

REPORT AS6171.101206.NVIA

**80 CHARLOTTE
STREET AND
65 WHITFIELD
STREET
CAMDEN**

**NOISE, VIBRATION AND EXTERNAL
BUILDING FABRIC ASSESSMENT**

Prepared: 6th December 2010

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1. INTRODUCTION

This Acoustic Statement is submitted in support of the application by West London & Suburban Property Investments Ltd for planning permission at 80 Charlotte Street and 65 Whitfield Street (The Site). The application proposes the partial redevelopment and refurbishment of the site to create a mixed use office and residential scheme with some flexible units at ground and lower ground floor in either office, retail or restaurant use (the Proposed Development).

Alan Saunders Associates has been commissioned by West London & Suburban Property Investments Ltd. to undertake an assessment of the current environmental noise impact on the site in accordance with the requirements of PPG24: *Planning and Noise: September 1994*: Department of Environment and London Borough of The London Borough of Camden requirements. An assessment of vibration from underground trains has been undertaken in accordance with BS6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings*.

This assessment would also consider the requirement for any outline mitigation measures as appropriate for the proposed residential development.

2. DESCRIPTION OF SITE

The site is currently occupied by a number of existing buildings all of which are in office use. There are a number of existing residential properties along Chitty Street. The location and size of the site are shown in Figure one.

The background noise climate is dominated by road traffic noise in the surrounding area and aircraft noise.

The site lies to the west of the Northern underground line, between Goodge Street and Warren Street stations.

3. SURVEY PROCEDURE & EQUIPMENT

3.1 Environmental Noise Survey

An environmental noise survey was undertaken in accordance with the requirements of PPG24: *Planning and Noise: September 1994*: Department of Environment. Noise levels were monitored at third floor level on the site over consecutive 5 and 15-minute periods between 11:30 hours on Wednesday 1st and 12:45 hours on Thursday 2nd September 2010.

The following equipment was used for the survey:

- 2 no. Norsonic sound level meter type I18
- 1 no. Rion sound level meter type NA28
- 1 no. Rion sound level meter type NL32
- 1 no. Rion calibrator type NC73
- Norsonic Sound Level Calibrator type I253

The calibration of the equipment was verified before and after use. No calibration drift was observed.

The monitoring positions used for continuous measurements are indicated in the attached site plan one.

The weather during the survey was dry with light winds. This made the conditions suitable for the measurement of environmental noise.

Measurements were made generally in accordance with the requirements of BS 7445:1991 *Description and measurement of environmental noise, Part 2 - Acquisition of data pertinent to land use*.

Descriptions and explanations of the acoustic parameters used in this report are shown in Appendix A.

3.2 Vibration Survey

An assessment of vibration was undertaken on site, as required by current guidance documents for sites close to underground or overground railway lines. The following equipment was used for the survey:

- Vibrock Seismograph type 901

The calibration of the equipment was verified before and after use.

All measurements were made at basement level generally in accordance with BS6472 and ANC guidelines for vibration measurement. This location represents the worst case scenario and is indicated on the site plan one.

Vibration levels were monitored at site over consecutive 30 second periods in three axes between 12:04 hours on Wednesday 1st and 12:54 hours on Thursday 2nd September 2010

4. RESULTS

4.1 Environmental Noise Survey

The results of the continuous monitoring are shown as time histories of the $L_{Aeq, 15mins}$, $L_{Amax, 15mins}$, $L_{A10, 15mins}$ and $L_{A90, 15mins}$ in Figures AS6171/TH1-TH4.

4.2 Vibration Survey

The maximum results of the vibration measurements during the survey period are shown in Table 5.4 in terms of vibration dose values (VDV) for day and night periods.

| Daytime VDV _{day} (m/s ^{-1.75}) | Night-time VDV _{night} (m/s ^{-1.75}) |
|--|---|
| 0.040 | 0.031 |

Table 4.1 – Daytime and night-time VDV's

5. SUITABILITY OF THE SITE FOR RESIDENTIAL DEVELOPMENT

It is proposed to develop the first floor and above of 65 Whitfield Street and 14 Charlotte Mews and a section of the building on the corner of Whitfield and Chitty Street for residential use. The site is affected by road traffic in the surrounding area and aircraft flying overhead.

5.1 PPG 24: September 1994

In order to assess the suitability of the site for residential development, reference to current guidance documents is appropriate. The PPG 24: *Planning and Noise: September 1994*, gives guidance to local authorities in England on the use of their planning powers to minimise the adverse impact of noise.

The PPG introduces in paragraph 8 the concept of Noise Exposure Categories (NEC) from A to D, to help planning authorities in their consideration of applications for residential development near transport sources. Category A represents the circumstances in which noise is unlikely to be a determining factor, whilst Category D relates to the situation in which development should normally be refused.

