

1-6 Field Street and 14-16 Leeke Street London



Noise and Vibration Impact Assessment Report
Report 22784.NVA.01

PPF Real Estate Nominee 1 Ltd and PPF Real Estate Nominee 2 Ltd
c/o CBRE Global Investors
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Report 22784.NVA.01			
Revision History			
First Issue Date: 24/06/2021			
A		D	
B		E	
C		F	
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SUMMARY

KP Acoustics Ltd has been commissioned to assess the suitability of the site at 1-6 Field Street And 14-16 Leeke Street, London, WC1X 9JF for an office and residential development in accordance with the provisions of the National Planning Policy Framework and the Noise Policy Statement for England (NPSE).

An environmental noise survey has been undertaken on site in order to establish the current ambient noise levels, as shown in Table 3.1.

Sound reduction performance calculations have been undertaken in order to specify the minimum performance required from glazed elements in order to meet the requirements of BS8233:2014, taking into consideration the non-glazed external building fabric elements. The results of these calculations and the sound reduction performance requirements for the glazed elements are shown in Table 5.2.

The noise implications of the ventilation strategy have been considered, with options being provided to ensure that the ventilation requirements of Approved Document F are achieved.

Further advice can be provided with regards to the overheating strategy to assess the noise implications once thermal modelling calculations have been undertaken.

Noise levels within external amenity areas would be expected to meet the recommended levels provided within BS8233:2014, providing mitigations are being implemented.

No further mitigation measures should be required in order to protect the proposed habitable spaces from external noise intrusion.

1.0 INTRODUCTION

KP Acoustics Ltd has been commissioned by PPF Real Estate Nominee 1 Ltd and PPF Real Estate Nominee 2 Ltd, c/o CBRE Global Investors, One New Change, London, EC4M 9AF, to assess the suitability of the site at 1-6 Field Street And 14-16 Leeke Street, London, WC1X 9JF for a residential development in accordance with the provisions of the National Planning Policy Framework and the Noise Policy Statement for England (NPSE).

This report presents the results of the environmental survey undertaken in order to measure prevailing background noise and vibration levels and outlines any necessary mitigation measures.

2.0 SITE SURVEYS

2.1 Site Description

The site is bounded by residential properties to the north, to the west and to the south, and London Underground railway tracks to the east. Entrance to the site is located on Field Street. At the time of the survey, the background noise climate was dominated by road and rail traffic noise from King's Cross Road and the the neighbouring London Underground railway tracks.

2.2 Environmental Noise Survey Procedure

Two noise surveys were undertaken on the proposed site as shown in Figure 2.1. The locations were chosen in order to collect data representative of the worst-case levels expected on the site due to all nearby sources.

Continuous automated monitoring was undertaken for the duration of the survey between 11:55 on 11/06/2021 and 12:03 on 14/06/2021.

Weather conditions were generally dry with light winds and therefore suitable for the measurement of environmental noise. The measurement procedure complied with ISO 1996-2:2017 Acoustics '*Description, measurement and assessment of environmental noise - Part 2: Determination of environmental noise levels*'.

2.3 Vibration Survey Procedure

Vibration Survey Procedure

Continuous automated vibration monitoring was undertaken in conjunction with the noise survey between 12:39 on 11/06/2021 and 11:45 on 14/06/2021 on First Floor level at the position shown in Figure 2.1. Measurements were made of vertical (z-axis) and horizontal (x - y axes) vibration dose value levels.

This survey addressed underground rail traffic vibration from the nearby railways. The character of the vibration would be considered to be intermittent.

The vibration monitoring position was chosen in order to capture worst case expected levels of vibration as stated within BS6472-1:2008 *“Guide to evaluation of human exposure to vibration in buildings”*.

Manual Measurement Procedure

Manual vibration measurements of vertical (z-axis) and horizontal (x - y axes) VDV levels were undertaken on site between 11:58 and 12:29 on 14/06/2021 on Ground Floor level, at the position shown in Figure 2.1.

This survey addressed underground rail traffic vibration from the nearby railways. Measurements were undertaken for several train pass-bys in each direction in order to gain an understanding of vibration levels typical on site. The character of the vibration would be considered to be intermittent.

The vibration monitoring position was chosen in order to capture worst case expected levels of vibration as stated within BS6472-1:2008 *“Guide to evaluation of human exposure to vibration in buildings”*.

2.4 Measurement Locations

Measurement positions are as described within Table 2.1 and shown within Figure 2.1.





Icon	Descriptor	Location Description
	Noise Measurement Position 1	The meter was installed on the rooftop of the North West façade, in direct line of sight with King’s Cross Road in-free field conditions.
	Noise Measurement Position 2	The meter was installed on the rooftop of the East façade, in direct line of sight with the railways services in-free field conditions.
	Attended Vibration Measurement Position	The accelerometer was installed adjacent to the building on the ground-floor of the North East façade adjoining the nearby railway tracks on a steel cube and attached with manufacturer issued mounting wax.
	Unattended Vibration Measurement Position	The accelerometer was installed on the edge of the first-floor balcony from the East façade adjoining the nearby railway tracks on a steel cube and attached with manufacturer issued mounting wax.

Table 2.1 Measurement positions and descriptions



Figure 2.1 Site measurement positions (Image Source: Google Maps)

2.5 Equipment

The equipment calibration was verified before and after use and no abnormalities were observed. The equipment used is described within Table 2.2.

