the criteria in DP 28. It should be noted that these predictions do not take into account potential losses through the building foundations which may result in lower levels of re-radiated noise than predicted here.

The calculated levels of re-radiated noise within the residential accommodation of 16A – 18 West Central Street are on the threshold of LBC's criteria of L_{ASmax} 35 dB. On this basis, it is considered that isolation of the building structure from groundborne vibration is not essential to the creation of an acceptable residential environment.

Appendix A

Equipment calibration information

The calibration data for the equipment used during the survey is provided below.

Table A1 Equipment calibration data

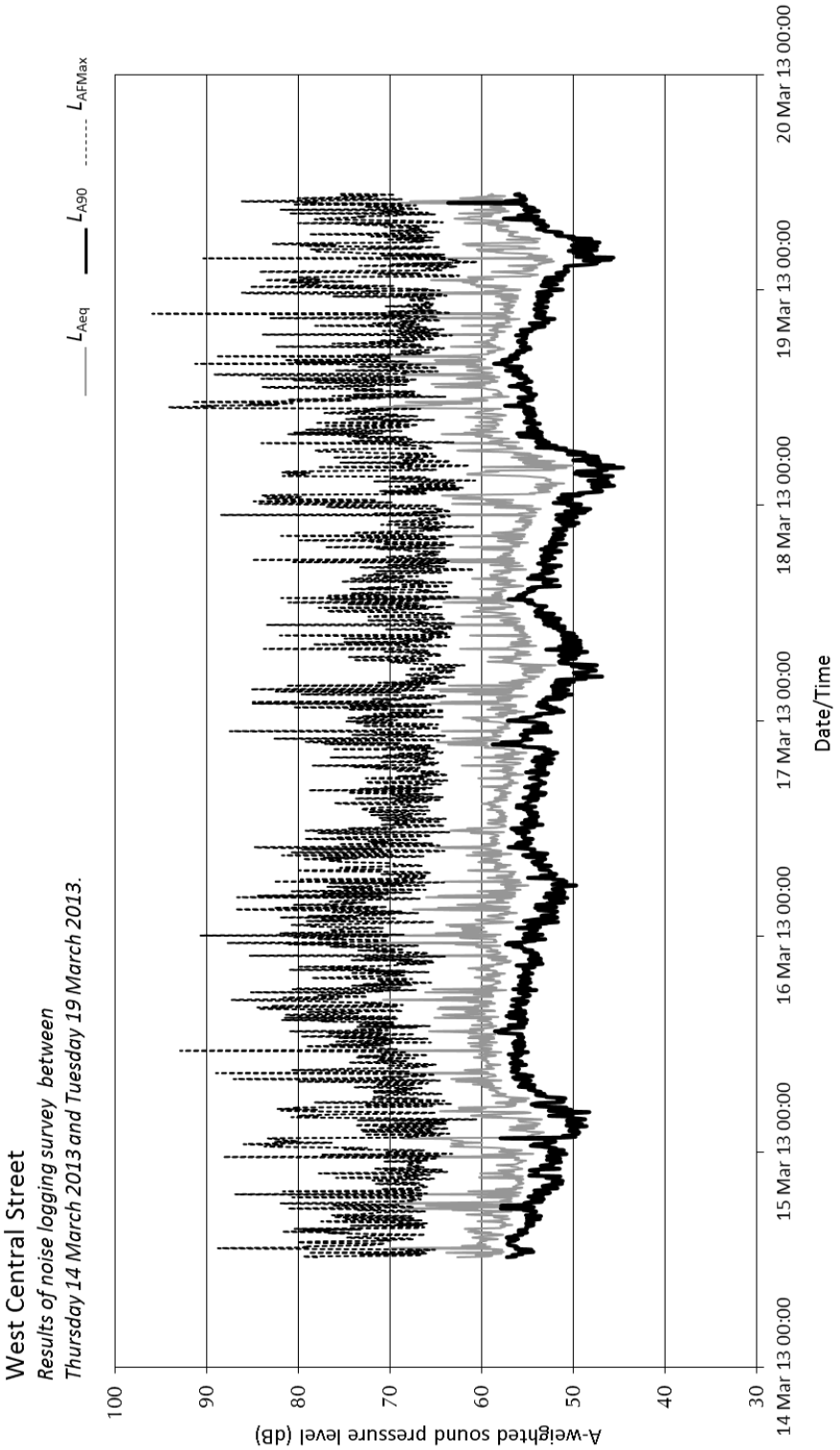
Equipment description	Type/serial number	Manufacturer	Calibration expiry	Calibration certification number
Sound level meter	2260 / 2553982	Bruel & Kjaer	22/11/14	06848
Microphone	4189 / 2556112	Bruel & Kjaer	22/11/14	06848
Pre-amplifier	ZC0026 / 4584	Bruel & Kjaer	22/11/14	06848
Calibrator	4231 / 2558390	Bruel & Kjaer	16/11/14	06845
Vibration meter	948 / 9363	Svantek	02/10/2014	1210417
Accelerometer	3233A / 188	Dytran	22/08/2014	1208354/5/6
Vibration calibrator	AT01 / 6049	Svantek	23/08/2014	1208361
Sound level meter	948 / 9363	Svantek	02/10/2014	1210417
Microphone	4189 / 1940030	Bruel & Kjaer	02/10/2014	1210417
Pre-amplifier	SV121 / 10669	Svantek	02/10/2014	1210417
Calibrator	SV30A / 10558	Svantek	02/10/2014	1210416
Sound level meter	2260 / 2553982	Bruel & Kjaer	22/11/14	06848
Pre-amplifier	4189 / 2556112	Bruel & Kjaer	22/11/14	06845
Accelerometer	4370 / 2107103	Bruel & Kjaer	09/08/2014	2602875
Vibration calibrator	4294 /	Bruel & Kjaer	09/08/2014	1208336

