

ACOUSTIC DESIGN TECHNOLOGY
Noise and Vibration Consultants

ADT 2727

12 June 2018

Wakefield College
Wakefield City Campus
Margaret Street
WAKEFIELD
WF1 2DH

PRELIMINARY ACOUSTIC DESIGN GUIDANCE
GISSING BUILDING, WAKEFIELD COLLEGE
ACOUSTIC CONSULTANCY REPORT 2727/DG

Revision	Date	Issued By	Revision Notes
-	12 June 2018	Chris Middleton	first issue

1.0 INTRODUCTION

1.1 Development Proposals

The building is located on Balne Lane, Wakefield, and is a two storey education building, largely early 20th century with a modern extension to the rear.

The building is currently fully occupied by the Wakefield College Art, Media and Design department. The proposal is to relocate the music department into the ground floor of the building and decant the existing uses to elsewhere on campus.

1.2 Scope of Investigations

Acoustic Design Technology have been commissioned to provide an acoustic investigation of the building to form part of the feasibility study. As part of this exercise a series of acoustic tests have been undertaken, and preliminary design recommendations have been made.

Building Bulletin 93 (2015) provides useful acoustic design criteria for music teaching accommodation - as the design guide for primary and secondary schools the criteria are also useful for further education buildings. However, it is not a Building Regulations requirement to achieve compliance with the BB93 criteria, as it would be for a primary or secondary school.

It should be noted at the outset that complete 'soundproofing' between adjacent function areas is unlikely to be viable. This is essential in BBC and commercial broadcast studios, although the constructions required to deliver this are very substantial, and normally beyond the scope of most FE or HE projects. The aim is still to provide the best acoustics possible within the practical constraints of the development.

2.0 ACOUSTIC TESTS

2.1 Introduction

The tests were undertaken on Thursday 31 May 2018 by Chris Middleton of Acoustic Design Technology Ltd.

The programme of tests included measurements of external noise intrusion and internal sound insulation tests. Reverberation measurements were not undertaken in the existing ground floor rooms as the room finishes will be replaced as part of the refurbishment.

The test results and the implications on the scheme design are described in the following sections.

2.2 External Noise Intrusion

The building fronts onto a relatively minor road, and backs onto a landscaped area and small car park. As such, the incident noise levels are relatively low.

The building envelope is understood to be solid brickwork, with modern double glazed units of unknown specification. Measurements of typical traffic noise intrusion were undertaken in room WD001, at the south-eastern end of the building nearest the Balne Lane / Mulberry Way junction, with windows closed.

The results are as follows:

$L_{Aeq,T}$	27 dB
L_{Amax}	43 dB
L_{A90}	22 dB

BB93 recommends indoor ambient noise levels from $L_{Aeq, 30 \text{ mins}}$ 30 - 35 dB in music accommodation, and the measured levels are clearly within that range. It should be noted that while the BB93 criteria are suitable for general music teaching, rehearsals and performances, recording usually requires somewhat lower levels, closer to $L_{Aeq,T}$ 20 dB. Secondary glazing or blocking up of the windows to recording rooms will therefore be necessary, as described in in Section 3.0 below.

The other point to highlight is that the indoor ambient noise levels with windows open would of course be substantially higher, and as with most music facilities in an urban setting, mechanical ventilation is a necessity.

2.3 Sound Insulation of Separating Floors

Airborne sound insulation tests were undertaken on a sample of separating floors, with the summary results in the following table, and the detailed third octave band results plotted on the attached graphs 2727/G1 – G4.

Ref	Source Room	Receiver Room	$D_{nT,w}$ dB
A1	WD001	WD101	53
A2	WD001	WD102	54
A3	WD004	WD109	56
A4	WD008	WD113	51

The sound insulation results from the reinforced concrete floors in the original building (tests A1 to A3) are reasonably consistent in terms of the overall levels ($D_{nT,w}$) and the frequency characteristics, and are typical of this form of construction. The removal of the existing mineral fibre tiled ceilings would reduce the performance by 2 or 3 dB.

