TEMPLAR HOUSE

ACOUSTIC STATEMENT

JULY 2015

NORTHWOOD INVESTORS

ASTUDIO

Northwood Investors

Templar House

Acoustic Report - Planning

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Ove Arup & Partners Ltd
13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

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			Prepared by	Checked by	Approved by
		Name	Adrian Passmore BEng CEng MIOA	Ian Knowles BSc AUS CPhys MinstP FIOA	Adrian Passmore BEng CEng MIOA
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
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			Prepared by	Checked by	Approved by
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		Signature			

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Appendices

Executive Summary

Arup has carried-out a detailed Noise Impact Assessment of the proposed mixed-use development at Templar House, London, This has been done with regard to the London Borough of Camden's (LBC) planning policy and the requirement of the Building Regulations. The conclusions of this study are:-

- ***Site suitability for residential development***
    - The existing environmental noise levels at the future residential building are predicted to be below those at which LBC would not grant planning permission and in the range where attenuation measured may be required. It is expected that sealed double glazed units will be able to provide sufficient sound insulation so that the BS8233 guidance on internal noise levels can be met. (Apartments will be provided with comfort cooling and mechanical ventilation so that residents will not need to open windows for the purposes of either ventilation and/or thermal comfort.)
    - The estimated vibration due to London Underground Central Line train movements is significantly below LBC's criteria in the future residential units and the associated ground-borne regenerated noise is also within LBC's criterion.
- ***Protecting the amenity of the existing population***
    - Based on the lowest measured background noise levels, cumulative services noise emission limits have been specified in accordance with LBC's criterion. The design will be developed to include mitigation as necessary to achieve these.
- ***Building regulations***
    - Confirmation is provided that the design will achieve the minimum required levels of sound insulation and that reverberant noise control will be provide in the communal residential spaces.

1 Introduction

Arup has been instructed by Northwood Investors to provide acoustic consultancy services on the proposed mixed-use development at Templar House, London, which includes being commissioned by Northwood Investors to produce a report in support of the planning application.

Arup has carried-out a detailed Noise Impact Assessment with regard to the requirements of the London Borough of Camden and the Building Regulations. This report presents the details of that assessment.

Appendix A contains a glossary of acoustic terminology used in this document.

2 Local Planning Authority Requirements

The London Borough of Camden's (LBC) *Local Development Framework - Camden Development Policies - Adoption version 2010* defines their approaches to assessing the appropriateness of planned residential development and also the quantitative measure for protecting the amenity of the existing population from planned introduction of new noise sources such as building services.

The relevant extracts from the LBC policy that stipulate the objective criteria are reproduced in the following sub-sections.

2.1 Site suitability for residential development

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

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

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

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

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

Vibration description and location of measurement	Period	Time	Vibration levels
Vibration inside critical areas such as a hospital operating theatre	Day, evening and night	0000-2400	0.1 VDV ms-1.75
Vibration inside dwellings	Day and evening	0700-2300	0.2 to 0.4 VDV ms-1.75
Vibration inside dwellings	Night	2300-0700	0.13 VDV ms-1.75
Vibration inside offices	Day, evening and night	0000-2400	0.4 VDV ms-1.75
Vibration inside workshops	Day, evening and night	0000-2400	0.8 VDV ms-1.75
Where dwellings may be affected by ground-borne regenerated noise internally from, for example, railways or underground trains within tunnels, noise levels within the rooms should not be greater than 35dB(A)max			

2.2 Protecting the amenity of the existing population

Table E: Noise levels from plant and machinery at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000-2400	10dB(A) <LA90
Noise at 1 metre external to sensitive façade where LA90>60dB	Day, evening and night	0000-2400	55dB$_{LAeq}$

3 Acoustic surveys

3.1 Environmental noise

3.1.1 Details

Unattended noise monitoring was carried out between Wednesday 19 November and Tuesday 25 November 2014, supplemented with attended, short-duration measurements at the start and end of this period.

Figure 1 indicates the survey locations. The data loggers were placed on the High Holborn elevation at 8th floor (Logger A) and at the balcony on the 5th floor on Eagle Street (Logger B). The manned survey locations (Locations 1 and 2) were at pedestrian level.