Measurement instrumentation		Serial no.	Date	Cert no.
Noise Kit 3	Svantek Type 977 Class 1 Sound Level Meter	34104	12/03/2020	14015015-2
	Free-field microphone Aco Pacific 7052E	66830		
	Preamp Svantek 2v12L	17293		
	Svantek External windshield	-	-	-
Noise Kit 4	Svantek Type 977B Class 1 Sound Level Meter	36453	27/02/2020	14015014-1
	Free-field microphone Aco Pacific 7052E	54143		
	Preamp Svantek 2v12L	41508		
	Svantek External windshield	-	-	-
Noise & Vibration Kit 3	Svantek Type 958 Class 1 Sound Level Meter	59558	04/10/2019	14012955-
PCB Piezotronics 356B18 Triaxial Accelerometer		LW1762 43	29/01/2020	14014834-2
Larson Davis CAL200 Class 1 Calibrator		17148	27/04/2021	05223/1

Table 2.2 Measurement instrumentation

3.0 RESULTS

3.1 Noise Survey

The $L_{Aeq: 5min}$, $L_{Amax: 5min}$, $L_{A10: 5min}$ and $L_{A90: 5min}$ acoustic parameters were measured throughout the duration of the survey. Measured levels are shown as a time history in Figure 22784.TH1-1 and in Figure 22784.TH1-2. Average daytime and night time noise levels are shown in Table 3.1.

Measured noise levels are representative of noise exposure levels expected to be experienced by all facades of the proposed development, and are shown in Table 3.1.

Time Period	Noise Measurement Position 1 (Measured Noise level – dBA)	Noise Measurement Position 2 (Measured Noise level – dBA)
Daytime $L_{Aeq,16hour}$	74	58
Night-time $L_{Aeq,8hour}$	69	55

Table 3.1 Site average noise levels for daytime and night time

3.2 Vibration Survey

Vibration Survey Procedure

The results of the vibration measurements captured during the automated survey period are shown as a time history in Figure 22787.VH1 as VDV levels over the full survey period.

Manual Measurement Survey Procedure

Table 3.2 provides typical VDV throughout the day from the 30min attended measurement from ground floor level. The data presented is the W_b weighted VDV level on the horizontal (x - y) axes, and W_d weighted VDV levels on the vertical (z-axis).

Measurement Type	W_d Weighted x-axis VDV $mm/s^{-1.75}$	W_d Weighted y-axis VDV $mm/s^{-1.75}$	W_b Weighted z-axis VDV $mm/s^{-1.75}$
Train Pass-by	0.33	0.26	0.05

Table 3.2 VDV levels measured on site

Note that approximately 30 individual train pass-bys occurred within the 30-minute measurements period, which is deemed representative for the full daytime period.

4.0 NOISE AND VIBRATION ASSESSMENT GUIDANCE

4.1 Noise Policy Statement For England 2019

The National Planning Policy Framework (NPPF) has superseded and replaces Planning Policy Guidance Note 24 (PPG24), which previously covered issues relating to noise and planning in England. Paragraph 170 of the NPPF states that planning policies and decisions should aim to:

- preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans

In addition, Paragraph 180 of the NPPF states that *'Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should':*

- Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life
- Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason

The Noise Policy Statement for England (NPSE) was developed by DEFRA and published in March 2010 with the aim to 'Promote good health and good quality of life through the effective management of noise within the context of Government policy on sustainable development.'

Noise Policy Statement England (NPSE) noise policy 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*

The Noise Policy Statement England (NPSE) outlines observed effect levels relating to the above, as follows:

- NOEL – No Observed Effect Level
 - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- LOAEL – Lowest Observed Adverse Effect Level
 - This is the level above which adverse effects on health and quality of life can be detected.
- SOAEL – Significant Observed Adverse Effect Level
 - This is the level above which significant adverse effects on health and quality of life occur.

As stated in The Noise Policy Statement England (NPSE), it is not currently possible to have a single objective based measure that defines SOAEL that is applicable to all sources of noise in all situations. Specific noise levels are not stated within the guidance for this reason, and allow flexibility in the policy until further guidance is available.

4.2 BS8233:2014

BS8233:2014 ‘Sound insulation and noise reduction for buildings’ describes recommended internal noise levels for residential spaces. These levels are shown in Table 4.1.

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Rooms	35 dB(A)	-
Dining	Dining Room/area	40 dB(A)	-
Sleeping (daytime resting)	Bedrooms	35 dB(A)	30 dB(A)

Table 4.1 BS8233 recommended internal background noise levels

It should be noted that the recommended internal noise levels outlined above are not applicable under “purge ventilation” conditions as defined by Approved Document F of the Building Regulations, as this should only occur occasionally (E.G. to remove odour from painting or burnt food). However, the levels above should be achieved whilst providing sufficient background ventilation, either via passive or mechanical methods.

The external building fabric would need to be carefully designed to achieve these recommended internal levels.

In addition to guidance on internal levels, BS8233:2014 also states the following with regards to noise within external amenity spaces:

‘For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$, which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.’

As outlined above, the resulting noise levels in external amenity areas should not be a reason for refusal, providing that the noise levels are designed to be as low as practically possible within external amenity areas.

Expected levels within the proposed external amenity areas are outlined in Section 8.0 in more detail.

4.3 WHO Guidelines for Community Noise (1999)

WHO Guidelines for Community Noise (1999) recommends that internal noise levels for individual events should not exceed 45dB L_{Amax} more than 10-15 times per night.