The BB93 guideline performance for the separating floor would be minimum $D_{nT,w}$ 55 dB, although that is not usually sufficient to contain amplified music breakout to a noise sensitive room above, and 65 dB would be a more appropriate target. Sound insulation improvements are therefore required, i.e. a plasterboard based acoustic ceiling to replace the existing mineral fibre tiled ceiling, as detailed in Section 3.0 below.

Test A4 in the modern extension yielded a lower result, with high frequency leakage apparent at the external wall junction and noticeable 'singing' from the exposed steel columns. These issues would also need to be addressed, in addition to the provision of an acoustic ceiling.

3.0 PRELIMINARY DESIGN REVIEW

3.1 Introduction

The preceding sections outlined the results of the acoustic tests on the existing building and the general implications for the design. The following sections provide preliminary design guidance on the various acoustic issues.

Indicative materials and build ups are suggested, although these are for guidance only, as a starting point to inform space planning and costing, and they are not intended to be a final definitive acoustic performance specification.

3.2 Environmental Noise Emissions

The surrounding buildings are primarily associated with the College, offices or civic buildings, with the nearest residential properties around 200 metres away, further down Balne Lane.

It is reasonable to assume that with windows closed and mechanical ventilation in place, music breakout should only be noticeable within a few metres, and is therefore an internal issue rather than one affecting neighbouring properties.

The addition of new ventilation and comfort cooling plant would require a planning application, and it would be normal to control environmental noise from fixed plant to limits defined using BS 4142:2014, typically with the rating level not exceeding the otherwise prevailing background level. Night time background levels from L_{A90} 36 dB have been measured at the nearby Wakefield Archive building, and are considered typical of the area.

As a guide at this stage it is recommended that cumulative noise emissions from fixed plant installations associated with the development do not exceed the following limits:

At 1 metre from any residential window	$L_{Aeq,T}$ 35 dB
At 1 metre from any site boundary	$L_{Aeq,T}$ 55 dB

3.3 Building Envelope

As noted in Section 2.2 above, the existing noise levels in the building with windows closed are below $L_{Aeq,T}$ 30 dB and are therefore technically suitable for use as a music teaching facility without additional sound insulation measures, following the BB93 guidance. However, there are reasons to upgrade the sound insulation to certain rooms:

- i. in rooms where recording is taking place, external noise intrusion needs to be reduced substantially below $L_{Aeq,T}$ 30 dB, and ideally down to 20 dB if background noise is not to compromise the recording. This will require secondary glazing to the relevant rooms on Balne Lane.

- ii. environmental noise breakout from rehearsal rooms could be significant without improvements to the existing thermal double glazing and the lightweight curtain walling.
- iii. the external walls have an effect on sound insulation between adjoining rooms and from ground to first floor, as sound travels between rooms via the external wall – this is known as flanking transmission. If this is not addressed, the sound insulation of the separating walls and separating floor will be limited, and the 1st floor rooms could be unusable, particularly those in the modern extension to the rear.

Indicative guidance on the main elements of the building envelope is set out in the following sections, to address each of the above issues.

3.3.1 External Walls – Solid Masonry

The existing solid brick work walls are estimated to be at least 350mm thick, and in and of themselves should provide more than sufficient sound insulation against external noise intrusion and environmental noise breakout.

Some degree of flanking transmission to rooms adjoining and above via the brickwork is still possible, and as a precaution, the rehearsal rooms, recording booths and live rooms with a solid masonry external wall should have an acoustic lining of for example 2 layers of 12.5mm Soundbloc on a framework independent of the original masonry, for example, 50mm I-studs set nominally 10mm away from the masonry. This construction method is illustrated on the attached sketch 2727/SK1, while the proposed extents are marked in blue on the attached plan 2727/SK2.

3.3.2 External Walls – Modern Curtain Walling

Flanking sound transmission via the modern curtain walling is expected to be significant, and would negate the improvement provided by an acoustic ceiling if not addressed. It is therefore advisable to form an acoustic lining as described in Section 3.3.1 above but with thicker linings, a larger frame and thicker mineral wool, for example 3 layers of 15mm Soundbloc on 90 - 100mm metal or timber frame with 100mm mineral wool batts between studs with minimum 10mm clear gap to the curtain walling. This therefore consumes nominally 150mm overall depth.