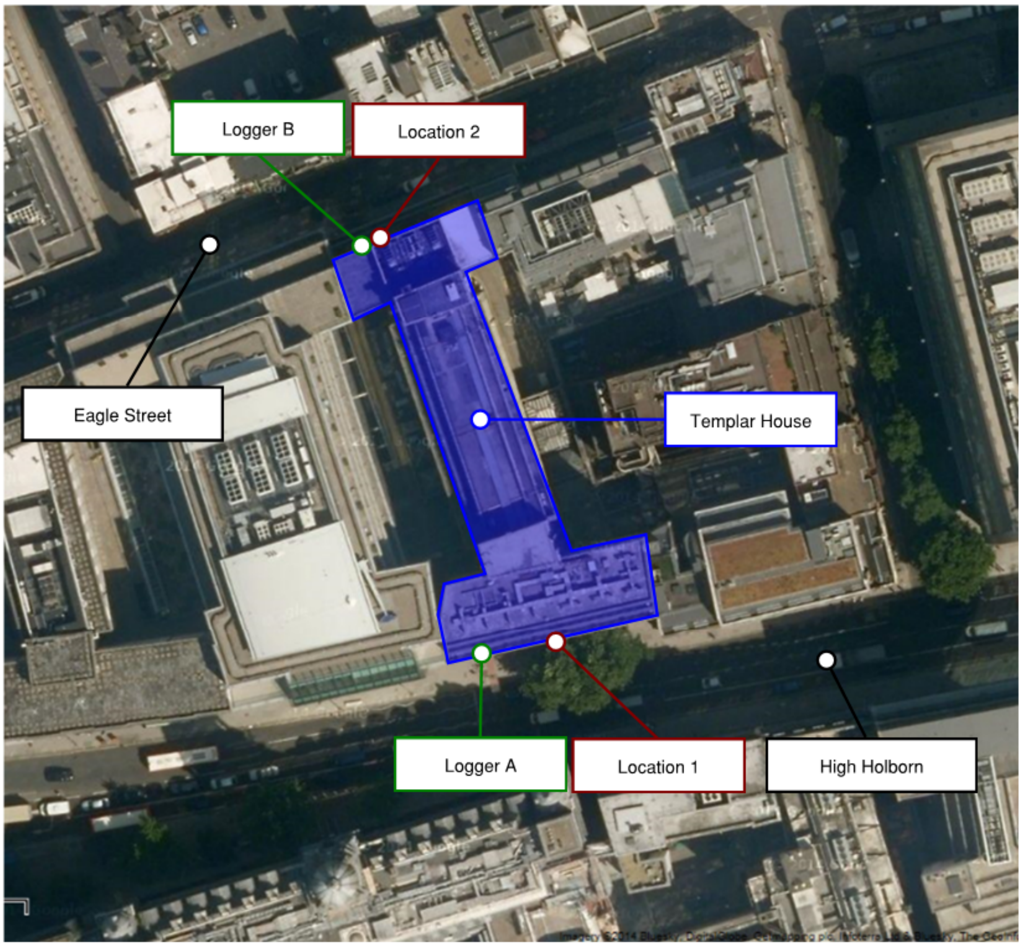

Figure 1: Environmental noise survey locations

3.1.2 Results

Figures 2 and 3 present the survey results from the two data loggers.

