


Holborn Links – Project 2

RIBA Stage 3 Acoustic Design Report

May 2022

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Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2008 and BS EN ISO 14001: 2004)

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1. Introduction

This report has been prepared by Waterman Infrastructure & Environment Ltd. (hereafter 'Waterman'), it provides acoustic design recommendations for the proposed internal refurbishment 6 – 8 Southampton Place as Project 2 of the proposed Holborn Links Estate (hereafter the 'Site'). The Site is bound Southampton Place and a courtyard to the rear, a layout of the Site is presented as Figure 1-1. The purpose of the report is to inform the design team of the proposed acoustic requirements in aiding design proposals. It should be considered as a document for discussion and an agreed basis on which the design can be progressed.

There are broadly four acoustic design issues to be addressed as part of the development:

- Control of external noise / vibration intrusion.
- Acoustic separation afforded by internal wall and floor constructions.
- Control of reverberation (the time for sound to decay).
- Control of building services noise and vibration both to the environment and within the development.

1.1 Description of Existing Development Site & Development Proposals

The Site lies within an urban area nearby Holborn Station, with surrounding land uses being predominantly commercial (office, retail, restaurants and cafes), with some residential dwellings in the nearby vicinity. As stated above, the Site is bound by Southampton Place. The predominant noise source at the Site is road traffic noise from the surrounding transport network.

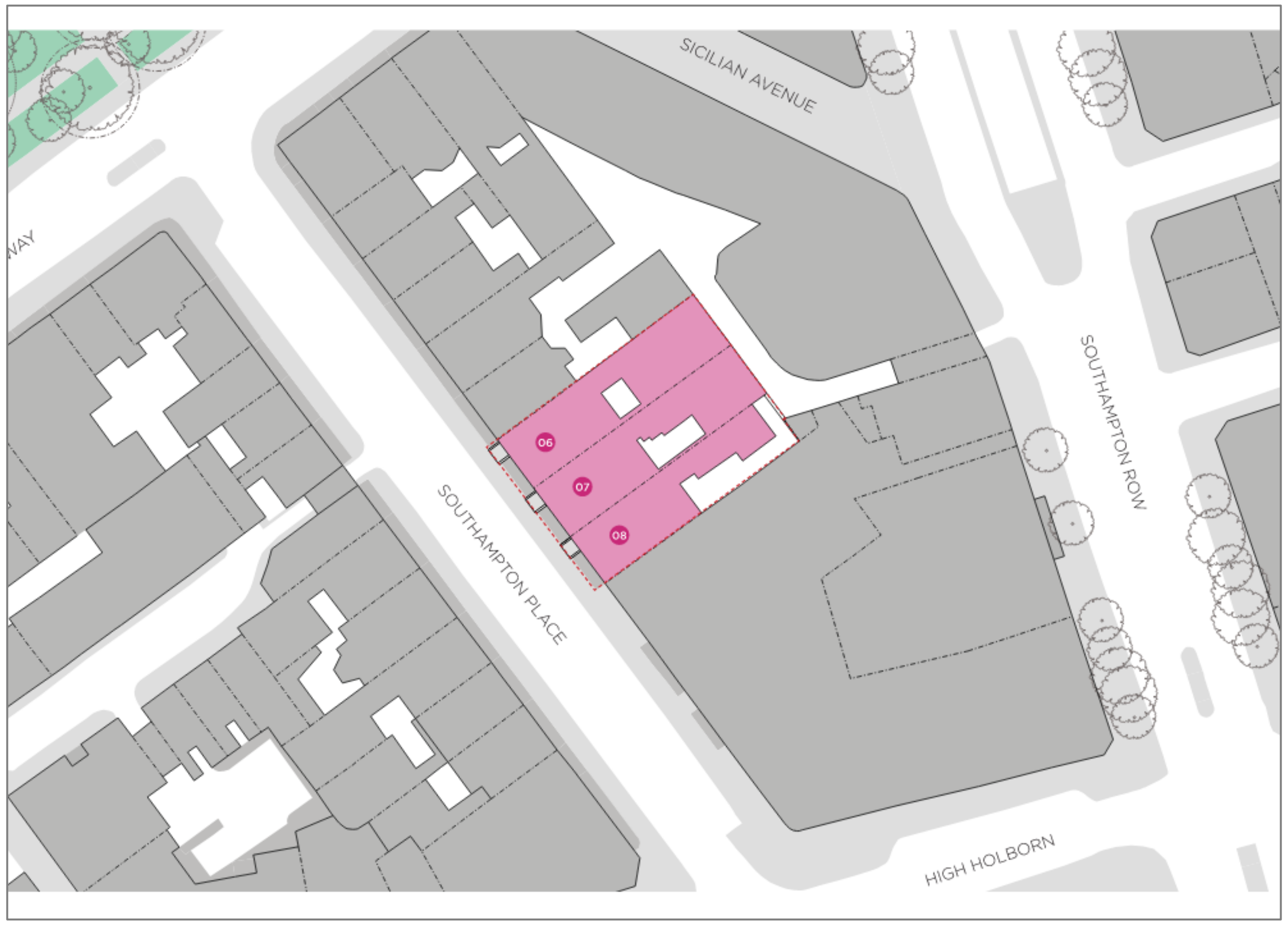
The current development proposals are to refurbish the internal areas of the Site to provide new office accommodation at 6 – 8 Southampton Place.

1.2 Proposed Design Standards & Guidance

The scheme should as a minimum comply with the following acoustic standards and guidance:

- BS 8233:2014 Guidance on Sound Insulation and noise reduction for buildings.
- British Council for Offices Guide to Specification 2019' (BCO Offices Guide 2019).
- British Council for Offices Guide to Fit-out 2011.
- BS 4142:2014+A1:2019 Method for rating and assessing industrial and commercial sound.
- Requirements of BREEAM 2018 Hea05 and Pol05.
- Relevant noise policies of the Local Authority of the London Borough of Camden (LBC).

Figure 1-1: Layout of Holborn Links Project 2



2. Design Criteria and Guidance

2.1 External Noise Intrusion

2.1.1 Internal Noise Criteria

To aid in the design of the building and the control of external-to-internal noise transmission, reference has been made to relevant and credited guidance documents including BCO *'Guide to Specification' 2019* and BS8233:2014. These guidance documents recommend upper limits for external noise intrusion via internal ambient noise level (IANL) criteria. These criteria are to be met within the commercial and retail areas to ensure the acoustic environment within different room spaces are appropriate for their function.

IANL criteria relevant to both the retail and commercial elements are presented in Table 2-1.

Table 2-1: Internal Noise Criteria in Unoccupied Spaces.