The PPG also introduces a definition of night and day and are as follows:

- Daytime 07:00 - 23:00 hours

- Night-time 23:00 - 07:00 hours

The PPG uses the L_{Aeq} value for the above periods to assess the potential impact of noise on any developments from a specific source – in this case mixed sources. PPG24 also recommends that a vibration assessment be undertaken where sites are close to railway lines and that they be assessed in accordance with BS6472:1992, which has been superseded by BS6472: 2008.

5.2 Noise Assessment

The average noise levels for the 'Daytime' and 'Night-time' periods are shown in Table 5.1.

| Position | Daytime $L_{Aeq,16hour}$ (dB) | Night-time $L_{Aeq,8hour}$ (dB) |
|---------------------|-------------------------------|---------------------------------|
| Whitfield Street | 58 | 54 |
| 65 Whitfield Street | 60 | 55 |

Table 5.1 – Daytime and night-time average noise levels [dB ref. 20 μ Pa]

Table 5.2 below shows the results, indicating that the site should be rated in the following categories for 'Daytime' and 'Night-time' with respect to mixed noise sources.

| Position | Daytime Category | Night-time Category |
|---------------------|------------------|---------------------|
| Whitfield Street | B | B |
| 65 Whitfield Street | B | B |

Table 5.2 – PPG 24 day and night-time categories for site

Table AS6171/NEC defines the categories of PPG24 and their significance in regards to noise exposure.

Appendix B shows noise exposure categories of PPG24 and their significance with regard to noise exposure. The most exposed area designated for residential development categorises the site as NEC B.

For sites within NEC B, PPG24 states:

'Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.'

It should be noted that, in urban areas, development sites generally fall into NEC B, C or even D and mitigation measures are frequently incorporated within building design to provide appropriate internal acoustic conditions.

5.3 BS8233:1999 Sound insulation and noise reduction for buildings

The guidance in this document indicates 'good' and 'reasonable' noise levels for various activities within residential and commercial buildings.

The relevant sections of this standard are shown in the following table:

| Criterion | Typical Situations | Design range $L_{Aeq,T}$ dB | |
|--|--------------------|-----------------------------|------------|
| | | Good | Reasonable |
| Reasonable resting/sleeping conditions | Living Rooms | 30 | 40 |
| | Bedrooms | 30 | 35 |

Table 5.3 – Excerpt from BS8233: 1999

This standard also states that individual noise events should not normally exceed 45 dB $L_{Amax,fast}$ within bedrooms at night.

It is understood that The London Borough of Camden requires 'good' internal noise levels for residential dwellings.

Residential buildings would, therefore, be designed and all elements of the building envelopes specified to ensure that internal noise levels as shown in Table 5.3 are achieved, whilst taking into account all current and future permanent noise sources.

5.4 Vibration Survey

The maximum results of the vibration measurements during the survey period are repeated below in Table 5.4 in terms of vibration dose values (VDV) for day and night periods.

| Daytime VDV_{day} ($m/s^{-1.75}$) | Night-time VDV_{night} ($m/s^{-1.75}$) |
|---------------------------------------|--|
| 0.040 | 0.031 |

Table 5.4 – Daytime and night-time VDV

5.5 BS6472-1:2008 Guide to evaluation of human exposure to vibration in buildings

BS6472 specifies building vibration with respect to human response to be measured and assessed in the form of a vibration dose value (VDV). The VDV defines a relationship that

yields a consistent assessment of continuous, intermittent, occasional and impulsive vibration and correlates well with subjective response. The vibration is to be evaluated for the axis in which the magnitude of weighted acceleration is greatest, against the values in Table 5.5 below.

| Place and Time | Low probability of adverse comment | Adverse comment possible | Adverse comment probable |
|--------------------------|------------------------------------|--------------------------|--------------------------|
| 16h day (07:00 – 23:00) | 0.2 to 0.4 | 0.4 to 0.8 | 0.8 to 1.6 |
| 8h night (23:00 – 07:00) | 0.1 to 0.2 | 0.2 to 0.4 | 0.4 to 0.8 |

Table 5.5 – VDV ranges resulting in risk of probable comment [values ref. $m/s^{-1.75}$]

The vibration levels measured on site are substantially lower than levels associated with a *low probability of adverse comment*. BS6472-1:2008 states that ‘below these ranges adverse comment is not expected’.

6. DESIGN REVIEW

The following design review is based on the architectural drawings available at the time of writing for the proposed construction of the residential areas of the development.