It should be noted that this impact is increasingly being regarded as ‘LOAEL’ for this number of exceedances, as described in Section 4.1.

The external building fabric would need to be carefully designed to ensure that the above guidance is achieved.

4.4 ANC Residential Design Guide to Acoustics, Ventilation and Overheating

The ANC guide to acoustics, ventilation and overheating provides an integrated approach to achieving good acoustic design with the ventilation requirements of Approved Document F of the Building Regulations and consideration for overheating control. This good practice document recognises the interdependence of ventilation and overheating when assessing noise, and provides a methodology for assessing the noise implications surrounding ventilation and overheating control.

Ventilation

The ANC Guide to Acoustics, Ventilation and Overheating states the following with regards to ventilation:

‘It is important to differentiate between the need to provide ‘purge ventilation’ as required occasionally under Part F, which applies to all building types, in all locations and throughout the year; against the need to provide ventilation for the ‘overheating condition’ which is influenced by the location, orientation, type and design of the building and may be required for sustained periods of time, or not at all, depending on the overheating risk...

Approved Document F outlines the three main types of ventilation as whole house ventilation (continuous ventilation of rooms or spaces at a relatively low rate to dilute and remove pollutants and water vapour), extract ventilation (typically for kitchens or bathrooms), and purge ventilation (manually controlled ventilation of rooms or spaces at a relatively high rate to rapidly dilute pollutants and / or water vapour, provided by natural or mechanical means).

It also provides four template systems which can be adopted to demonstrate compliance with the Building Regulations, which are outlined in Table 4.2 below.

Ventilation System	Provision with ADF System / Purpose		
	Whole Dwelling Ventilation	Extract Ventilation	Purge Ventilation
System 1 – Trickle vents & intermittent extract fans	Trickle vents	Intermittent extract fans	Typically provided by opening windows
System 2 – Passive stack	Trickle vents and passive stack ventilation	Continuous via passive stack	Typically provided by opening windows
System 3 – Cont. mechanical extract (MEV)	Continuous mechanical extract – min. low rate Trickle vents for inlet air	Continuous mechanical extract – min. high rate Trickle vents for inlet air	Typically provided by opening windows
System 4 – Cont. mechanical supply & extract with heat recovery (MEV)	Continuous mechanical supply and extract – min. low rate	Continuous mechanical supply and extract – min. high rate	Typically provided by opening windows

Table 4.2 ADF template systems

Overheating

Overheating is a serious concern within residential developments as there is currently no requirement for overheating prevention within the Building Regulations.

The ANC Guide to Acoustics, Ventilation and Overheating states the following with regards to overheating:

'Developments will normally (but not always) require additional ventilation (above ADF whole dwelling ventilation provisions) in order to mitigate overheating. Where an overheating assessment is undertaken, it should provide details as to the duration and rate of any additional ventilation required to meet overheating compliance criteria. Where this additional ventilation is provided passively, the overheating assessment should also provide information about the required size of façade openings.'

It should be noted that the main differentiation between ventilation and overheating control is that the ventilation conditions prescribed by Approved Document F are applicable all of the time, whilst the overheating component applies only part of the time (to be defined by an overheating assessment for the scheme, if appropriate).

It is important to note that the recommended internal noise levels shown in Table 4.1 should be achieved whilst providing adequate ventilation (as outlined by Approved Document F), but the overheating condition should allow a relaxed standard internal sound environment, as follows:

'...it is considered reasonable to allow higher levels of internal ambient noise from transport sources when higher rates of ventilation are required in relation to the overheating condition'.

The rationale behind this is that the overheating condition would only apply for a relatively short period of time, and residential occupants would typically accept higher acoustic conditions internally whilst having control over thermal comfort within their property.

Table 4.3 below provides guidance for the assessment of the overheating condition.

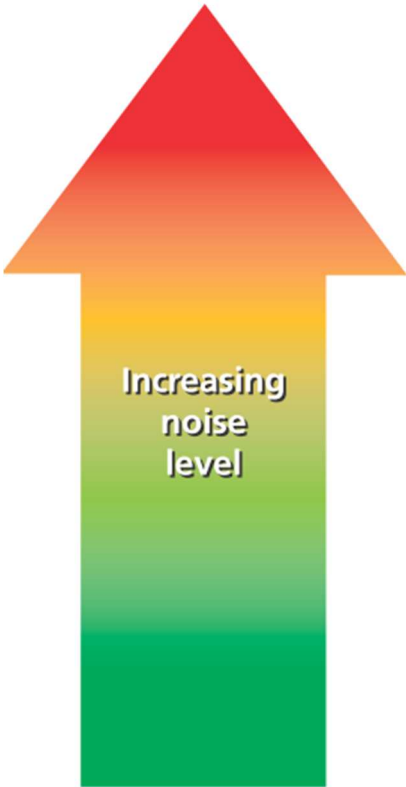
Internal Ambient Noise Level			Examples of Outcomes	
$L_{Aeq, T}$ during 07:00-23:00	$L_{Aeq, T}$ during 23:00-07:00	Individual noise events during 23:00-07:00		
> 50dB	> 42dB	Normally exceeds 65dB $L_{AF, max}$	The noise causes a material change in behaviour e.g. having to keep windows closed most of the time	Avoiding certain activities during periods of intrusion. Having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.
 <p>Increasing noise level</p>			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods. As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life. At lower noise levels, limited behavioural change is expected unless conditions are prevalent for most of the time.
≤35dB	≤30dB	Do not normally exceed $L_{AF, max}$ 45dB more than 10 times per night	Noise can be heard but does not cause any change in behaviour.	Noise can be heard but does not cause any change in behavior, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.