Room / Space	Period	Design Criteria	Purpose
Commercial			
Meeting Rooms, Executive Offices	All Periods	35-45[1] $L_{Aeq,T}$ / NR30 35-40 $L_{Aeq,T}$ / NR30	Reasonable conditions for study and work requiring concentration
Speculative Offices		40-50 $L_{Aeq,T}$ / NR38	
Open Plan Offices, Reception Rooms		45-50 $L_{Aeq,T}$ / NR35 45-50 $L_{Aeq,T}$ / NR35	Reasonable acoustic privacy in shared spaces
Ancillary areas, Corridors, Toilets		45-55[1] $L_{Aeq,T}$ / NR40	Reasonable speech or telephone conversations

Notes: [1] Lower limit of criteria required under BREEAM New Construction.

In addition, maximum noise intrusion levels should not normally exceed L_{AF01} 50 dB in cellular offices and L_{AF01} 55 dB in open plan offices. The above target criteria for internal noise levels also satisfy the requirements of BREEAM Hea05.

2.2 External Vibration and Groundborne / Structure-borne Noise Intrusion

Guidance provided by the BCO with regards to vibration and groundborne / structure-borne noise from external vibration sources (e.g. trains, road traffic) and internal vibration sources (e.g. plant items such as transformers, air handling units, chillers, etc) in offices states the following:

"vibration transfer from continuous sources (e.g. plant items) to internal areas should not exceed 0.01 m/s² peak acceleration, based on Wb weighting as defined in clause 3.3 of BS6472-1:2008. Vibration transfer from intermittent sources (e.g. underground trains) to internal areas should not lead to re-radiated noise levels in occupied cellular offices and meeting rooms in excess of 45dB $L_{Amax(fast)}$ or in the case of open plan offices in excess of 50dB $L_{Amax,fast}$."

2.3 Internal Acoustic Separation

To provide sufficient acoustic separation between different user spaces, separating walls and floors will need to provide a sufficient level of sound insulation, having regard to the likely activity level in the source room and the tolerance level in the receiving room.

The office sound insulation design via direct sound path through walls or floors shall comply with the guidance provided in the BCO Guide to Specification 2019 in that:

"Sound level difference vertically between individual office floors should be at least D_{nTw} 45dB at shell and core stage, or at least D_{nTw} 48dB if fitted to Cat A standards…where an adjacent office occupier demise is separated by a wall constructed as part of the shell and core or Cat A fit-out, then the same sound insulation standards as set for the floors shall be achieved."

The façade flanking transmission sound paths e.g. via mullions or transoms shall also comply with BCO Guidance for speculative offices in that:

"Within offices flanking transmission horizontally across cladding mullions at the potential fit out partitions should be capable of demonstrating a weighted normalised flanking difference of at least $D_{nf,w}$ 45dB" and "…should be capable of being upgraded in the (Cat B) fit out to at least $D_{nf,w}$ 53dB".

The above is also translatable to vertical flanking transmission across transoms between floors of the development. The above target criteria for acoustic separation also satisfy the requirements of BREEAM Hea05.

2.3.1 Impact Sound Transmission

As well as the transmission of airborne sound between individual spaces, vertical impact sound transmission should also be controlled. Regarding impact sound, BCO states:

"*Impact noise due to footfall in office areas should be controlled. This is normally achieved with carpet but where hard floor finishes are proposed additional impact measures will be required both to control sound to adjacent areas and within the space itself. A weighted standardised impact sound pressure level ($L'_{nT,w}$) of 60 dB is considered a reasonable maximum value for floors over office areas. Individual situations that may require superior impact sound insulation should also be considered."*

2.3.2 Between Other Spaces

Acoustic separation between other non-office use spaces will be considered on a case-by-case basis, based on the privacy requirement and the target noise level of each space.

2.4 Reverberation Control

2.4.1 Offices Spaces

Office and other sensitive spaces require good acoustic conditions for comfort and clarity of speech, with control of reverberant (reflected) noise an integral component. Although some reverberation within a space is desirable in aiding speech distribution, longer reverberation times will cause a build-up of noise and degrade speech intelligibility.

BCO recommends that for base-build office design (Cat A), an acoustically absorbent ceiling achieving a Class A rating should be installed in addition to carpets. Where a Class A ceiling is not proposed to the entire ceiling, alternative provisions should be made for the control of reverberation in the office space.

2.5 Building Services Noise

2.5.1 Internal Building Services Noise

To ensure that noise from building services systems do not cause disturbance to the residents/tenants of the office building, building services noise should be controlled to meet the noise ratings presented in Table 2-2.

Table 2-2: Noise Emission Limits for Internal Building Services.

Room Space	Internal Building Services Noise Limiting Criteria
Cellular Offices / Meeting Rooms	NR 30
Open Plan Offices	NR 35
Speculative Offices	NR 38
Entrance Lobbies	NR 40
Circulation Spaces	NR 40
Toilets	NR 45

As well as the above, noise generated by internal plants should be limited/mitigated against to suit adjacent occupied areas. Noise levels within plant rooms should not exceed the Control of Noise at Work Regulations 2005 first action level which is 80 dBA (NR70).

2.5.2 Lift Shaft Noise Criteria

Where service risers and lift shafts abut office areas, limits in Table 2-3 should not be exceeded. This information should be forwarded to the lift contractor to ensure that a suitable lift is procured.

Table 2-3: Noise Criteria for Building Lifts.

Room / Space (Measurement Location)	Limit of Noise Intrusion L_{Afmax} dB
In lift car and in lift lobby	55
Into offices without lift lobbies	50
Into offices through lift shaft walls	35

2.5.3 External Building Services Noise Emissions to Atmosphere

The significance of building services noise impacts depends upon a number of factors including but not limited to, the absolute noise level, the nature of the noise, the time and duration at which the noise occurs, whether the noise is temporary, intermittent or permanent, whether the impact is as a result of a new source, or whether it is a change to an existing source and/or the sensitivity of the receptor.

The primary source of guidance in relation to noise which is commercial in nature, such as fixed building services plant, is provided in BS 4142:2014+A1:2019 '*Methods for rating and assessing industrial and commercial sound'*. BS 4142 provides an objective method for rating the likelihood of compliance from industrial and commercial operations and also provides a means of determining noise levels from fixed building services plant installations and prevailing background noise levels on, and around, proposed developments. The criteria for the assessment of complaints as taken from BS 4142 are presented in Table 2-4.

Table 2-4: Likelihood of Complaints (BS 4142).