6.1 Architectural Arrangements

It has been assumed that all non-glazed elements, i.e. masonry walls/facings and the roof systems, will provide the following minimum sound insulation performances, when tested in accordance with BS EN ISO, 140-3:1995.

| Frequency (Hz) | Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz) | | | | | |
|----------------|---|-----|-----|----|----|----|
| | 125 | 250 | 500 | 1k | 2k | 4k |
| Masonry | 38 | 39 | 49 | 53 | 55 | 55 |

Table 6.1 – Assumed minimum sound reduction indices of solid constructions

7. REQUIRED GLAZING PERFORMANCE

The minimum sound insulation specifications for the glazed elements of the building façades are given in the table below, with an aim to meet the ‘good’ standard specified in BS8233 as required by The London Borough of Camden. These have been calculated using the monitoring data noise levels using $L_{Aeq,16hr,8hr}$ and L_{Amax} .

| Frequency (Hz) | Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz) | | | | | |
|----------------|---|-----|-----|----|----|----|
| | 125 | 250 | 500 | 1k | 2k | 4k |
| Type A | 16 | 21 | 31 | 34 | 37 | 26 |

Table 7.1 – Minimum required sound reduction indices for glazing

The façades overlooking Charlotte Mews would be shielded from road traffic noise. No other noise sources were found, therefore it is expected that standard, thermally sealed double glazing should provide sound reduction to achieve suitable internal levels.

It is important that all principal building elements are tested in accordance with BS EN ISO 140-3:1995 and that the quoted minimum sound reduction specifications are met by the windows, including frames, seals, etc. Glass performance alone is not an acceptable means of demonstrating compliance with the specification for window performance.

The minimum sound reduction indices specified in the Table 7.1 are required to ensure that levels of traffic and plant noise intrusion are controlled with regard to the criteria stated. It must be the responsibility of the glazing system supplier/manufacture to ensure that these performances are achieved as installed on site, and that the systems proposed for this project are therefore selected in order to achieve this.

It should be noted that the performance of the selected system must be confirmed for the actual configuration and construction used. Independent testing at a UKAS accredited laboratory or at an equal and approved laboratory will be required.

The sound reduction of the windows should be met with any proposed trickle vents installed and open. If this cannot be met then alternative means of ventilation may be required, although there is no reason why windows cannot be openable as a matter of personal preference.

8. PLANT NOISE DESIGN CRITERIA

The minimum measured background L_{A90} noise levels are shown in Table 8.1.

| Location | Assessment period | Minimum $L_{A90,T}$ |
|---|-------------------|---------------------|
| Howland Street | 07:00 – 23:00 | 53 dB |
| Charlotte Street | | 54 dB |
| Whitfield Street | | 52 dB |
| 65 Whitfield Street (Chitty/Whitfield Street) | | 52 dB |
| Howland Street | 23:00 – 07:00 | 50 dB |
| Charlotte Street | | 51 dB |
| Whitfield Street | | 50 dB |
| 65 Whitfield Street (Chitty/Whitfield Street) | | 48 dB |

Table 8.1 - Minimum measured background noise levels

[dB ref. 20 μ Pa]

It is understood that The London Borough of Camden require noise levels 1m from the façade of the nearest noise sensitive receiver to be 5dB less than the existing background measurement (L_{A90}) when assessed in accordance with BS4142:1997 *Method for rating industrial noise affecting mixed residential and industrial areas*. However, in recent discussions with the Environmental Health Department at Camden, there has been a preference for 10dB below the existing background noise climate in more residential areas.

If the proposed plant has tonal qualities or operates intermittently then the plant noise emissions criterion should be an additional 5dB lower than the proposed values detailed in Table 8.2. All plant will be designed to meet these external plant noise emissions criteria.

| Location | Period | Minimum $L_{A90,T}$ |
|---|---------------|---------------------|
| Howland Street | 07:00 – 23:00 | 43 dB |
| Charlotte Street | | 44 dB |
| Whitfield Street | | 42 dB |
| 65 Whitfield Street (Chitty/Whitfield Street) | | 42 dB |
| Howland Street | 23:00 – 07:00 | 40 dB |
| Charlotte Street | | 41 dB |
| Whitfield Street | | 40 dB |
| 65 Whitfield Street (Chitty/Whitfield Street) | | 38 dB |

Table 8.2 – Proposed plant noise emissions criteria

[dB ref. 20 μ Pa]

9. CONCLUSIONS

Measurements have been made of the prevailing noise climate at the proposed site for a retail and residential development at 80 Charlotte Street and 65 Whitfield Street, Camden. Measurements of vibration affecting the site have also been made.

The measured noise levels have been assessed against currently available Standards and the guidance document, PPG24: *Planning and Noise: September 1994*, to consider whether the site is suitable for its proposed residential use.

This report shows that areas within the development site fall into Noise Exposure Category B.