Table 4.3 Guidance for assessment of noise from transportation noise sources relating to overheating condition (Ref: Table 3.3 of AVO Guide)

It should be noted that the ANC guide to acoustics, ventilation and overheating document is not an official government code of practice, and neither replaces nor provides an authoritative interpretation of the law or government policy, and therefore should be seen as a good practice document only.

4.5 BS6472-1-2008 - Vibration Assessment

BS 6472 provides guidance on predicting human response to vibration in buildings over the frequency range 0.5 Hz to 80 Hz. The vibration dose value is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

Table 4.4 shows the different likelihoods of adverse comment from nearby vibration sources on residential occupants.

Place and time	Low probability of adverse comment m.s ^{-1.75}	Adverse comment possible m.s ^{-1.75}	Adverse comment probable m.s ^{-1.75}
Residential buildings 16h day	0.2-0.4	0.4-0.8	0.8-1.6
Residential buildings 8h night	0.1-0.2	0.2-0.4	0.4-0.8

Table 4.4 Likelihood of comment on vibration perceived within residential dwellings

It should be noted that the vibration levels outlined in Table 3.1 are at the point of entry into the human body, and not the point of entry of vibration into the structure itself. In the cases where the proposed structure is not yet built and vibration measurements cannot be taken inside the building, losses should be accounted for due to the transfer function between the ground and building structure and its foundations. As ground conditions, foundation types, building construction, and floor construction and loading are all variables in terms of transfer function and losses, this report will assume piled foundations in rock and a negligible loss as a worst-case scenario.

In addition to potential losses as vibration passes from unloaded ground into the structure, amplification of vibration can occur as the vibration propagates across a suspended floor, such as in upper floors of the proposed building. As this is fully dependent on the input frequency of vibration and the natural frequency of the receiving structure, VDV levels would only be considered on the ground floor of the proposed development within this assessment.

5.0 EXTERNAL BUILDING FABRIC SPECIFICATION

Sound reduction performance calculations have been undertaken in order to specify the minimum performance required from glazed and non-glazed elements in order to achieve the recommended internal noise levels shown in Table 4.1, taking into account average and maximum noise levels monitored during the environmental noise survey.

Typical sized bedrooms and open plan offices with a high ratio of glazing to masonry have been used for all calculations in order to specify glazing requirements. The following dimensions were used in the calculations:

- 16 m² Bedroom, Second Floor, East façade - glazing: 5 m²
- 356 m² Open Plan Offices, Ground Floor, East façade - glazing: 24 m²

As a more robust assessment, L_{Amax} spectrum values of night-time peaks have also been considered and incorporated into the glazing calculation in order to cater for the interior limit of 45 dB L_{Amax} for individual events, as recommended in WHO Guidelines.

Please note that the glazed and non-glazed element calculations would need to be finalised once all design proposals are finalised.

5.1 Non-Glazed Elements

At this project stage, the exact construction of the non-glazed external building fabric is unknown, however, it is understood that it would be based upon the construction proposed in Table 5.1 and would be expected to provide the minimum figures shown above when tested in accordance with BS EN ISO, 140-3:1995.

Element	Octave band centre frequency SRI, dB					
	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
Triple partition Metsec with Brick slip and Cement particle board	44	51	56	58	60	70

Table 5.1 Assumed sound reduction performance for non-glazed elements

The above façade performance has been simulated using Insul based on the construction detail provided by Orbit Architects.

5.2 Glazed Elements

Minimum octave band sound reduction index (SRI) values required for all glazed elements to be installed are shown in Table 5.2. The performance is specified for the whole window unit,

including the frame and other design features such as the inclusion of trickle vents. Sole glass performance data would not demonstrate compliance with this specification.

The assessment has been also undertaken for offices and commercial spaces located on the existing ground and first floor of the development ,in accordance with BS 8233-2014.

Elevation	Octave band centre frequency SRI, dB						R _w (C;C _{tr}), dB
	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
Residential – North Elevations	23	22	27	38	40	41	33 (-1;-4)
Residential – West Elevations	27	37	44	51	50	53	46 (-2;-7)
Residential – South Elevations	27	37	44	51	50	53	46 (-2;-7)
Residential – East Elevations	27	37	44	51	50	53	46 (-2;-7)
Offices/Commercial Spaces	28	23	32	38	42	44	35 (-1;-4)

Table 5.2 Required glazing performance

The nominated glazing supplier should verify that their proposed window system meets the attenuation figures shown at each centre frequency band as shown in Table 5.2.

Example glazing types that would be expected achieve the above spectral values are shown in Table 5.3.

Elevation	Example glazing type
Residential – North Elevations	6/12/4
Residential – West Elevations	Primary window: 9/20/11 50mm air gap Secondary window 6.4mm
Residential – South Elevations	Primary window: 9/20/11 50mm air gap Secondary window 6.4mm
Residential – East Elevations	Primary window: 9/20/11 50mm air gap Secondary window 6.4mm
Offices/Commercial Spaces	4/12/10

Table 5.3 Example glazing types

All major building elements should be tested in accordance with BS EN ISO 140-3:1995.