Noise Level Difference dB(A)	Likelihood of Complaints
>10 dB	Typically, the greater this difference, the greater the magnitude of the impact
10 dB	A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
5 dB	A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context
<5 dB	The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

The standard sets out a methodology whereby the likelihood of complaints about an industrial noise source can be assessed. The measured or predicted noise level from the source in question, the 'specific noise' level, immediately outside the dwellings is compared with the 'background noise' level. Where the noise contains a "*distinguishable discrete continuous note (whine, hiss, screech, hum, etc.)*" or "*if there are distinct impulses in the noise (bangs, clinks, clatters or thumps)",* or *"if the noise is sufficiently irregular as to attract attention*", then a correction of is added based on the assessors' judgment of the potential effects these subjective characteristics could have on the extent of community annoyance due to the source. The corrected level is the referred to as the 'rating level' in dB $L_{Ar,Tr}$. The likelihood of noise provoking complaints is assessed by subtracting the background noise level from the rating noise level.

Requirements of London Borough of Camden

Chapter four entitled 'Noise and Vibration' of Camden's Planning Guidance 6 Amenity[1], states that the Council "*will ensure that noise and vibration is controlled and managed to limit noise and vibration emissions from new development*".

LBC's Development Policy 28 (DP28) entitled Noise and Vibration[2] states that noise emissions from new plant and machinery should not exceed Camden's specified thresholds. Table 2-5 presents LBC's noise limiting criteria.

Table 2-5: Plant/Machinery Noise Threshold Levels of Camden Council

Noise Description and Location of Measurement	Period	Time	Noise Level
Noise at 1 metre external to a sensitive facade	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

[1] London Borough of Camden. (2010) Camden Planning Guidance CPG 6 Amenity. London Borough of Camden.

[2] London Borough of Camden. (2010) Camden Development Policies 2010-2015. Local Development Framework. London Borough of Camden.

Noise Description and Location of Measurement	Period	Time	Noise Level
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 L_{Aeq}

2.6 BREEAM Acoustic Criteria

The following BREEAM (2018) credits are available for the proposed development:

- Hea 05 – Acoustic performance
- Pol 05 – Reduction of noise pollution

The target design criteria set out in the subsections above satisfy – or in some cases exceed – the targeted credits for both Hea 05 and Pol 05. For completeness, the credits being targeted have been summarised below.

2.6.1 Hea 05 Acoustic performance

Table 2-6 presents the three Hea 05 BREEAM credits available for office buildings.

Table 2-6: BREEAM acoustic criteria for Offices

Office Buildings (three credits)	
First credit - Sound insulation	
Criteria	The sound insulation between acoustically sensitive rooms and other occupied areas complies with the performance criteria given in Section 7 of BS 8233:2014
Testing Requirement	A programme of pre-completion acoustic testing is carried out by a compliant test body in accordance with the acoustic testing and measurement procedures outlined in the Additional information section of this BREEAM issue.
Second credit – Internal Indoor ambient noise levels	
Criteria	Achieve indoor ambient noise levels that comply with the design ranges given in Section 7 of BS 8233:2014.
Testing requirement	A programme of acoustic measurements is carried out by a compliant test body in accordance with the acoustic testing and measurement procedures outlines in the Additional information section of this BREEAM issue.
Third credit - Room acoustics	
Criteria	Acoustic environment (control of reverberation, sound absorption and speech transmission index): Achieve the requirements relating to sound absorption and reverberation times, where applicable, set out in Section 7 of BS 8233:2014.
Testing Requirement	A programme of acoustic measurements is carried out by a compliant test body in accordance with the acoustic testing and measurement procedures outlined in the Additional information section of this BREEAM issue.

2.6.2 Pol 05 Reduction of Noise Pollution

Assessment criteria and compliance at the design stage information for Pol 05 has been referenced from BREEAM 2018 and is presented below.

Assessment criteria

One credit 1 There are no noise-sensitive areas within the assessed building or within 800m radius of the assessed site.

OR

2. Where there are noise-sensitive areas within the assessed building or noise-sensitive areas within 800m radius of the assessed site, a noise impact assessment compliant with BS 4142:2019 is commissioned. Noise levels must be measured or determined for:

2.a. Existing background noise levels:

2.a.i at the nearest or most exposed noise-sensitive development to the proposed assessed site

2.a.ii including existing plant on a building, where the assessed development is an extension to the building

2.b. Noise rating level from the assessed building.

3. The noise impact assessment must be carried out by a suitably qualified acoustic consultant.

4. The noise level from the assessed building, as measured in the locality of the nearest or most exposed noise sensitive development, must be no greater than +5 dB lower than the background noise (L_{A90}) throughout the day and night.

5. If the noise sources from the assessed building are greater than the levels described in criterion 4, measures have been installed to attenuate the noise at its source to a level where it will comply with the criterion.

2.6.3 Compliance at the Design Stage

At the design stage of assessment, where noise-sensitive areas or buildings are present, actual measurement is unlikely to be possible due to the planned but non-existent installation. In such situations, compliance can be demonstrated through the use of acousticians' calculations or by scale model investigations. For such cases, BS 4142:2019+ states:

"Determine the specific sound level by calculation alone if measurement is not practicable, for example if the source is not yet in operation. In such cases, report the method of calculation in detail and give the reason for using it."

Where prediction methods are not possible, measurement will be necessary using either a noise source similar to that proposed or measurement of the actual noise from the installation (once installed). Compliance with the latter approach requires a written commitment to appoint a suitably qualified acoustician to carry out the required measurements post-installation, and a further commitment to attenuate the noise source in compliance with criteria 4 above and 5 above (if proved necessary by the measurements).

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3. Baseline Environmental Conditions

3.1 Nearest Noise Sensitive Receptors

Following a review of the site and surrounds, the closest existing sensitive receptors that have the potential to be adversely affected by the development have been identified and are presented as Table 3-1.

Table 3-1: Nearest Sensitive Receptors

Receptor	Type of Receptor	Description / Name	Approximate Distance to Site Boundary (m)
SR A	Commercial	Commercial Operations along Southampton Place	Immediately adjacent Site
SR B	Commercial	Adjacent Commercial Operations along Southampton Row (1 Southampton Row)	Across courtyard behind Site, approx. 10m from Site boundary
SR C	School	CATS London, 43 – 45 Bloomsbury Square	Across courtyard behind Site, approx. 25m from Site boundary
SR D	Residential	Residential Dwellings along Barter Street	Approx. 60m south west of Site boundary

Further to the above, a greater number of sensitive receptors have been identified around the site than are presented in Table 3-1; however, given their distance relative to the site and the above receptors, it is considered that so long as noise impacts are adequately controlled at the receptors identified above, further receptors would experience no significant noise effects. Receptors further to the above have therefore not been considered within these assessments.

3.2 Environmental Noise Survey – July 2016

A baseline environmental noise survey was previously conducted by Waterman at and within the vicinity of Southampton Row from Tuesday 12th July until Wednesday 13th July 2016, to establish the prevailing ambient noise levels. To allow continuous noise monitoring at secure locations, an environmental sound level meter was installed on a balcony at 5th floor level of 21 Southampton Row overlooking Southampton Row. In addition to this an environmental noise logger was installed at the rear of the building at ground floor level and is considered representative of the background noise level at the rear of buildings on Southampton Place.