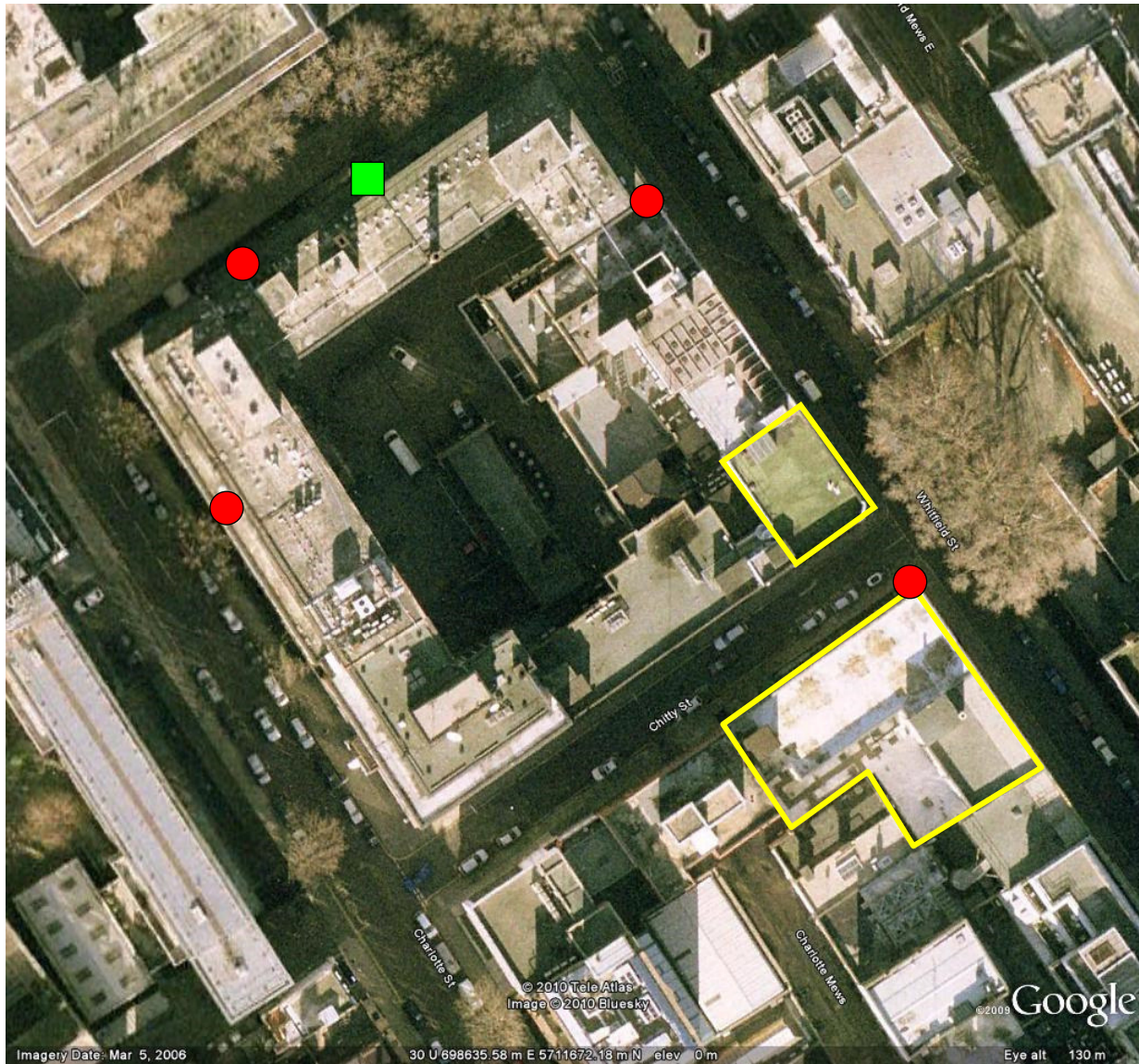
The survey has allowed the minimum sound reduction requirements of the external building fabric to be established as a performance specification, which should be incorporated into the scheme at the detailed design stage.

It is important that the successful contractor demonstrates in a UKAS accredited or an equal and approved laboratory that the minimum sound reduction requirements can be achieved by their proposed window systems.

Measured levels of vibration have been found to be within acceptable limits, with reference to BS6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings*.

Measurements have been made to establish the current background noise climate. This has enabled design criteria to be set for the control of plant noise emissions to noise sensitive properties, in accordance with The London Borough of Camden requirements.