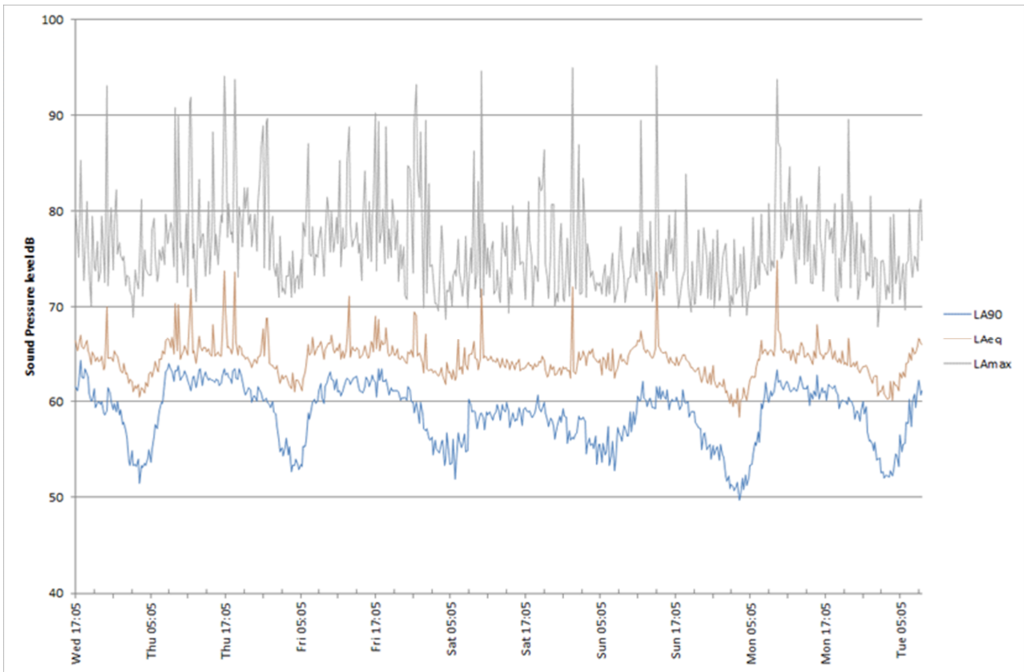

Figure 2: Logger A survey results Wednesday 19 November to Tuesday 25 November 2014

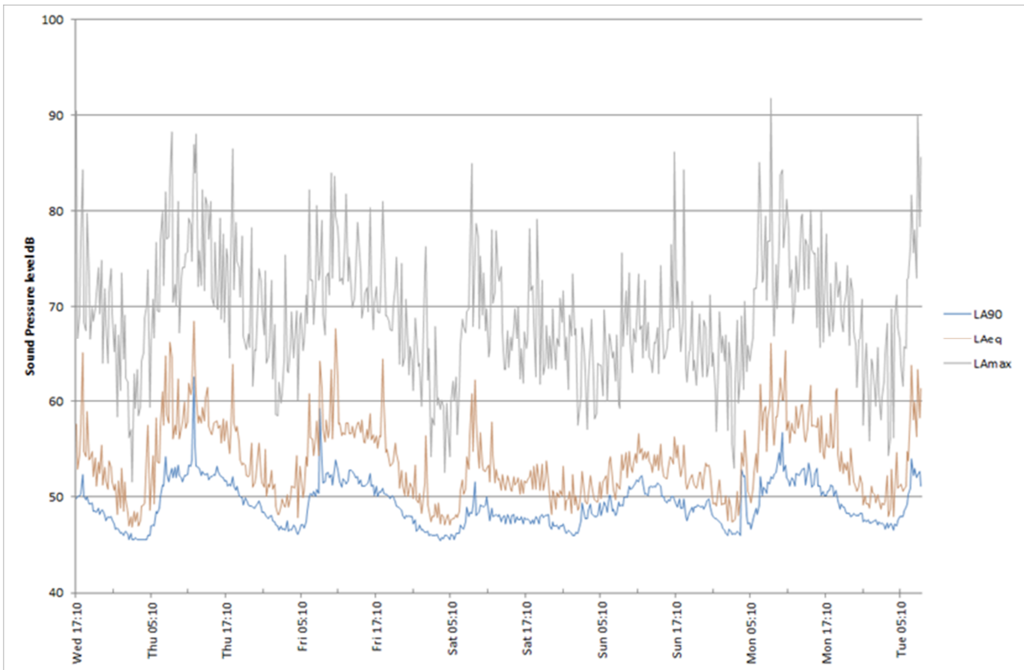

Figure 3: Logger B survey results Wednesday 19 November to Tuesday 25 November 2014

Table 1 presents the manned survey results. At High Holborn, in addition to road traffic, pedestrian noise also contributed to the measured noise levels, albeit to a lesser degree.