The proposed extents of this higher performance lining are marked in red on the attached plan 2727/SK2.

3.3.3 Windows

It is advisable to install secondary glazing to all of the rehearsal rooms, live rooms and recording booths, in other words, all of the rooms marked for acoustic wall linings on the attached plan 2727/SK2.

The sound insulation performance is primarily governed by the type of secondary glass unit and the cavity between the primary and secondary units. Other factors affecting the performance are the type of frame (i.e. sliding units or casements) and whether it is viable to install sound absorptive panels to the reveals.

The secondary glass unit should be as thick as possible, and ideally laminated. Secondary glazing is typically provided with 6mm or 6.4mm acoustic laminate glass, although the system will be more effective if a 8.8mm or 10.8mm laminated glass unit is used, while the depth of the cavity should be at least 100mm and ideally at least 200mm.

The selection of the framing system will depend on the maintenance strategy, in terms of how often the units need to be opened for cleaning. As a general rule casement units with multi-point locking or demountable frames provide better sound insulation than sliding units, as it is easier to make a compressible seal.

In terms of the sound absorptive material to the reveals, this should be a Class A sound absorptive panel (e.g. Soundsorba 'Wallsorba') or a Class A acoustic tile designed for mounting direct to a solid substrate (e.g. Ecophon 'Master F'). The tiles may be a more practical option, as they can be cut down to suit the space available relatively easily.

For the rehearsal rooms in the modern extension (rooms 2, 3 and 4), it could be problematic to attempt to fix the secondary glazing to the inside of the existing curtain walling. This would also bridge the isolation of the independent wall lining described in Section 3.3.2 above. It would therefore be advisable to install the secondary glazing frame to the independent acoustic lining framework described in Section 3.3.2 above. A detail would need to be developed for an internal reveal between the original curtain walling and the new independent acoustic lining which does not rigidly connect the independent acoustic lining framework to the existing curtain walling.

3.4 Internal Acoustic Separation

3.4.1 Introduction

BB93 recommends sound insulation of in situ $D_{nT,w}$ 55 dB between adjoining music rooms, and from music to other teaching rooms (such as the art rooms above).

This could generally be achieved with standard twin stud separating walls (nominally R_w 63 and 250mm thick), and a basic acoustic ceiling to protect the rooms above (e.g. 2 layers of 12.5mm plasterboard on standard MF grid with mineral wool overlay), in addition to the external wall linings and secondary glazing described in Section 3.3 above. Walls with observation windows or access doors would not achieve this standard, although BB93 makes provision for this, and recommends a R_w 45 spec for observation windows and R_w 35 for interconnecting doors.

However, while the implementation of these BB93 performance standards would equate to moderate containment of amplified music, it is very likely that the resulting noise levels in the art rooms above would not be acceptable, while sound bleed between recording rooms and through to control rooms would severely limit their usefulness. A more substantial package of sound insulation measures is therefore recommended.

At this stage it is not possible to put a precise figure on the level of uplift that can be achieved, as this will be determined by the scope of sound insulation measures provided, and that will be subject to space and budget considerations. As a guide, it would be advisable to aim for sound insulation of at least $D_{nT,w}$ 65 dB between ground and 1st floor rooms and between recording rooms (booths and live rooms), except those containing a door.

Preliminary guidance on possible sound insulation measures is set out on a room by room basis in the following sections.