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- Automated noise monitoring position
- Automated vibration monitoring position
- Approximate boundary of residential areas

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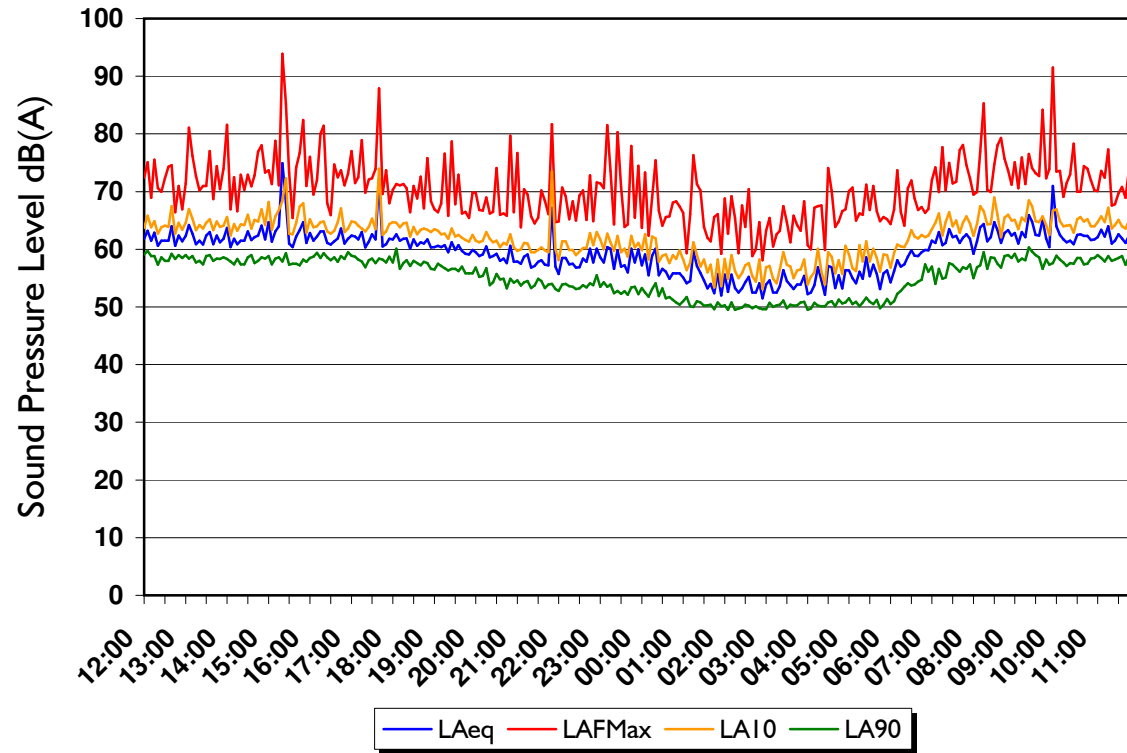
Title:
 Indicative Site Plan