The calibration certificates for the equipment stated above are available upon request.

Calibration of the sound level meters and vibration level meters used for the measurements is traceable to national standards. All 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


West Central Street
Results of noise logging survey between
Thursday 14 March 2013 and Tuesday 19 March 2013.
L_{Aeq}
L_{A90}
L_{AFMax}
A-weighted sound pressure level (dB)
100
90
80
70
60
50
40
30
14 Mar 13 00:00
15 Mar 13 00:00
16 Mar 13 00:00
17 Mar 13 00:00
18 Mar 13 00:00
19 Mar 13 00:00
20 Mar 13 00:00
Date/Time

Appendix C

Vibration measurement results

Table C1 Vibration dose values measured

Start time (hh:mm)	Duration (mm:ss)	Measurement description	Measured VDV values in each axis ($m/s^{1.75}$)		
			X	Y	Z
11:57	00:23	Train	0.00190	0.00076	0.00593
11:59	00:19	Train	0.00132	0.00079	0.00556
12:02	00:32	Train	0.00166	0.00070	0.00610
12:05	00:50	Multiple trains	0.00153	0.00074	0.00593
12:08	00:27	Train	0.00106	0.00060	0.00244
12:09	00:22	Train	0.00099	0.00053	0.00564
12:10	00:23	Background	0.00138	0.00066	0.00110
12:12	00:28	Train	0.00129	0.00068	0.00592
12:15	00:38	Multiple trains	0.00121	0.00074	0.00565
12:18	00:23	Background	0.00126	0.00055	0.00179
12:19	00:19	Train	0.00098	0.00057	0.00599
12:23	00:24	Train	0.00133	0.00067	0.00558
12:24	00:21	Train	0.00091	0.00061	0.00579
12:25	00:21	Train	0.00083	0.00058	0.00225
12:27	00:20	Train	0.00098	0.00054	0.00576
12:29	00:21	Background	0.00117	0.00064	0.00109
12:30	00:22	Train	0.00120	0.00059	0.00269

Table C3 Predicted re-radiated noise levels in basement of 10-12 Museum Street

Start time (hh:mm)	Duration (mm:ss)	Measurement description	Predicted re-radiated noise level L_{ASmax} (dB)
11:57	00:23	Train	44
11:59	00:19	Train	45
12:02	00:32	Train	45
12:05	00:50	Multiple trains	44
12:07	00:27	Train	32
12:09	00:22	Train	44
12:10	00:23	Background	19
12:12	00:28	Train	45
12:14	00:38	Multiple trains	45
12:18	00:23	Background	18
12:18	00:19	Train	45
12:22	00:24	Train	45
12:24	00:21	Train	45
12:25	00:21	Train	33
12:26	00:20	Train	45
12:28	00:21	Background	20
12:29	00:22	Train	32

Appendix D

Plant noise calculations

Calculation of plant to exisitng noise sensitve receptors (section 6.2)