Independent testing at a UKAS accredited laboratory will be required in order to confirm the performance of the chosen system for an actual configuration.

6.0 VENTILATION AND OVERHEATING

6.1 Ventilation Strategy

Based on the noise levels measured on site, appropriate ventilation systems are outlined in Table 6.1 below in order to ensure the internal noise environment is not compromised.

Ventilation System	Whole Dwelling Ventilation	Extract Ventilation
ADF System 1	North façade: Acoustic wall vent providing a minimum performance of 34dB $D_{n,e,w}$ West, South and East façades: Acoustic wall vent providing a minimum performance of 49dB $D_{n,e,w}$	Intermittent extract fans
ADF System 3	Continuous mechanical extract (low rate) and acoustic wall vents for supply providing a minimum performance of 34dB $D_{n,e,w}$ for North façade and 49dB $D_{n,e,w}$ for West, South and East façades	Continuous mechanical extract (high rate) with trickle vents providing inlet air
ADF System 4	Continuous mechanical supply and extract (low rate)	Continuous mechanical supply and extract (high rate)

Table 6.1 Ventilation systems

In the case of mechanical ventilation, systems should be designed to meet the internal noise levels as defined in CIBSE Guide A (2015), as shown in Table 6.2.

Room Type	L_{Aeq} , dB	NR
Bedrooms	30	25
Living Rooms	35	30
Kitchen	45-50	40-45

Table 6.2 CIBSE Guide A 2015 guidance levels for mechanical building services

In all cases, purge ventilation would be provided by openable windows. As outlined in Section 4.3, the internal noise level requirement would not be applicable during purge conditions as this would only occur occasionally.

6.2 Overheating Control Strategy

In order to provide commentary with regards to the noise implications of the overheating strategy, thermal modelling calculations should be undertaken to inform the design team on the type of overheating strategy which will be adopted. The internal noise level would be

dependent on the open area required to manage overheating, and the time that the element would be required to be open.

Various solutions to control overheating and noise passively are outlined in Table 6.2. Please note that the preferable solution would need to be assessed in full by KP Acoustics in order to confirm the viability to provide a compliant internal noise level.

Mitigation Type	Description and References	Approximate Level Difference*	Improvement Relative to a Window Providing the Same Amount of Ventilation
1. Standard opening windows	Window(s) open sufficiently to provide a ventilation free-area equivalent to 2% of the floor area	13dB	0dB
2. Open windows with sound attenuating balconies	1. plus balconies with solid balustrade or enclosed to a further degree (maintaining an open area for ventilation). Absorption may be provided to the balcony soffit or potentially to other surfaces	17-23dB	4-10dB
3. Attenuated or plenum windows	Dual windows (spaced by around 200mm) with staggered openings and absorptive linings to the cavity reveals. Various other configurations also possible in principle	17-24dB	4-11dB
4. Attenuated vents/ louvres	Ventilation openings with means of attenuating sound. Typically acoustic louvres or acoustically lined ducts/ plena	17-29dB	4-16dB
Combination of 2, 3 and 4	Combined use of options 2, 3 and 4. Refer to descriptions above	21-39dB	8-26dB

Table 6.1 Examples of passive ventilation systems (Ref: AVO Guide)

***External free field level to internal reverberant level**

7.0 VIBRATION ASSESSMENT

72 Hour Vibration Survey Procedure

The unattended vibration measurements have been carried out on first floor level on the balcony as shown in Figure 2.1. Because of the location, results of the first floor vibrations measurements are indicative and therefore have not been used for the assessment of $VDV_{b/d,day}$.

Manual Measurement Survey Procedure

$VDV_{b/d,day}$ for the daytime period have been calculated based on formula 2 within Section 3.5 of BS6472-1:2008, as follows:

$$VDV_{b/d,day} = (t_{day} / t_T)^{0.25} \times VDV_{b/d,T}$$

The results from the calculations are shown in Table 7.1.

Axis	Vibration Measurement	Calculated VDV Level $m/s^{1.75}$	Likelihood of Comment
x	$VDV_{d,day}$	0.330	Adverse comment is not expected
y	$VDV_{d,day}$	0.256	Adverse comment is not expected
z	$VDV_{b,day}$	0.049	Adverse comment is not expected

Table 7.1 Daytime and night-time VDV levels and likelihood of comment in accordance with BS6472

As shown in Table 7.1, the most dominant axis of vibration is the x-axis with a $VDV_{d,day}$ of $0.33m/s^{1.75}$, which correlates with adverse comment not being expected from future occupiers within the development.

8.0 EXTERNAL AMENITY AREA ASSESSMENT

The existing noise levels affecting the balconies of the East façade are expected to be 74dBA during daytime and 69dBA during night-time. BS8233 encourages that the “noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ ”. An absorptive acoustic soffit above the façade could be implemented along with a solid balustrade to reduce the existing noise levels of the trains pass-bys and reduce the noise levels by approximately 5dB.

Alternatively, sealed winter gardens on each balcony with openable sections can be built to achieve BS8233 recommended guidelines with regards to noise within external amenity spaces. This would allow the residential users to open the windows for fresh air without being affected by high noise levels coming from the railways underneath.