Supplementary short-term attended noise monitoring was conducted within the alleyway that connects Southampton place to the courtyard to the rear of the Site.

Table 3-2 presents the results of the baseline noise survey with monitoring locations described above. The daytime period is taken as 07:00 – 19:00, evening period as 19:00 – 23:00 and night-time period as 23:00 – 07:00.

Table 3-2: Summary of Baseline Survey Results

ID	Description	Period	L_{Aeq}[1]	L_{AFmax}[2]	L_{A10}[3]	L_{A90}[3]
LT1	21SH 5th Floor Balcony	Day	70	87	70	64
		Eve	66	82	69	60
		Night	65	82	68	58
LT2	Rear of 21SH Ground Floor	Day	56	79	56	53
		Eve	54	77	54	51
		Night	51	69	52	49
ST1	Alley Way (Under croft South of 21SH)	Day	70	86	71	64

Note: [1] Logarithmic average. [2] 90th Percentile. [3] Arithmetic average.

The weather conditions during the survey period were monitored remotely, weather station ID IGREATER13 at Bloomsbury. Wind speeds throughout out the survey period were less than 5 m/s. During the afternoon period of Tuesday 12th July 2016 some light rain was recorded with a rain event during the evening and night-time period. Although the rain did not appear to have affected the measured noise levels, these data sets when rain was presents were removed from the subsequent data analysis.

The noise climate at all locations was dominated by road traffic noise although at the rear of the building the building structure itself affords attenuation against road traffic noise. At the rear of the building it is considered that there is also some contribution to the noise climate from existing building services plant although the selected noise monitoring location was shielded from plant within the rear courtyard area of 21 Southampton Row.

Full details of the baseline survey are available on request.

3.3 Survey Data Validation

Given the existing high traffic flows on the surrounding road network, it is considered that the noise levels around the Site would have been unlikely to have changed since the surveys in 2016.

To check the validity of the noise survey data, a noise propagation model of the Site and its surrounds was built using the CadnaA software package and calibrated to the measurements above. The calibrated model was then compared to the DEFRA strategic noise mapping for England and Wales[3]. The model calibrated to the 2016 data shows good correlation with the DEFRA noise maps and, as such, is considered suitable for use within this assessment.

[3] Accessed via: http://www.extrium.co.uk/noiseviewer

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4. Assessment

4.1 External Noise Intrusion

The overall performance of a façade system is generally determined by the performance of the weakest element. In most cases – with the exception of some "lightweight" façade systems – the weakest element is the glazing. It is currently understood that the glazing units will not be replaced (nor secondary glazing units installed) as part of the as part of the proposed fit-out works.

Notwithstanding the above, should the design intent change such that credits under BREEAM Hea 05 are targeted, it is recommended that secondary glazing units are installed to ensure that the external noise intrusion criteria of Hea 05 are met.

Based on the survey data presented in **Section 3** of this report and historical noise data around the Site, **it is recommended that should glazing be a replaced a minimum performance of ≥28 dB R_w+C_{tr}.**

It should be noted that the sound insulation performance is for the glazing units as a whole (including framing, seals openable lights etc.) as opposed to the glass panels alone. Accordingly, all laboratory tested data provided by suppliers should include relevant corrections for losses due to the inclusion of frames, seals and openable lights etc., which in practice must not to compromise the overall performance of the façade system. Similarly, all calculated or indicative specifications provided by suppliers should include relevant corrections for frame losses and margins of error in calculations.

4.1.1 Ventilation

It is currently understood that all areas of the development building are to be mechanically ventilated. The ventilation strategy is suitable from a noise perspective.

Further details of the ventilation proposals will be assessed at the next design stage.

4.2 Internal Acoustic Separation

Stair Cores Sound Insulation

Sensitive rooms located adjacent to concrete stairwells and where relevant lift shafts should be fitted with an independent wall lining (IWL) including:

- 2 x layers 12.5 mm plasterboard on studs (independent of the lift shaft wall)
- 25 mm mineral wool insulation in the cavity (minimum density 33 kgm^{-3}).

Sound Insulation of Building Services Risers

Riser walls should provide a minimum acoustic performance of D_{nTw} 42 dB (~Rw 49 dB).

Soil Vent Pipe (SVP) and Rainwater Pipes

Where rainwater/SVP pipes run through sensitive rooms said pipes should lagged with 25 mm insulation and boxed in with 2 layers of 12.5 mm gypsum wallboard.

4.2.1 Doors

Recommended sound insulation performance requirements for doors have been included within Appendix C.

4.2.2 Floors

Floor Types,

The existing slab construction is not known. The performance of the floor slab should be confirmed at the next design stage following further structural site investigations.

Rooftop Plant to Office Floor

Although the final floor construction of the rooftop plant areas has not yet been finalised, there is the potential that the construction may not offer sufficient sound insulation due to the lightweight structure of the upper floors, and that the slab / roof construction could potentially be set into vibration due to its potential lack of mass and thinness.

It is recommended that all plant should be mounted on vibration isolators and that the ceiling construction below these areas should be enhanced as follows:

- 2 x layers plasterboard (min surface mass 10 kgm^{-2}) suspended on isolated resilient clips / hangers to isolate ceiling from noise and vibration transmission from the rooftop plant;
- 100mm cavity lined with 50mm acoustic insulation (min. density 30 kgm^{-3}).

Section 5.3 provides guidance for the provision of plant isolators to reduce vibration transmission from plant into the floor slab.