Location	Start Time	Noise Index		
		dBL_{A90}	dBL_{Aeq}	$dBL_{Amax,fast}$
1	17:50	65	72	92
	18:05	66	72	92
	18:21	66	72	90
2	19:05	48	56	76
	19:20	49	58	81
	19:36	49	57	78

Table 1: Daytime attended measurement results

3.2 Train vibration

3.2.1 Details

On Wednesday 19 November 2014, sample measurements of train vibration were made at two locations on the existing basement floor of Templar House, as indicated in Figure 4. These locations were selected to provide the worst-case levels that the future commercial and residential elements could be exposed to.

Prior to the survey, Transport for London were contacted and they confirmed that no track maintenance has taken place recently, and neither was there any planned works in the future. The Central Line was operating a “good” service for the duration of the vibration survey.

Figure 4: Train vibration survey locations

3.2.2 Results

Figure 5 presents an extract of the vibration time history as was measured at the survey location directly below the proposed location of the residential block in the existing car park.

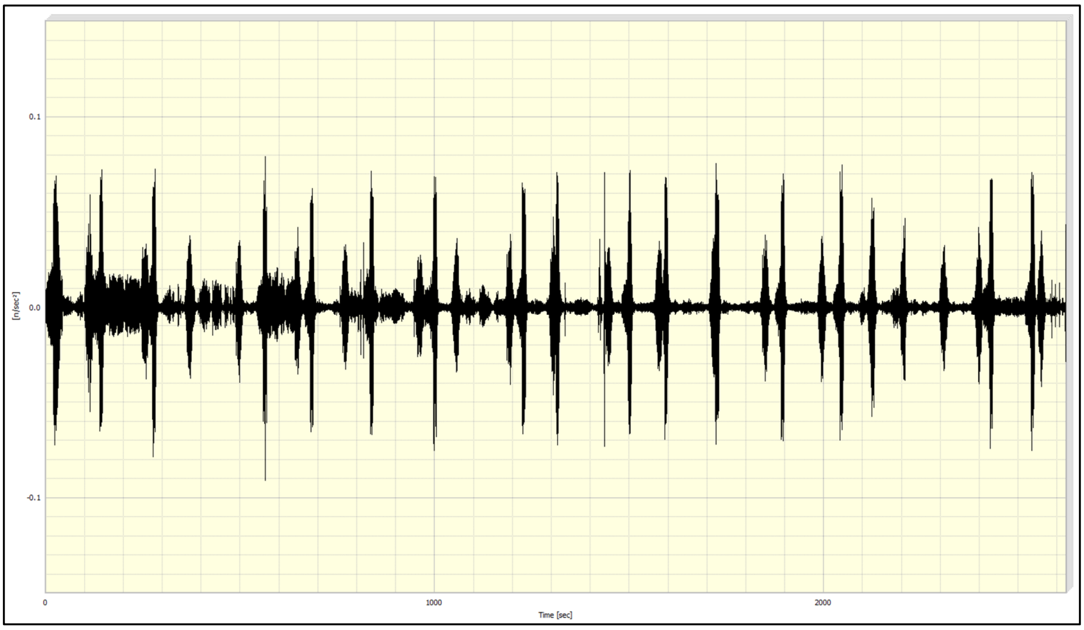

Figure 5: Vibration time history extract from Car Park

4 Assessment

4.1 Site suitability for residential development

4.1.1 Noise levels inside future residential units

The entire survey data from the data logging noise monitor located at the most noise exposed elevation of the future residential block has been assessed with regards to the time periods specified in LBC's policy.

The data logger was positioned at the 5th floor of the existing building and so the results have been corrected to predict noise exposure at the lower floors ie those be closer to Eagle Street. This has been done by quantifying the difference between the manned measurements made at pedestrian level with those that were measured at the same time at the 5th floor with the data logger. The differences were in the range 4-6dB, and we have conservatively used the largest difference. This approach introduces a further degree of conservatism in that the lowest floor of proposed residential accommodation will be at first floor level and not ground floor.

The results are presented in the following table and compared to LBC's objective criteria.