The following glazing specification would be suitable for the proposed winter gardens:

Elevation	Octave band centre frequency SRI, dB						$R_w(C;C_{tr})$, dB
	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
West Elevations	23	22	27	38	40	41	33 (-1;-4)

Table 8.1 Proposed sound reduction performance for winter gardens elements

9.0 CONCLUSION

An environmental noise and vibration survey has been undertaken at 1-6 Field Street And 14-16 Leeke Street, London, WC1X 9JF allowing the assessment of daytime and night-time levels likely to be experienced by the proposed development.

Measured noise levels allowed a robust glazing specification to be proposed which would provide internal noise levels for all residential environments of the development commensurate to the design range of BS8233.

No further mitigation measures should be required in order to protect the proposed habitable spaces from external noise intrusion.

Measurement of railways from train activity indicates that vibration levels are below the threshold of human perception in the z-axis, in accordance with BS6472: 2008.

Rooftop level, facing railways
Environmental Noise Time History
From 11 June 2021 To 14 June 2021

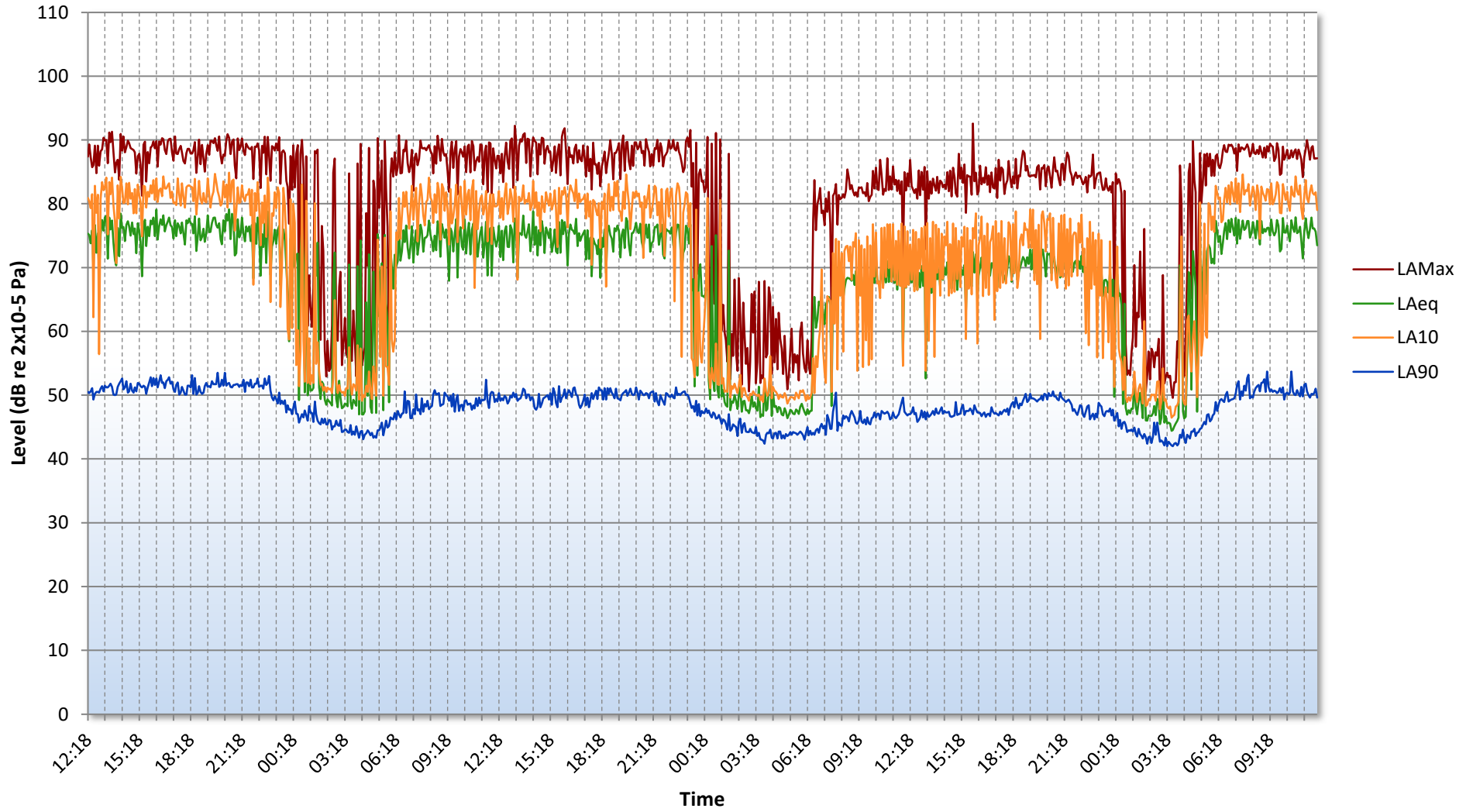


Figure 22784.TH1

Rooftop level, facing Leeke Street
Environmental Noise Time History
From 11 June 2021 To 14 June 2021