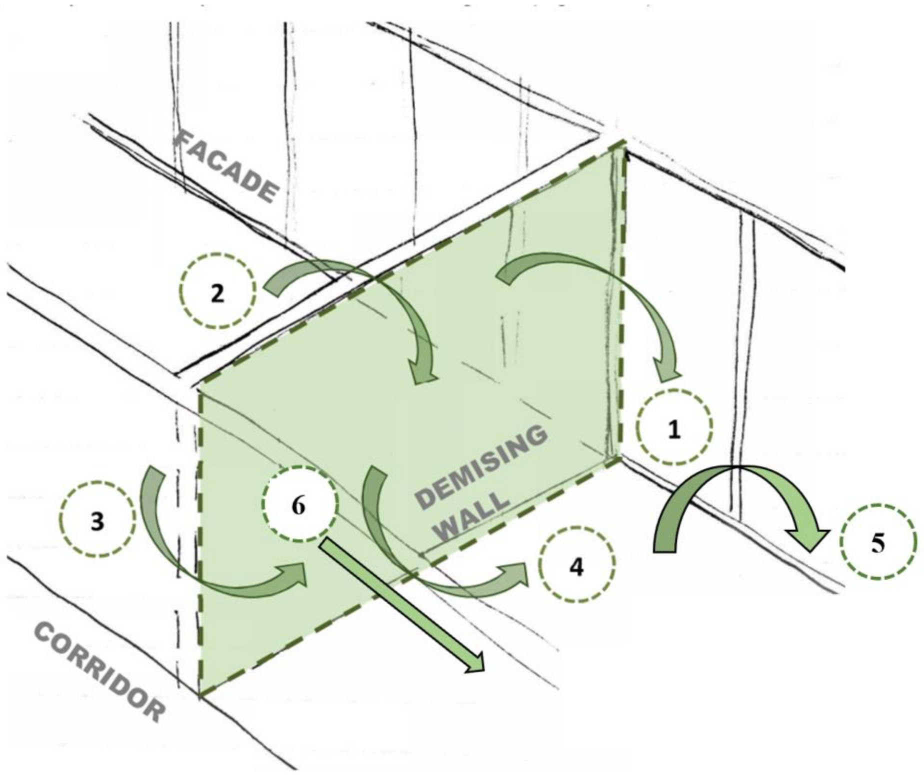
4.2.3 Control of Flanking Sound

Flanking sound occurs when sound transmits between spaces via indirect paths around the main separating element. Some common flanking sound paths are listed below and illustrated by Figure 4-1.

1. Horizontal sound transmission between rooms across the façade via the separating wall;
2. Horizontal sound transmission between rooms via the ceiling and deflection head of the separating demise wall;
3. Horizontal sound transmission between rooms via the corridor walls and doors;
4. Horizontal sound transmission via a continuous floor under the separating wall;
5. Vertical sound transmission between spaces via façade transoms, via closure/movement detail fire stopping, and via the façade glazing; and
6. Flanking via electrical services sockets, ducts, pipes between separating demise walls.

Specific sound flanking paths relevant to the Site proposals are addressed in the following sections.

Figure 4-1: Common Sound flanking Paths at Demise Wall



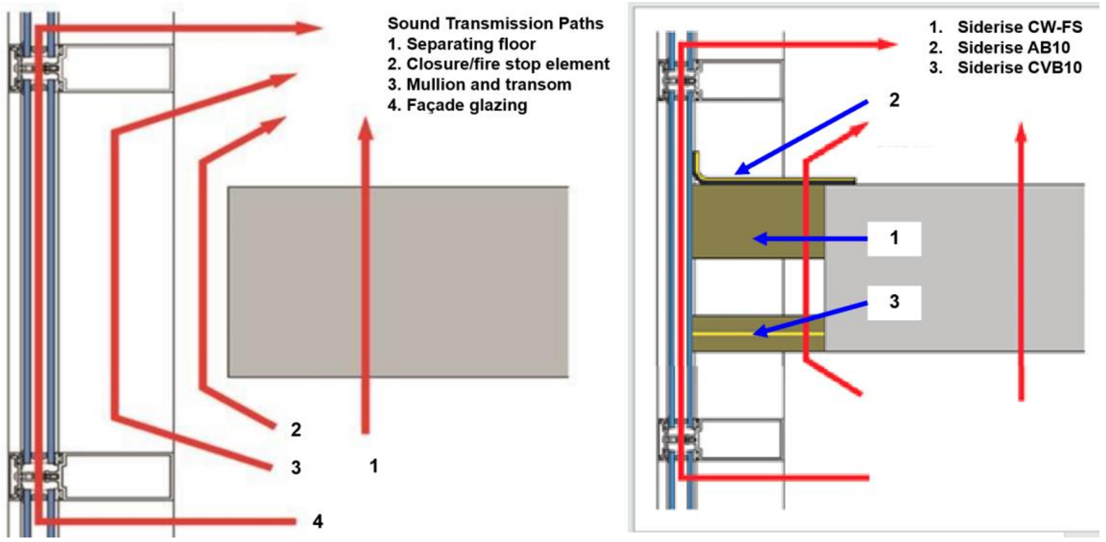
Horizonal Flanking via Head and Base of Partitions

Example suitable head and base details for both lightweight and masonry partitions are included as Appendix D. It is recommended that separating walls should be built off the base floor slab and up to the underside of the slab above to reduce potential sound flanking over / under the partition. It should also be ensured that gaps at the base and head are filled with bulk jointing compound and acoustic non-hardening sealant to maintain sound insulation of walls.

Vertical Flanking via Junction of Slab Edge with Façade / Transoms

For information, flanking sound between vertical adjacencies is shown in Figure 4-2, although not all paths shown will apply to the proposed development. It will be important that details of the floor to façade junction are reviewed during the next design stage by Waterman to ensure that the sound path between floors is minimised.

Figure 4-2: The Vertical Flanking Sound Paths via Curtain Façade (left) and Flanking Control Methods (right) (Siderise[4] CW-FS, AB10, and CVB10).



4.3 Control of Reverberation

4.3.1 Offices

The scope of the refurbishment works for this development does not include the provision of acoustic absorption for the office spaces, as this is considered a fit-out design issue. Under the guidance provided in BCO this should be made clear in the Base Build Definition along with guidance with regards to the amount of absorption which would be required to comply with BCO.

4.3.2 Corridors and Circulation Spaces

Guidance[5] for the control of reverberation in these spaces is typically referenced from Building Regulations document Approved Document E which provides two methods including Method A and Method B. Method A is typically the easier to implement and states to use a Class C absorber of area equal to or greater than the floor area. It will normally be convenient to cover the ceiling area throughout these areas however if this is not possible then absorption on the walls is advised.

5. Building Services Noise Control

5.1 External Building Services Noise

As discussed in Section 2 of this report, the noise level emitted from any new plant shall be controlled to the requirements of LBC which meet or exceed the requirements of BREEAM Pol 05. Plant noise level assessments are typically carried out in accordance with BS 4142:2014 at 1 metre from the window of the nearest noise sensitive premises and include the total contribution of noise from all plant items associated with the proposed plant scheme.

To ensure that noise emissions from fixed mechanical plant are adequately controlled, noise level limits have been recommended based on the existing noise levels around the Site (dB L_{A90}) and the guidance provided in BS 4142:2014+A1:2019[6].

[4] https://www.siderise.com/applications/products/

[5] Approved Document E – ‘Resistance to the passage of sound’. 2010. ISBN 978 1 85946 204 1

[6] British Standard Institute (BSI) (2019) BS4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound. BSI.

Table 5-1 presents the recommended plant noise limits.