Figure:
 AS6171/SP1

Date:
 6th December
 2010

80 Charlotte Street - Howland Street

Environmental Noise Time History

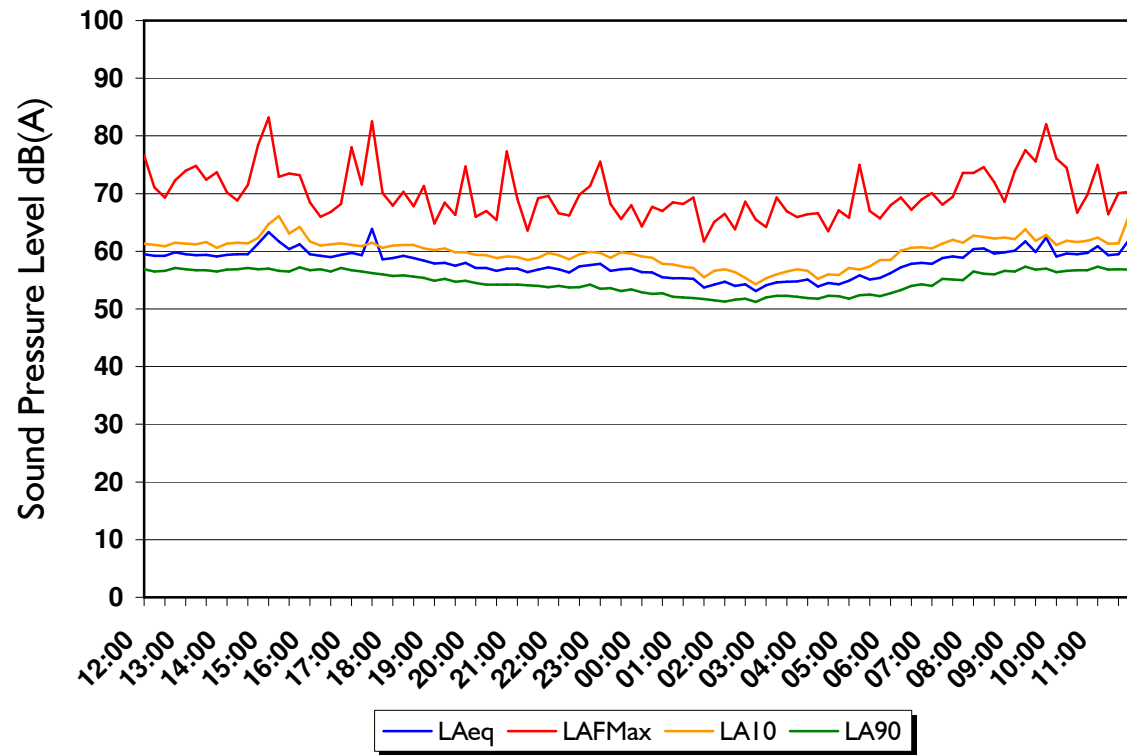


Wednesday 01 September to Thursday 02 September

Figure AS6171/TH1

80 Charlotte Street - Charlotte Street

Environmental Noise Time History

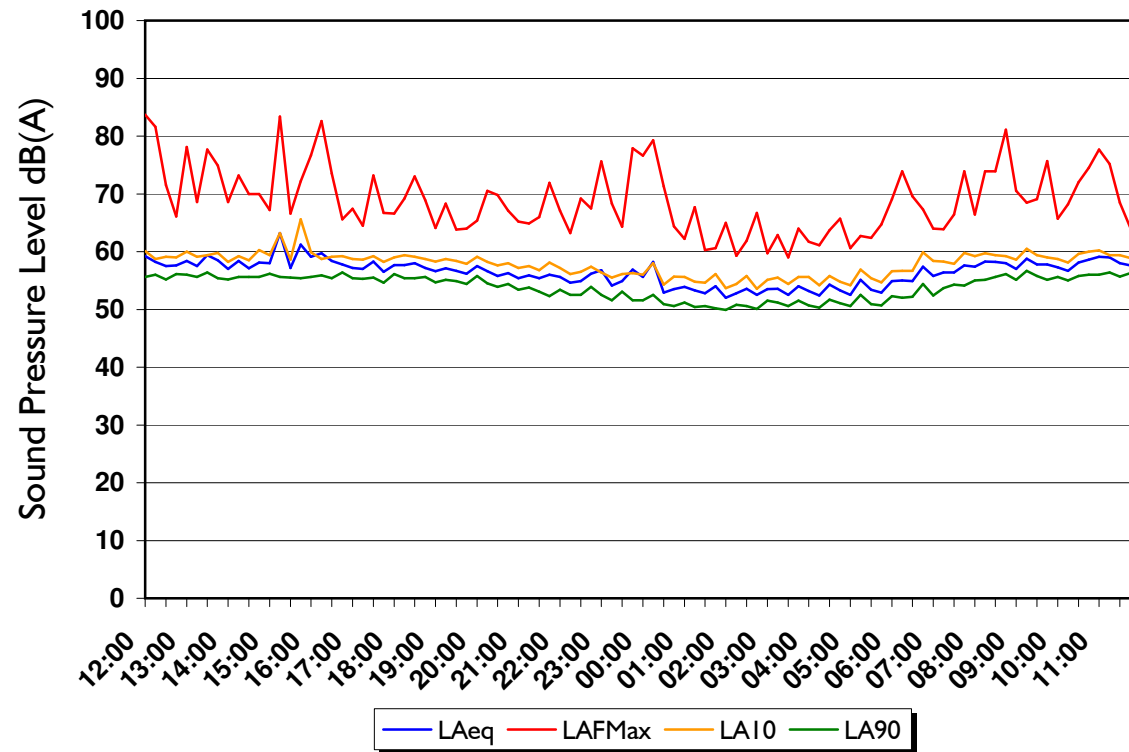


Wednesday 01 September to Wednesday 01

Figure AS6171/TH2

80 Charlotte Street - Whitfield Street

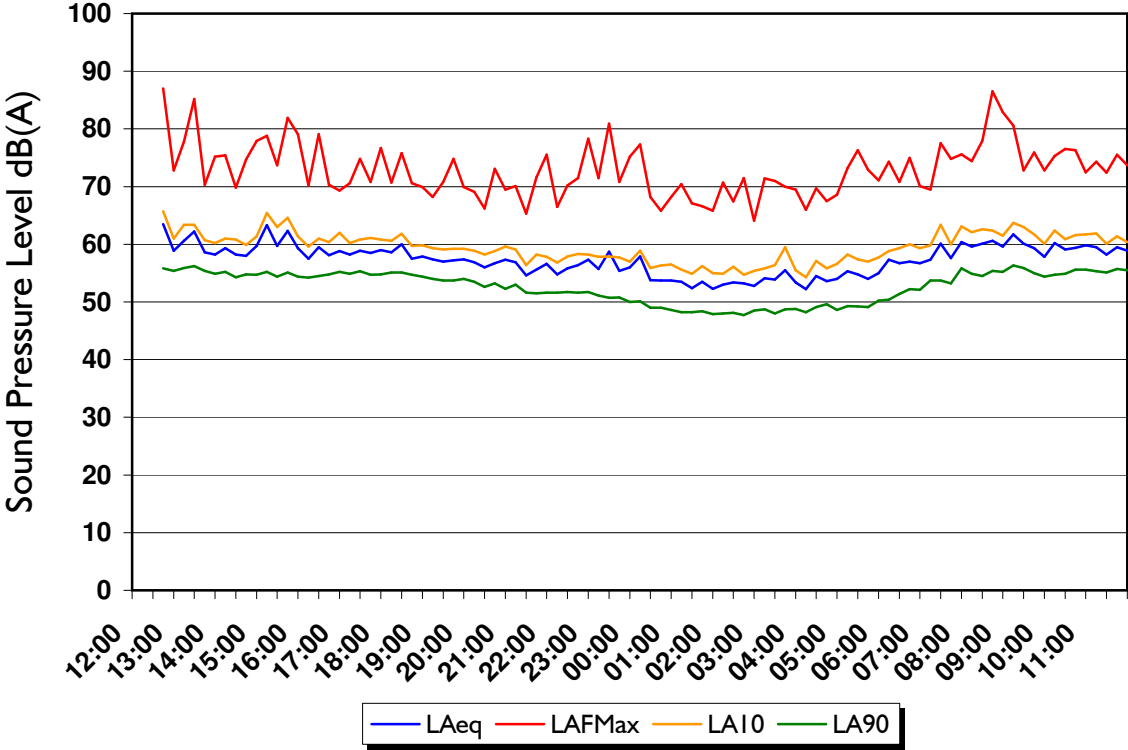
Environmental Noise Time History



Wednesday 01 September to Wednesday 01

Figure AS6171/TH3

65 Whitfield Street Environmental Noise Time History



Wednesday 01 September to Thursday 02 September

Figure AS6171/TH4

RECOMMENDED NOISE EXPOSURE CATEGORIES FOR NEW DWELLINGS NEAR EXISTING NOISE SOURCES: PPG24

| NOISE LEVELS ⁰ CORRESPONDING TO THE NOISE EXPOSURE CATEGORIES FOR NEW DWELLINGS L _{Aeq,T} dB | | | | | |
|--|----------------------------|-------------------------|---------|---------|-----|
| | | NOISE EXPOSURE CATEGORY | | | |
| NOISE SOURCE | PERIOD | A | B | C | D |
| road traffic | 07.00 - 23.00 | <55 | 55 - 63 | 63 - 72 | >72 |
| | 23.00 - 07.00 ¹ | <45 | 45 - 57 | 57 - 66 | >66 |
| rail traffic | 07.00 - 23.00 | <55 | 55 - 66 | 66 - 74 | >74 |
| | 23.00 - 07.00 ¹ | <45 | 45 - 59 | 59 - 66 | >66 |
| air traffic ² | 07.00 - 23.00 | <57 | 57 - 66 | 66 - 72 | >72 |
| | 23.00 - 07.00 ¹ | <48 | 48 - 57 | 57 - 66 | >66 |
| mixed sources ³ | 07.00 - 23.00 | <55 | 55 - 63 | 63 - 72 | >72 |
| | 23.00 - 07.00 ¹ | <45 | 45 - 57 | 57 - 66 | >66 |

NOTES