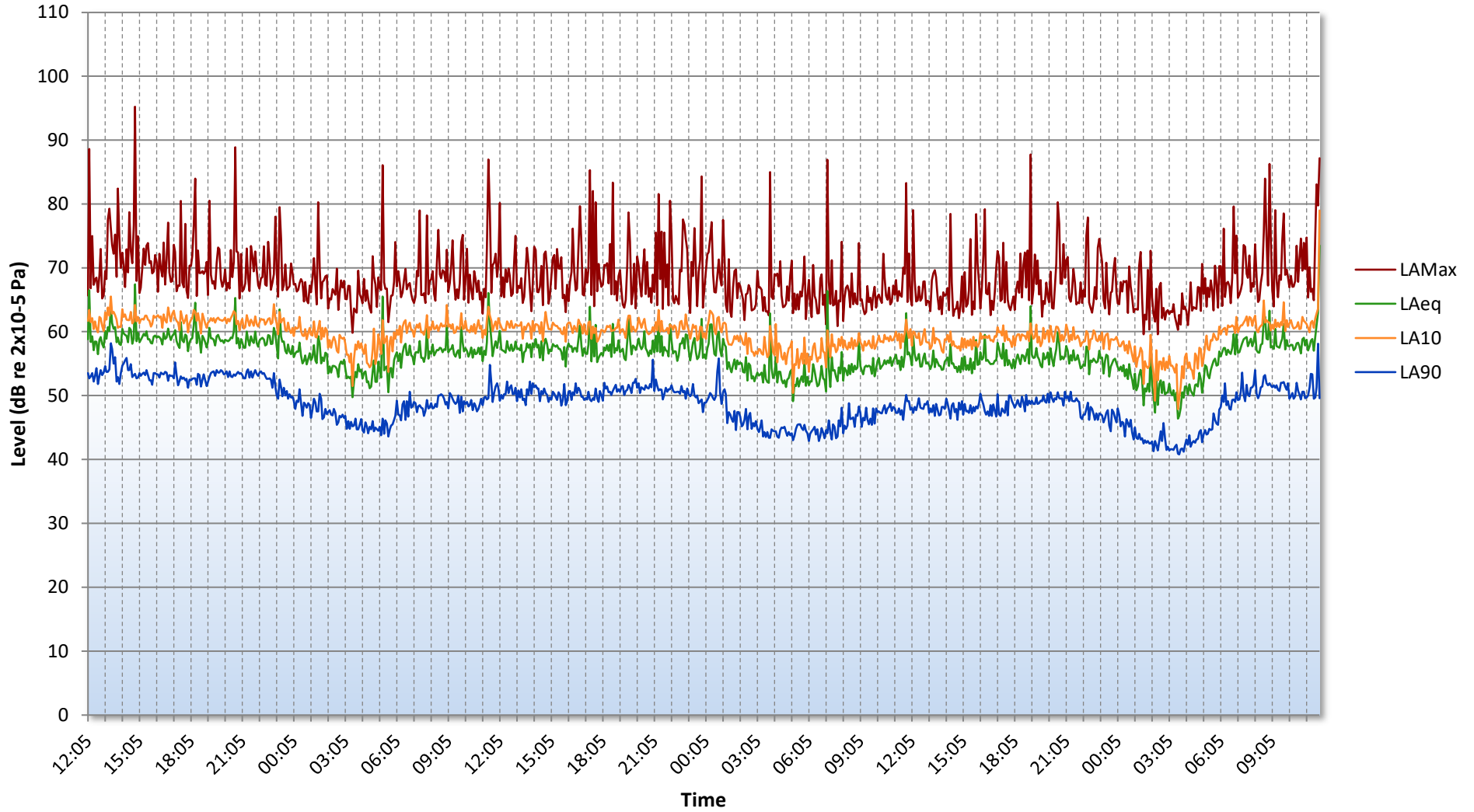


Figure 22784.TH2

1-6 Field Street and 14-16 Leeke Street, London
VDV Time History
From 11/06/2021 To 14/06/2021