LBC Time Period	**Predicted noise level**	**LBC' s policy**	
		"Noise levels on residential streets …at which planning permission will not be granted"	**"Noise levels on residential streets…at and above which attenuation measures may be required"**
Daytime (0700 to 1900)	$64dBL_{Aeq,12hrs}$	$72dBL_{Aeq,12hrs}$	$62dBL_{Aeq,12hrs}$
Evening (1900 to 2300)	$60dBL_{Aeq,4hrs}$	$72\ dBL_{Aeq,4hrs}$	$57dBL_{Aeq,4hrs}$
Night time (2300 to 0700)	$57dBL_{Aeq,8hrs}$	$66\ dBL_{Aeq,8hrs}$	$52\ dBL_{Aeq,8hrs}$
	$58\text{-}83dBL_{Amax,fast}$	n/a	$82dBL_{Amax,slow}$

Table 1: Predicted noise levels assessed against LBC criteria

The average daytime, evening and night time noise levels at the most noise exposed part of the future residential building are below the level at which LBC would not grant planning permission and in the range where attenuation measured may be required.

Figure 6 presents a histogram of the maximum noise levels measure at night time across the entire survey period. There were only 3 individual events that were marginally above 82dB(A), these occurred on separate nights and furthermore the sound level meter on the 'fast' time setting which would be higher than the 'slow' time setting expressed in LBC's criteria. It is considered, therefore, that the LBC trigger level for maximum event noise levels was not exceeded.

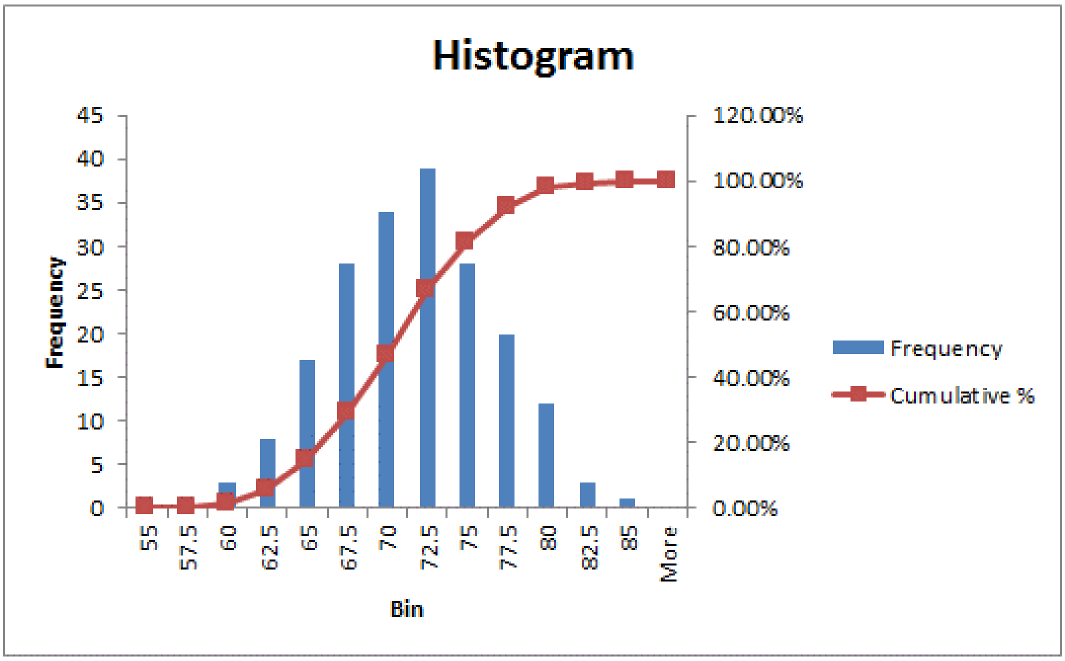

Figure 6: Maximum noise level histogram

4.1.2 Façade sound insulation

BS8233: 2014 *Guidance on sound insulation and noise reduction for buildings* suggests 35dB$L_{Aeq,16hrs}$ and 30dB$L_{Aeq,8hrs}$ as being appropriate internal ambient noise levels inside dwellings during the daytime and night time periods respectively.