Comments	Octave band centre frequency (Hz)								Rating 1		Rating 2	
	63	125	250	500	1k	2k	4k	8k				
Daytime plant noise criteria									L_A=	44		
Evening plant noise cirteria									L_A=	45		
Night time plant noise criteria									L_A=	40		
Calculation of all plant to 43 New Oxford Street												
EMRQ16A												
Sound pressure level at 1m	67	64	63	60	59	54	46	43	L_A=	63		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (15m)	-24	-24	-24	-24	-24	-24	-24	-24				
Barrier Attenuation	-7	-8	-10	-12	-15	-18	-21	-24				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	39	35	32	27	23	15	4	-2	L_A=	30		
REYQ14P												
Sound pressure level at 1m	66	64	63	59	56	53	46	43	L_A=	62		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (15m)	-24	-24	-24	-24	-24	-24	-24	-24				
Barrier Attenuation	-7	-8	-10	-12	-15	-18	-21	-24				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	38	35	32	26	20	14	4	-2	L_A=	29		
ERQ008BBV3												
Sound pressure level at 1m	46	49	49	48	46	39	34	27	L_A=	50		
Correction for 3 items of plant	5	5	5	5	5	5	5	5				
Distance attenuation (30m)	-30	-30	-30	-30	-30	-30	-30	-30				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	24	27	27	26	24	17	12	5	L_A=	28		
Sound pressure levels from each plant item												
Plant item 1	39	35	32	27	23	15	4	-2	L_A=	30		
Plant item 2	38	35	32	26	20	14	4	-2	L_A=	29		
Plant item 3	24	27	27	26	24	17	12	5	L_A=	28		
Total	42	39	36	32	28	21	13	7	L_A=	34		

Comments	Octave band centre frequency (Hz)								Rating 1		Rating 2	
	63	125	250	500	1k	2k	4k	8k				
Daytime plant noise criteria									L_A=	44		
Evening plant noise cirteria									L_A=	45		
Night time plant noise criteria									L_A=	40		
Calculation of all plant to wost affected window 33 New Oxford Street												
EMRQ16A												
Sound pressure level at 1m	67	64	63	60	59	54	46	43	L_A=	63		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (15m)	-24	-24	-24	-24	-24	-24	-24	-24				
Barrier Attenuation	-7	-8	-10	-12	-15	-18	-21	-24				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	39	35	32	27	23	15	4	-2	L_A=	30		
REYQ14P												
Sound pressure level at 1m	66	64	63	59	56	53	46	43	L_A=	62		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (15m)	-24	-24	-24	-24	-24	-24	-24	-24				
Barrier Attenuation	-7	-8	-10	-12	-15	-18	-21	-24				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	38	35	32	26	20	14	4	-2	L_A=	29		
ERQ008BBV3												
Sound pressure level at 1m	46	49	49	48	46	39	34	27	L_A=	50		
Correction for 3 items of plant	5	5	5	5	5	5	5	5				
Distance attenuation (5m)	-14	-14	-14	-14	-14	-14	-14	-14				
Barrier Attenuation	-7	-8	-10	-12	-15	-18	-21	-24				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	33	35	33	30	25	15	7	-3	L_A=	31		
Sound pressure levels from each plant item												
Plant item 1	39	35	32	27	23	15	4	-2	L_A=	30		
Plant item 2	38	35	32	26	20	14	4	-2	L_A=	29		
Plant item 3	33	35	33	30	25	15	7	-3	L_A=	31		
Total	43	40	37	33	28	20	10	3	L_A=	34		

Comments	Octave band centre frequency (Hz)								Rating 1		Rating 2	
	63	125	250	500	1k	2k	4k	8k				
Daytime plant noise criteria									L_A=	44		
Evening plant noise cirteria									L_A=	45		
Night time plant noise criteria									L_A=	40		
Calculation of all plant to wost affected window of the Traveloge												
EMRQ16A												
Sound pressure level at 1m	67	64	63	60	59	54	46	43	L_A=	63		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (28m)	-29	-29	-29	-29	-29	-29	-29	-29				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	41	38	37	34	33	28	20	17	L_A=	37		
REYQ14P												
Sound pressure level at 1m	66	64	63	59	56	53	46	43	L_A=	62		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (28m)	-29	-29	-29	-29	-29	-29	-29	-29				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	40	38	37	33	30	27	20	17	L_A=	36		
ERQ008BBV3												
Sound pressure level at 1m	46	49	49	48	46	39	34	27	L_A=	50		
Correction for 3 items of plant	5	5	5	5	5	5	5	5				
Distance attenuation (25m)	-28	-28	-28	-28	-28	-28	-28	-28				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation	0	0	0	0	0	0	0	0				
Total sound pressure level	26	29	29	28	26	19	14	7	L_A=	30		
Sound pressure levels from each plant item												
Plant item 1	41	38	37	34	33	28	20	17	L_A=	37		
Plant item 2	40	38	37	33	30	27	20	17	L_A=	36		
Plant item 3	26	29	29	28	26	19	14	7	L_A=	30		
Total	44	41	40	37	35	31	24	20	L_A=	40		