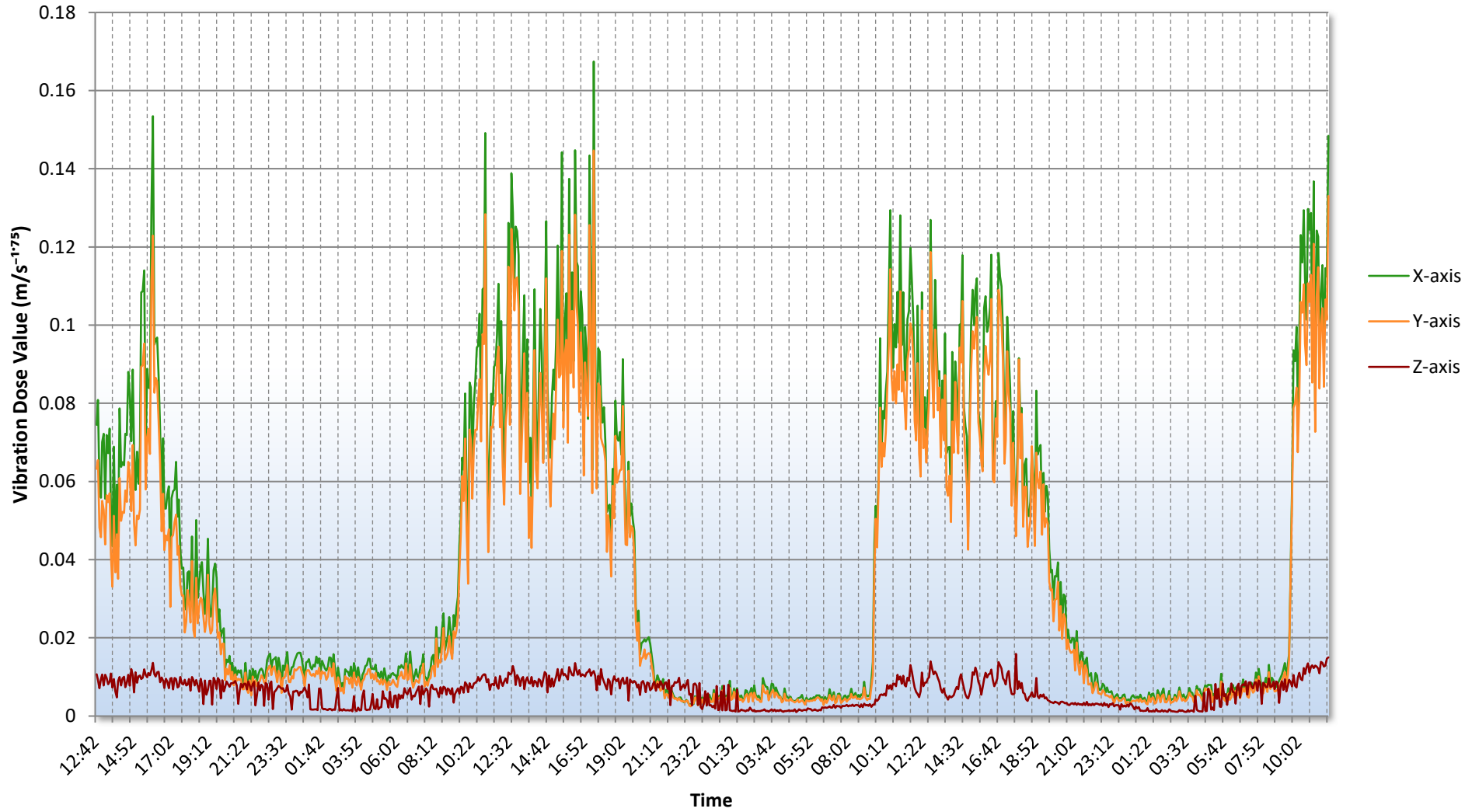


Figure 22787.VH1

GENERAL ACOUSTIC TERMINOLOGY

Decibel scale - dB

In practice, when sound intensity or sound pressure is measured, a logarithmic scale is used in which the unit is the 'decibel', dB. This is derived from the human auditory system, where the dynamic range of human hearing is so large, in the order of 10^{13} units, that only a logarithmic scale is the sensible solution for displaying such a range.

Decibel scale, 'A' weighted - dB(A)

The human ear is less sensitive at frequency extremes, below 125Hz and above 16Khz. A sound level meter models the ears variable sensitivity to sound at different frequencies. This is achieved by building a filter into the Sound Level Meter with a similar frequency response to that of the ear, an A-weighted filter where the unit is dB(A).

L_{eq}

The sound from noise sources often fluctuates widely during a given period of time. An average value can be measured, the equivalent sound pressure level L_{eq} . The L_{eq} is the equivalent sound level which would deliver the same sound energy as the actual fluctuating sound measured in the same time period.

L_{10}

This is the level exceeded for no more than 10% of the time. This parameter is often used as a "not to exceed" criterion for noise.

L_{90}

This is the level exceeded for no more than 90% of the time. This parameter is often used as a descriptor of "background noise" for environmental impact studies.

L_{max}

This is the maximum sound pressure level that has been measured over a period.

Octave Bands

In order to completely determine the composition of a sound it is necessary to determine the sound level at each frequency individually. Usually, values are stated in octave bands. The audible frequency region is divided into 11 such octave bands whose centre frequencies are defined in accordance with international standards. These centre frequencies are: 16, 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000 and 16000 Hertz.

Environmental noise terms are defined in BS7445, *Description and Measurement of Environmental Noise*.

APPLIED ACOUSTIC TERMINOLOGY

Addition of noise from several sources

Noise from different sound sources combines to produce a sound level higher than that from any individual source. Two equally intense sound sources operating together produce a sound level which is 3dB higher than a single source and 4 sources produce a 6dB higher sound level.

Attenuation by distance

Sound which propagates from a point source in free air attenuates by 6dB for each doubling of distance from the noise source. Sound energy from line sources (e.g. stream of cars) drops off by 3dB for each doubling of distance.

Subjective impression of noise

Hearing perception is highly individualised. Sensitivity to noise also depends on frequency content, time of occurrence, duration of sound and psychological factors such as emotion and expectations. The following table is a guide to explain increases or decreases in sound levels for many scenarios.

Change in sound level (dB)	Change in perceived loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable
10	About twice as loud

Transmission path(s)

The transmission path is the path the sound takes from the source to the receiver. Where multiple paths exist in parallel, the reduction in each path should be calculated and summed at the receiving point. Outdoor barriers can block transmission paths, for example traffic noise. The effectiveness of barriers is dependent on factors such as its distance from the noise source and the receiver, its height and construction.

Ground-borne vibration

In addition to airborne noise levels caused by transportation, construction, and industrial sources there is also the generation of ground-borne vibration to consider. This can lead to structure-borne noise, perceptible vibration, or in rare cases, building damage.

Sound insulation - Absorption within porous materials

Upon encountering a porous material, sound energy is absorbed. Porous materials which are intended to absorb sound are known as absorbents, and usually absorb 50 to 90% of the energy and are frequency dependent. Some are designed to absorb low frequencies, some for high frequencies and more exotic designs being able to absorb very wide ranges of frequencies. The energy is converted into both mechanical movement and heat within the material; both the stiffness and mass of panels affect the sound insulation performance.