Based on the survey results and BS8233 guidance, an initial estimate for the sound insulation required for the Eagle Street façade is in the order of R_w36. A typical window configuration that could achieve this is 6.4mm laminated pane + 12mm gas filled space + 6mm glass. (Apartments will be provided with comfort cooling and mechanical ventilation so that residents will not need to open windows for the purposes of either ventilation and/or thermal comfort.)

It is expected that the remaining elevations, particularly the one facing into the development, will be exposed to lower noise levels and so a commensurately lower facade sound insulation could be used.

4.1.3 Train vibration inside future residential units

The vibration dose value has been estimated (eVDV) based on highest individual train vibration measured and with reference to the Central Line timetable. Table 2 presents the results compared to LBC's criteria.

	Day and evening (0700 to 2300)		Night (2300 to 0700)	
	Assessed Level	**LBC Criterion**	**Assessed Level**	**LBC Criterion**
eVDV, $m.s^{-1.75}$	0.04	0.2 to 0.4	0.03	0.13

Table 2: Assessment of train vibration

The calculated estimated train vibration is significantly below LBC's criteria.

4.1.4 Ground-borne regenerated noise in future residential units due to train vibration

Based on 34 individual train passes, the calculated ground-borne regenerated noise in the lowest floor of residential accommodation is in the range 24 to 35dB$L_{Amax(slow)}$, which is within LBCs criterion.

4.2 Protecting the amenity of the existing population

The lowest background noise levels measured across the surveys were:-

- 53dBL_{A90} and 50dBL_{A90} on High Holborn during the daytime and night time respectively.
- 46dBL_{A90} and 45dBL_{A90} on Eagle Street during the daytime and night time ie respectively.

Based on these results, and compliance with LBC's criterion, cumulative noise emissions from the building services installation will be limited to 48dBL_{Aeq} and 45dBL_{Aeq} outside neighbouring properties on High Holborn during daytime and night time periods respectively. The limit outside neighbouring properties on Eagle Street is 40dBL_{Aeq}.

5 Compliance with Building Regulations

Approved Document E (ADE) of the Building Regulations (2010): *Resistance to the passage of sound* specifies minimum requirements for acoustics separation between and within dwellings (Regulations E1 and E2) and the approach required in communal areas to controlling reverberant noise via architectural finishes (Regulation E3). The specific requirements are summarised below and it is confirmed the design will be developed based on full-compliance.

- Regulations E1 and E2
  Airborne sound insulation between dwellings ≥ $D_{nT,w} + C_{tr}$ 45
  Impact sound isolation between dwellings ≤ $L'_{nT,w}$ 62
  Airborne sound insulation for walls within dwellings R_w40

- Regulation E3
  In entrance halls, corridors and hallways an area equal to or greater than the floor should be covered with a Class C absorber (average absorption coefficient should be at least 0.6).
  In stairways and stairwells, the treatment area is calculated based on the combined area of stair treads and landings. Either an equal area to this is treated with a Class D absorber (average coefficient 0.3) or an area equal to 50% is treated with a Class C absorber.

Appendix A

Acoustic Terminology

Decibel (dB)

The ratio of sound pressures which we can hear is a ratio of 106:1 (one million:one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (Lp) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

dB(A)

The unit used to define a weighted sound pressure level, which correlates well with the subjective response to sound. The 'A' weighting follows the frequency response of the human ear, which is less sensitive to low and very high frequencies than it is to those in the range 500Hz to 4kHz.

In some statistical descriptors the 'A' weighting forms part of a subscript, such as L_{A10}, L_{A90}, and L_{Aeq} for the 'A' weighted equivalent continuous noise level.

Equivalent continuous sound level

An index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

Frequency

Frequency is the rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A 1000Hz is often denoted as 1kHz, eg 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes the octave bands between 63Hz to 8kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

Impact sound pressure level, $L'_{nT,w}$

The impact sound insulation of floors is evaluated by measuring the sound pressure level in the receiving room resulting from a standard tapping machine placed on the floor of the source room. The measured values, in each of the third-octave bands from 100Hz to 3150Hz, are adjusted to allow for the acoustic of the receiving room and compared with a standard reference curve, in accordance with the procedure defined in BS EN ISO 717-2: 1997 to obtain the single figure weighted standardised impact sound pressure level, $L'_{nT,w}$.