⁰ **Noise Levels:** the noise level(s) (L_{Aeq,T}) used when deciding the NEC of a site should be representative of typical conditions.

¹ **Night time noise levels (23:00 - 07:00):** sites where individual noise events regularly exceed 82dB L_{Amax} (5 time weighting) several times in any hour should be treated as being in NEC C, regardless of the L_{Aeq,8hr} (except where the L_{Aeq,8hr} already puts the site in NEC D).

² **Aircraft noise:** daytime values accord with the contour values adopted by the Department of Transport which relate to levels measured 1.2m above open ground. For the same amount of noise energy, contour values can be up to 2dB(A) higher than those of other sources because of ground reflection effects.

³ **Mixed sources:** this refers to any combination of road, rail, air and industrial noise sources. The 'mixed source' values are based on the lower numerical values of the single source limits in the table. The 'mixed source' NECs should only be used where no individual noise source is dominant.

To check if any individual noise source is dominant (for the purposes of this assessment) the noise level from the individual sources should be determined and then combined by decibel addition (remembering first to subtract 2 dB(A) from any aircraft noise contour values). If the level of any one source then lies within 2 dB(A) of the calculated combined value, that source should be taken as the dominant one and the site assessed against the appropriate NEC for that source, rather than using the 'mixed source' NECs. If the dominant source is industrial noise see paragraph 19 of Annex 3.