Table 5-1: Recommended Plant Noise Limits

Measurement Location	Period	Representative (Modal Average) Background Noise Level dB L_{A90}	Plant Noise Limit dB $L_{Ar,Tr}$
All Sensitive Receptors (night time period only applicable to residential)	Day	52	≤47
	Night	49	≤44

Notes: [1]LT1 background noise levels used for all SRs.

Plant specification is sufficiently flexible as to ensure that suitably quiet, non-tonal plant can be procured and / or mitigation options such as screening (e.g. acoustic louvres) can be installed as necessary to ensure that guideline noise criteria set out in Table 5-1 are met. Measures to control noise from fixed mechanical plant to within the above criteria should be inherent in the detailed design of the development and, as such, potential effects associated with fixed mechanical plant would be insignificant.

A full assessment of plant noise impacts will be conducted at the next design stage, once plant selections and locations have been finalised.

5.2 Internal Building Services Noise

5.2.1 Mechanical Plant Internal Noise Rating Levels

Internal noise rating levels (NR) targets for habitable spaces within the development have been provided in Table 2-1 and are noted for each relevant room on the acoustic markups in Appendix C.

The noise within plant rooms should typically not exceed NR 70 so as to reduce noise transmission to adjacent spaces, reduce onerous structural constructions, and for worker health and safety reasons.

At this stage detailed information about internal building services systems is still under development, as such the following information is intended as general good practice guidance for building services systems designers to ensure that noise and vibration issues within the design are minimised.

5.2.2 Silencers and Maximum Air Velocities in Ducts

Attenuators in ductwork are recommended to mitigate against crosstalk between residential units via the ducts, as well as to control noise from air handling units. As with all service penetrations, a good, airtight seal will be required where ductwork passes through internal wall and floor partitions.

Noise may be regenerated at any ductwork discontinuity, bends, take-offs, dampers, etc., as well as at any terminal device itself. This regenerated noise manifests itself in the controlled space in the following manner:

1. As break-out noise radiation from the walls of the ductwork; and
2. As excessive noise radiation from the ductwork terminal to the conditioned space.

To reduce the most commonly occurring problems with duct services, the following items represent a list of good acoustic practice:

1. Bends and bifurcations – 90° bends should be either of the radiused type, or be fitted with equally spaced short chord turning vanes;
2. All branches should be fitted with boots or coned as standard practice; and
3. Transitions are to be as gradual as possible within the physical limitations and it is preferred that one pair of sides remain parallel.

When specifying and selecting mechanical plant it is important to consider noise generated by sources other than main air handling plant. To minimise the risk of regenerated noise, maximum duct velocities shown in Table 5-2 should be used.

Table 5-2: Maximum Recommended Duct Velocities

NR Design Levels	Maximum Duct Velocities (m/s)				
	Risers	Main branches	Ductwork to Grilles	Ductwork to Diffusers	Extract Stub Ducts (above ceiling voids)
25	5	3	1.5	1	1.5
30	6	4	2	1.5	2
35	7.5	5	2.5	2	3
38	9	5.5	2.5	2	3.5
>40	10	6	3	2.5	4

The above figures should be treated as a guide only. The position of the duct relative to the space and geometry of the fittings will determine whether increased or reduced air velocities are acceptable.

To aid with cost estimates, an approximation of the acoustic silencer length for various NR levels are provided in Table 5-3. It should be noted that pressure losses through silencers should normally be limited to 50 Pa.

Detailed calculations and selection should be carried out once plant equipment is finalised during the next design stage.

Table 5-3: Indicative Attenuator/Silencer Lengths (metres) for Required NR Level.

	NR 25	NR 30	NR 35	NR 40
Length of Acoustic Silencer (m)	3.0 - 3.6	1.8 - 2.4	1.5 - 1.8	1.2 - 1.5

5.2.3 Duct and Pipe Lagging Acoustic Specification

Where acoustic lagging for installation to ductwork and/or pipework is required, this shall consist of a resilient layer wrapped around the duct/pipework, together with an outer high mass skin. Potential lagging solutions are presented below.

Type A Standard Acoustic Lagging – All ducts and pipework

Resilient Layer: 50mm (minimum) thickness of mineral or fibreglass having a density of approximately 100kg/m³, or 50mm (minimum) thick Lamella mat at a density of 45 kg/m³,

Outer Mass Skin: Either a high-density sound deadening mat (10 kg/m^3) or a 2 mm thick synthetic lead sheet.

The materials should be installed in one of the following ways:

- Wrap the duct in the resilient layer and outer mass skin, the retain both with straps; or
- Using metal pins and large fixing washers. Pins will have perforated metal base plate and be non-self-adhesive but fixed to the duct surface with a suitable glue or other fixing, spaced at 300mm centres. The mineral wool and outer mass layer will be laid over the pins, which will then protrude, to be cut back to a minimum length and sealed with washers.

As an alternative to the above, any of several proprietary acoustic duct lagging products may be used e.g. H&H Muftiag. These must be first passed to the acoustic consultant for approval.

Type B Heavy Duty Acoustic Lagging – Fan Casings

- **Resilient Layer:** 75 mm (minimum) thickness of mineral or fibreglass having a density of approximately 100 kg/m^3, or 75 mm (minimum) thick Lamella mat at a density of 45 kg/m^3,
- **Outer Mass Skin:** 2 mm sheet steel, 19 mm plasterboard plank, or another sheet material of a surface density no less than 15 kg/m^2.

The sheet material shall be fixed to an independently supported timber or steel framework which does not come into direct contact with the duct work. All joints shall be taped and sealed with caulking or suitable dense mastic.

5.2.4 Plant Room Noise & Vibration Control

Vibration Isolation of Internal Plant Items

Internally located plant items adjacent to sensitive spaces should be isolated from the building structure to avoid undue vibration and resultant structure-borne noise.

All plant, equipment and associated service pipe and ductwork should be provided with appropriately designed and installed anti-vibration mounts to mitigate vibration transfer into the building structure. This may include springs, rubber mounts, air mounts, inertia bases or spring hangers.

Ideally the vibration transmissibility to the proposed building structure when above or adjacent to residential flats from mechanical plant items should not exceed 5% (i.e. the vibration isolation efficiency (VIE) should be equal or greater than 95% - VIE ≥ 95%). Since vibration from large plant items can transmit large distances within buildings it is recommended that all other plant items within the proposed Development are isolated to achieve at least VIE ≥ 90%.

The type of isolator that is most appropriate will depend on, among other factors, the mass of the plant item and the lowest forcing frequency of vibration to be isolated. The selection of bases and isolators types should follow the requirements of the selection guide for vibration isolation and/or Table 5.17 within CIBSE Guidance B4 as reproduced in Table 5-4. Supporting evidence should be provided in the form of efficiency graphs and calculations.