Calculation of plant to proposed noise sensitive receptors (section 6.3)

Comments	Octave band centre frequency (Hz)								Rating 1		Rating 2	
	63	125	250	500	1k	2k	4k	8k				
Daytime plant noise criteria									L_A=	44		
Evening plant noise cirteria									L_A=	45		
Night time plant noise criteria									L_A=	40		
Calculation of 16A-18 WCS plant to worst affected window of 16A-18 WCS												
EMRQ16A												
Sound pressure level at 1m	67	64	63	60	59	54	46	43	L_A=	63		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (5m)	-14	-14	-14	-14	-14	-14	-14	-14				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Atten. from Environ enclosure	-16	-18	-24	-37	-40	-39	-39	-37				
Total sound pressure level	40	35	28	12	8	4	-4	-5	L_A=	23		
REYQ14P												
Sound pressure level at 1m	66	64	63	59	56	53	46	43	L_A=	62		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (4m)	-12	-12	-12	-12	-12	-12	-12	-12				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Atten. from Environ enclosure	-16	-18	-24	-37	-40	-39	-39	-37				
Total sound pressure level	41	37	30	13	7	5	-2	-3	L_A=	25		
Sound pressure levels from each plant item												
Plant item 1	40	35	28	12	8	4	-4	-5	L_A=	23		
Plant item 2	41	37	30	13	7	5	-2	-3	L_A=	25		
Total	44	39	32	16	11	8	0	-1	L_A=	27		

Comments	Octave band centre frequency (Hz)								Rating 1		Rating 2	
	63	125	250	500	1k	2k	4k	8k				
Daytime plant noise criteria									L_A=	44		
Evening plant noise cirteria									L_A=	45		
Night time plant noise criteria									L_A=	40		
Calculation of 10-12 Museum Street plant to bedroom window of 16A-18 WCS												
ERQ008BBV3 on 12 Museum Street												
Sound pressure level at 1m	46	49	49	48	46	39	34	27	L_A=	50		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (15m)	-24	-24	-24	-24	-24	-24	-24	-24				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation												
Total sound pressure level	25	28	28	27	25	18	13	6	L_A=	29		
ERQ008BBV3 on 11 Museum Street												
Sound pressure level at 1m	46	49	49	48	46	39	34	27	L_A=	50		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (13m)	-22	-22	-22	-22	-22	-22	-22	-22				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation												
Total sound pressure level	27	30	30	29	27	20	15	8	L_A=	31		
ERQ008BBV3 on 10 Museum Street												
Sound pressure level at 1m	46	49	49	48	46	39	34	27	L_A=	50		
Correction for number of plant	0	0	0	0	0	0	0	0				
Distance attenuation (10m)	-20	-20	-20	-20	-20	-20	-20	-20				
Barrier Attenuation	0	0	0	0	0	0	0	0				
Façade correction	3	3	3	3	3	3	3	3				
Attenuation												
Total sound pressure level	29	32	32	31	29	22	17	10	L_A=	33		
Sound pressure levels from each plant item												
Plant item 1	25	28	28	27	25	18	13	6	L_A=	29		
Plant item 2	27	30	30	29	27	20	15	8	L_A=	31		
Plant item 3	29	32	32	31	29	22	17	10	L_A=	33		
Total	32	35	35	34	32	25	20	13	L_A=	36		

Appendix E

Acoustic enclosure data sheet

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environmodula EM2.2.25AC Acoustic Performance Data (November 2008)

Noise Measurement Information:

Test: Environ Modula Acoustic Enclosure - W 3200mm x D 1510mm x H 3000mm

Test Standard:

BS EN ISO 140-3 Acoustics - Measurement of Sound Insulation in Buildings and of Building Elements - Part 1: Airborne Sound Insulation

Sound Level Measuring Equipment:

Norsonic 830 RTA Precision Sound Analyser - Type 1
CEL 284/2 Acoustic Calibrator Type 1
JBL Loudspeaker driven by CEL White Noise Source

Transmission Loss Data:

Transmission Loss - Environ Modula EM2.2.25AC							
Octave Frequency in Hertz (dB ref 2 x 10^{-5} Pascals)							
63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
16	18	24	37	40	39	39	37
Summary							
Transmission Loss Equates to an Overall Reduction of 27 dB(A)							

Support Information:

Monitoring was carried out using the BS3740 technique, insofar as measurements were taken in each quadrant and the results averaged. Internal Test Room: 6m W x 12m L x 4m H. Background noise in the semi-reverberant test room was such as not to interfere with the practical measurements