If the contribution of the individual noise sources to the overall noise level cannot be determined by measurement and/or calculation, then the overall measured level should be used and the site assessed against the NECs for 'mixed sources'.

| NEC | GUIDANCE |
|-----|--|
| A | Noise need not be considered as a determined factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level. |
| B | Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise |
| C | Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise. |
| D | Planning permission should normally be refused. |

TABLE AS6171/NEC

APPENDIX A

ACOUSTIC TERMINOLOGY & HUMAN RESPONSE TO BROADBAND NOISE

1.0 ACOUSTIC TERMINOLOGY

The annoyance produced by noise is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and any variations in its level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

- dB (A):** The human ear is more susceptible to mid-frequency noise than the high and low frequencies. To take account of this when measuring noise, the 'A' weighting scale is used so that the measured noise corresponds roughly to the overall level of noise that is discerned by the average human. It is also possible to calculate the 'A' weighted noise level by applying certain corrections to an un-weighted spectrum. The measured or calculated 'A' weighted noise level is known as the dB(A) level.
- L_{10} & L_{90} :** If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The L_n indices are used for this purpose, and the term refers to the level exceeded for n% of the time, hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the average minimum level and is often used to describe the background noise.
- It is common practice to use the L_{10} index to describe traffic noise, as being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic noise.
- L_{eq} :** The concept of L_{eq} (equivalent continuous sound level) has up to recently been primarily used in assessing noise in industry but seems now to be finding use in defining many other types of noise, such as aircraft noise, environmental noise and construction noise.
- L_{eq} is defined as a notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (e.g. 8 hour, 1 hour, etc).
- The use of digital technology in sound level meters now makes the measurement of L_{eq} very straightforward.
- Because L_{eq} is effectively a summation of a number of noise events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute noise limit.
- L_{max} :** L_{max} is the maximum sound pressure level recorded over the period stated. L_{max} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the L_{eq} noise level.
- D** The sound insulation performance of a construction is a function of the difference in noise level either side of the construction in the presence of a loud noise source in one of the pair of rooms under test. D , is therefore simply the *level difference* in decibels between the two rooms in different frequency bands.
- D_w** D_w is the *Weighted Level Difference* The level difference is determined as above, but weighted in accordance with the procedures laid down in BS EN ISO 717-1.
- $D_{nT,w}$** $D_{nT,w}$ is the *Weighted Standardised Level Difference* as defined in BS EN ISO 717-1 and represents the *weighted level difference*, as described above, corrected for room reverberant characteristics.
- C_{tr}** C_{tr} is a spectrum adaptation term to be added to a single number quantity such as $D_{nT,w}$, to take account of characteristics of a particular sound.
- $L'_{nT,w}$** $L'_{nT,w}$ is the *Weighted Standardised Impact Sound Pressure Level* as defined in BS EN ISO 717-2 and represents the level of sound pressure when measured within room where the floor above is under excitation from a calibrated tapping machine, corrected for the receive room reverberant characteristics.

APPENDIX A

ACOUSTIC TERMINOLOGY & HUMAN RESPONSE TO BROADBAND NOISE

2.0 OCTAVE BAND FREQUENCIES

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation have agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, eg. 250 Hz octave band runs from 176 Hz to 353 Hz. The most commonly used bands are:

| | | | | | | | | |
|---------------------------------|----|-----|-----|-----|------|------|------|------|
| Octave Band Centre Frequency Hz | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---------------------------------|----|-----|-----|-----|------|------|------|------|

3.0 HUMAN PERCEPTION OF BROADBAND NOISE

Because of the logarithmic nature of the decibel scale, it should be borne in mind that noise levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) is not twice as loud as 50 dB(A) sound level. It has been found experimentally that changes in the average level of fluctuating sound, such as traffic noise, need to be of the order of 3dB(A) before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10 dB(A) is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in traffic noise level can be given.

INTERPRETATION

| Change in Sound Level dB(A) | Subjective Impression | Human Response |
|-----------------------------|---|------------------|
| 0 to 2 | Imperceptible change in loudness | Marginal |
| 3 to 5 | Perceptible change in loudness | Noticeable |
| 6 to 10 | Up to a doubling or halving of loudness | Significant |
| 11 to 15 | More than a doubling or halving of loudness | Substantial |
| 16 to 20 | Up to a quadrupling or quartering of loudness | Substantial |
| 21 or more | More than a quadrupling or quartering of loudness | Very Substantial |

4.0 EARTH BUNDS AND BARRIERS - EFFECTIVE SCREEN HEIGHT

When considering the reduction in noise level of a source provided by a barrier, it is necessary to establish the "effective screen height". For example if a 3 metre high barrier exists between a noise source and a listener, with the barrier close to the listener, the listener will perceive the noise source is louder, if he climbs up a ladder (and is closer to the top of the barrier) than if he were standing at ground level. Equally if he sat on the ground the noise source would seem quieter than it was if he were standing. This may be explained by the fact that the "effective screen height" is changing with the three cases above, the greater the effective screen height, in general, the greater the reduction in noise level.

Where the noise sources are various roads, the attenuation provided by a fixed barrier at a specific property will be greater for roads close to the barrier than for roads further away.