Table 5-4: Method for the Selection of Anti-Vibration Mounts (Extract from CIBSE B4).

Disturbing Frequency (Hz)	Machine Power (kW)					
		0 to 0.9 kW	1 to 9.9 kW	10 to 49.9 kW	50 to 99.9 kW	≥100 kW
Disturbing Frequency (RPM ÷ 60) 3.3 Hz	Vibration Isolation Efficiency	42 %	42 %	64 %	74 %	78 %
	Static Deflection	65 mm	65 mm	85 mm	105 mm	125 mm
	Mounting Resonance Frequency	2.0 Hz	2.0 Hz	1.7 Hz	1.5 Hz	1.4 Hz
Disturbing Frequency (RPM ÷ 60) 7.5 Hz	Vibration Isolation Efficiency	72 %	88 %	92 %	95 %	96 %
	Static Deflection	20 mm	40 mm	65 mm	85 mm	105 mm
	Mounting Resonance Frequency	3.5 Hz	2.5 Hz	2.0 Hz	1.7 Hz	1.5 Hz
Disturbing Frequency (RPM ÷ 60) 12 Hz	Vibration Isolation Efficiency	83 %	83 %	93 %	97 %	98 %
	Static Deflection	12 mm	12 mm	25 mm	65 mm	85 mm
	Mounting Resonance Frequency	4.6 Hz	4.6 Hz	3.0 Hz	2.0 Hz	1.7 Hz
Disturbing Frequency (RPM ÷ 60) 15 Hz	Vibration Isolation Efficiency	84 %	90 %	95 %	97 %	98 %
	Static Deflection	8 mm	12 mm	25 mm	40 mm	65 mm
	Mounting Resonance Frequency	5.5 Hz	4.5 Hz	3.2 Hz	2.5 Hz	2.0 Hz
Disturbing Frequency (RPM ÷ 60)	Vibration Isolation Efficiency	96 %	96 %	98 %	98 %	99 %

Disturbing Frequency (Hz)	Machine Power (kW)					
		0 to 0.9 kW	1 to 9.9 kW	10 to 49.9 kW	50 to 99.9 kW	≥100 kW
25 Hz	Static Deflection	12 mm	12 mm	20 mm	25 mm	40 mm
	Mounting Resonance Frequency	4.6 Hz	4.6 Hz	3.5 Hz	3.2 Hz	2.5 Hz

Notes:

1. The required Vibration Isolation Efficiency (VIE) is dependent on the sensitivity of the adjacent space from the plant item in question. For the selection of vibration isolators, the following VIE should be referenced Sensitive VIE 95%, Non-sensitive VIE 90%.
2. Obtain the plant power in kW.
3. Obtain the plant RPM and determine the disturbing frequency Hz of the machine (RPM ÷ 60).
4. Note the required static deflection required (mm).
5. Using static deflection, location (basement, floor span), type of equipment, choose anti-vibration mount and base type from 'Vibration Isolator Selection Chart' below.

Table 5-5 presents a vibration isolator selection chart based on the equipment type, location (ground or upper floors), floor span, and the minimum static deflection required as obtained from Table 5-4 above.

Table 5-5: Vibration Isolator Selection Chart (Extract from CIBSE Guide B4).

Equipment	Basement			6 m floor span			9 m floor span			12 m floor span			15 m floor span		
	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†
Refrigeration machines:															
— absorption	6	F/N	—	20	S	—	40	L	SBB	40	L	SBB	40	L	SBB
— centrifugal, scroll	6	F/N	—	20	S	—	40	L	SBB	40	L	SBB	40	L	SBB
— open centrifugal	6	N	CIB	20	S	CIB	40	L	CIB	40	L	CIB	40	L	CIB
Reciprocating chillers:															
— 500–750 r/min	25	L	—	40	L	CIB	60	L	CIB	60	L	CIB	90	L	CIB
— >751 r/min	25	L	—	20	L	CIB	40	L	CIB	60	L	CIB	60	L	CIB
Reciprocating air or refrigeration compressors:															
— 500–750 r/min	25	S	—	40	S	CIB	60	S	CIB	70	S	CIB	90	S	CIB
— >751 r/min	25	S	—	20	S	CIB	40	S	CIB	60	S	CIB	70	S	CIB
Boilers or steam generators	6	F	—	12	S	SBB	20	L	SBB	40	L	SBB	70	L	SBB
Pumps (water):															
— close coupled <4 kW	6	N	SBB	12	S	CIB	20	S	CIB	20	S	CIB	20	S	CIB
— close coupled >4 kW	20	S	CIB	20	S	CIB	40	S	CIB	60	S	CIB	60	S	CIB
— base mounted <4 kW	9	F	CIB	12	S	CIB	40	S	CIB	50	S	CIB	60	S	CIB
— base mounted >4 kW	25	S	CIB	20	S	CIB	40	S	CIB	60	S	CIB	90	S	CIB
Packaged unitary air handling units															
(low pressure, <750 Pa)	20	S	—	20	S	—	20	S	—	20	S	—	20	S	—
— suspended <4 kW	30	S	—	40	S	—	40	S	—	50	S	—	60	S	—
— suspended >4 kW, <500 r/min	25	H	—	25	H	—	25	H	—	40	H	—	50	H	—
— suspended >4 kW, >501 r/min	6	N	—	25	S	SBB	25	S	SBB	25	S	SBB	25	S	SBB
— floor mounted <4 kW	12	S	SBB	40	S	SBB	50	S	SBB	50	S	SBB	60	S	SBB
— floor mounted >4 kW, <500 r/min	12	S	SBB	25	S	SBB	25	S	SBB	40	S	SBB	50	S	SBB
— floor mounted >4 kW, >501 r/min	20	S	—	20	S	—	20	S	—	20	S	—	20	S	—
Axial fans (floor mounted):															
— <4 kW	6	N	—	25	S	SBB	25	S	SBB	25	S	SBB	25	S	SBB
— 4–15 kW, <500 r/min	12	S	SBB	40	S	SBB	50	S	SBB	50	S	SBB	60	S	CIB
— 4–15 kW, >501 r/min	12	S	SBB	25	S	SBB	25	S	SBB	40	S	SBB	50	S	SBB
— >15 kW <500 r/min	20	S	SBB	50	S	SBB	60	S	CIB	70	S	CIB	90	S	CIB
— >15 kW >501 r/min	12	S	SBB	25	S	SBB	30	S	SBB	40	S	SBB	50	S	SBB
Centrifugal fans (floor mounted) (low pressure, <750 Pa):															
— <4 kW	6	N	SFB	25	S	SFB	25	S	SFB	25	S	SFB	25	S	SFB
— >4 kW, <500 r/min	12	S	SFB	40	S	SFB	50	S	SFB	50	S	SFB	60	S	SFB
— >4 kW, >501 r/min	12	S	SFB	25	S	SFB	25	S	SFB	40	S	SFB	50	S	SFB
Centrifugal fans (floor mounted) (high pressure, >750 Pa)															
— <15 kW, 175–300 r/min	9	N	SFB	60	S	SFB	60	S	SFB	90	S	CIB	120	S	CIB
— <15 kW, 301–500 r/min	12	S	SFB	50	S	SFB	50	S	SFB	60	S	SFB	90	S	CIB
— <15 kW, >501 r/min	9	N	SFB	30	S	SFB	30	S	SFB	50	S	SFB	60	S	SFB
— >15 kW, 175–300 r/min	40	S	SFB	60	S	CIB	90	S	CIB	120	S	CIB	140	S	CIB