Where there are no flanking routes to modify the performance the results are described by $L_{nT,w}$.

Maximum noise level

The maximum noise level identified during a measurement period. Experimental data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125ms duration and fast time weighting (F) has an exponential time constant of 125ms which reflects the ear's response. Slow time weighting (S) has an exponential time constant of 1s and is used to allow more accurate estimation of the average sound level on a visual display.

The maximum level measured with fast time weighting is denoted as $L_{Amax, F}$. The maximum level measured with slow time weighting is denoted $L_{Amax, S}$.

Sound level difference (D)

The sound insulation required between two spaces may be determined by the sound level difference needed between them. A single figure descriptor, the weighted sound level difference, D_w, is sometimes used (see BS EN ISO 717-1).

Sound pressure level

The sound power emitted by a source results in pressure fluctuations in the air, which are heard as sound.

The sound pressure level (L_p) is ten times the logarithm of the ratio of the measured sound pressure (detected by a microphone) to the reference level of 2 x 10^{-5}Pa (the threshold of hearing).

Thus L_p (dB) = 10 log $(P_1/P_{ref})^2$ where Pref, the lowest pressure detectable by the ear, is 0.00002 pascals (ie $2x10^{-5}$ Pa).

The threshold of hearing is 0dB, while the threshold of pain is approximately 120dB. Normal speech is approximately 60dBL_A and a change of 3dB is only just detectable. A change of 10dB is subjectively twice, or half, as loud.

Sound reduction index (R)

The sound reduction index (or transmission loss) of a building element is a measure of the loss of sound through the material, ie its attenuation properties. It is a property of the component, unlike the sound level difference which is affected by the common area between the rooms and the acoustic of the receiving room. The weighted sound reduction index, R_w, is a single figure description of sound reduction index which is defined in BS EN ISO 717-1: 1997. The R_w is calculated from measurements in an acoustic laboratory. Sound insulation ratings derived from site (which are invariably lower than the laboratory figures) are referred to as the R'_w ratings.

Statistical noise levels

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for 10% of the time period under consideration, and can be used for the assessment of road traffic noise (note that L_{Aeq} is used in BS 8233 for assessing traffic noise). The L_{90}, the level exceeded for 90% of the time, has been adopted to represent the background noise level. The L_{1}, the level exceeded for 1% of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, e.g. $dBL_{A10, 5min}$ or $dBL_{A90, 8hr}$.

Structureborne noise

This is the transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, i.e. expansion joints and floating floors.

Vibration

Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing human comfort or structureborne noise issues.

Vibration amplitude may be quantified as a peak value, or as a root mean squared (rms) value. The rms value is of benefit because it takes into account both time history variation and energy content. The rms value is equal to 0.707 times the peak value and experience has shown that the overall rms value of vibration velocity, over the range of 10Hz to 1kHz, gives the best indication of vibration severity.

Vibration amplitude can be expressed as an absolute value e.g. $1mms^{-1}$ or as a ratio on a logarithmic scale in decibels, i.e.

vibration velocity level, dB = 20 log (V/V_{ref}),

where the preferred reference level, Vref, for vibration velocity = $1x10^{-9}$ ms^{-1}.

For example; $1mms^{-1}$ = 120dB

Note that the reference level for acceleration, aref, is $1x10^{-6}ms^{-2}$.

The decibel approach has advantages for manipulation and comparison of data and the definition of descriptors such as Leq and Lmax given above will also be applicable.

Generally humans are more sensitive to changes in vibration amplitude than they are to changes in the duration of the exposure to vibration.

Vibration dose value (VDV)

This is a complex metric that has been identified as being the best objective measure of human disturbance from intermittent/transient vibration. The VDV is the fourth root of the time integral of the fourth power of the weighted acceleration. VDV are measured in units of $m/s^{1.75}$. The frequency weightings are defined in BS 6472-1: 2008 and in BS 6841: 1987.

The VDV doubles in magnitude with a doubling of vibration amplitude. However, a 16-fold increase in the duration of exposure to the vibration is required to double the VDV (without any change in amplitude).