Equipment	Basement			6 m floor span			9 m floor span			12 m floor span			15 m floor span		
	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†	Minimum static deflection / mm	Mount type*	Base type†
— >15 kW, 301–500 r/min	25	S	SFB	50	S	CIB	60	S	CIB	90	S	CIB	120	S	CIB
— >15 kW, >501 r/min	12	S	SFB	30	S	CIB	50	S	CIB	60	S	CIB	90	S	CIB
Cooling towers:															
— <500 r/min	12	L	SBB	12	L	SBB	50	L	SBB	60	L	SBB	90	L	SBB
— >501 r/min	9	F/N	—	9	F/N	—	25	L	SBB	40	L	SBB	60	L	SBB
Internal combustion engines (standby power generation):															
— <20 kW	9	F	CIB	12	S	CIB	50	S	CIB	60	S	CIB	60	S	CIB
— 20–75 kW	12	S	CIB	50	S	CIB	60	S	CIB	90	S	CIB	90	S	CIB
— >75 kW	25	S	CIB	60	S	CIB	90	S	CIB	120	S	CIB	120	S	CIB

Notes:

1. The floor plan refers to the largest dimension between supporting columns. The equipment is assumed to be at mid-span.

2. * F = glass fibre, H = hanger, L = restrained spring, N = rubber, S = freestanding spring.
† SBB = steel beams, SFB = steel frame base, CIB = concrete inertia base.

APPENDICES

Appendix A Glossary of Acoustic Terms

Ambient sound — The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.

Assessment period — The period in a day over which assessments are made.

A-weighting — A frequency weighting applied to measured or predicted sounds levels in order to compensate for the non-linearity of human hearing.

Background noise — Background noise is the term used to describe the noise measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{90} noise level (see below).

Broadband — Containing the full range of frequencies.

Octave Band — A group of adjoining frequencies where the value of the upper limiting frequency is twice that of the lower limiting value

Decibel [dB] — The level of noise is measured objectively using a Sound Level Meter. This instrument has been specifically developed to mimic the operation of the human ear. The human ear responds to minute pressure variations in the air. These pressure variations can be likened to the ripples on the surface of water but of course cannot be seen. The pressure variations in the air cause the eardrum to vibrate and this is heard as sound in the brain. The stronger the pressure variations, the louder the sound that is heard.

The range of pressure variations associated with everyday living may span over a range of a million to one. On the top range may be the sound of a jet engine and on the bottom of the range may be the sound of a pin dropping.

Instead of expressing pressure in units ranging from a million to one, it is found convenient to condense this range to a scale 0 to 120 and give it the units of decibels. The following are examples of the decibel readings of every day sounds:

Four engine jet aircraft at 100m	120 dB
Riveting of steel plate at 10m	105 dB
Pneumatic drill at 10m	90 dB
Circular wood saw at 10m	80 dB
Heavy road traffic at 10m	75 dB
Telephone bell at 10m	65 dB
Male speech, average at 10m	50 dB
Whisper at 10m	25 dB
Threshold of hearing, 1000 Hz	0 dB

dB(A): A-weighted decibels — The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the 'A' filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.

Free Field — The term "free field" is used to define noise levels that have been measured or predicted in the absence of any influence of reflections from nearby surfaces, other than the ground. In practice, a noise level is considered to be free field if it is at a distance greater than 3.5 m from any reflecting surfaces, other than the ground.

Façade Noise Level — A noise level measured or predicted at the façade of a building, typically at a distance of 1m, containing a contribution made up of reflections from the façade itself (+3 dB).

L_{Amax} noise level — This is the maximum noise level recorded over the measurement period.

L_{Amin} noise level — This is the lowest level during the measurement period.

$L_{Aeq,T}$ noise level — This is the 'equivalent continuous A-weighted sound pressure level, in decibels' and is defined in British Standard 7445 as the 'value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, T, has the same mean square sound pressure as a sound under consideration whose level varies with time'.

It is a unit commonly used to describe construction noise, noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise.

L_{A90} noise level — This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.

L_{A10} noise level — This is the noise level which is achieved for 10% of the monitoring period and is often used to describe road traffic noise.

Noise Rating (NR) — A European method of rating broadband sound against a set of standardised curves that broadly equate to curves of equal loudness.

Sound Reduction Index (R) — The sound reduction index is a single-number rating of the sound reduction through a wall or other building element. Since the sound reduction may be different at different frequencies, test measurements are subjected to a standard procedure which yields a single number that is about equal to the average sound reduction in the middle of the human hearing range.

Weighted Sound Reduction Index (R_W) — Single number rating used to describe the **laboratory** airborne sound insulation properties of a material or building element over a range of frequencies, typically 100-3150Hz.

C_{TR} — An adjustment to the Rw scale to take account of the lower performance against a typical spectrum of road traffic noise dominated by low frequencies.

Standardised Level Difference ($D_{nT,w}$) — This is the level difference achieved from one room to another, normalised to a standard reverberation time of 0.5 seconds and weighted to provide a single-figure value. This is a field measurement of air-borne sound reduction between one room and another – there will be flanking transmission, so the whole room needs to be considered because the element under test, such as the separating wall, may not be the weakest path. environment.

Element Normalised Level Difference ($D_{ne,w}$) — From BSEN ISO 12354;2000 – the difference in the space and time average sound pressure level produced in two rooms by a source in one, where sound transmission is only due to a small building element – for example, transfer air devices, electrical cable ducts, transit sealing systems.

Weighted normalised impact sound pressure level ($L_{n,w}$) — Laboratory measurement of sound performance of a building element (floor) – there is no flanking (indirect) transmission loss, so only the element under test needs to be considered.

Peak Particle Velocity (PPV) — The highest instantaneous particle velocity during a given time interval.

VDV — This is the vibration dose value, a measure of vibration exposure; the fourth root of the integral, over the measurement period, of the fourth power of the frequency-weighted and time-varying acceleration.

UK and Ireland Office Locations