3.4.1 Rehearsal Rooms

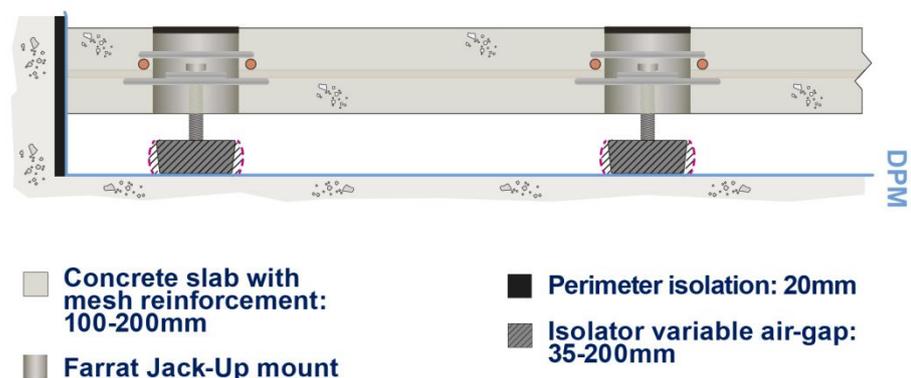
The primary aim is to ensure that noise breakout from the rehearsal rooms does not unduly affect the use of the recording suite and the art rooms above.

The starting point is to consider a floating floor, as sound transfer via the ground floor slab is a flanking transmission route between adjoining rooms, and the vibration generated by amplified instruments and particularly drums can spread widely.

Floating floor options

The most basic type of floating floors are either a simple platform floor of 18mm flooring grade chipboard or similar with a foam or rubber resilient backing, or acoustic batten floors, all primarily designed for the residential market. These are better than nothing, but would not provide sufficient isolation of low frequency vibration.

A 'jack up' concrete floor (using Farrat or Mason Industries components, for example) would be the best approach. This would typically comprise 100mm reinforced concrete on jack up mounts, which create a clear isolated air gap of nominally 35 - 50mm. The Farrat system is illustrated as follows:



While this is the best approach, there can be issues with cost, structural loading and the depth of the build up of a jack up floor. The second best option is to form a more lightweight floating floor on rubber blocks (again by Farrat or Mason for example), which would comprise a floor deck supported by nominally 25mm to 45mm rubber pads.

The more substantial the floating floor deck, the more stable and effective the system will be, and it would be advisable to use at least a triple layer of flooring particle board, or better still, concrete flagstones sandwiched between particle boards. The overall system depth is still likely to be at least 100mm.

Acoustic ceiling

The acoustic ceiling to the rehearsal rooms can be reasonably straightforward, comprising for example 3 layers of 12.5mm Soundbloc on an MF grid supported by neoprene acoustic hangers (e.g. BG GAH1), set at least 300mm below the soffit, with 100mm mineral wool overlay.

It is advisable to avoid compromising the integrity of this ceiling with building services, and a secondary tiled grid ceiling may therefore be advisable. As noted in Section 3.5 below, this would also be a useful way to provide the necessary sound absorption / reverberation control.

The separating walls between rehearsal rooms can be a reasonably standard R_w 63 twin stud wall as described in Section 3.4 above. The existing steel columns can be buried in the separating walls, provided there is no rigid contact between the plasterboard or studwork and the column, or sit within the room. In the latter case, they will need an acoustic enclosure comprising say 2 layers of 12.5mm Soundbloc on studwork supported independently from the column, with a mineral wool fill around the column.

Whatever partition build up is selected, it is critical that the partition runs from slab to slab, in other words, it should not sit on a floating floor, but the floating floors should be installed separately for each room.

The sound insulation of the corridor wall is less critical, and a rating of nominally R_w 63 should be sufficient, again a basic twin stud wall. The doors should be rated at minimum R_w 40 in order to control noise transfer across to the control rooms.

3.4.2 Recording Rooms

Noise levels in the recording rooms are potentially similar to those in the rehearsal rooms, and there is the additional requirement to control noise bleed to adjoining rooms.

The floating floors and acoustic ceilings to the recording booths and live rooms should be as described in Section 3.4.1 for the rehearsal rooms. These provide control of noise breakout to above, and flanking transmission to and from adjoining rooms.

The separating walls themselves should be formed as wide airspace unbraced twin stud walls. The optimum build up would be 3 layers of 15mm Soundbloc each side, with the frames set for nominally 450mm overall partition width and a full fill of mineral wool. This can of course be thinner and use less substantial linings, with a commensurate reduction in performance. As with the rehearsal rooms, the partitions should run slab to slab, with separate floating floors installed for each room.

The observation windows are potentially a major weak point, and to be effective they would need to be formed as a double window, with each frame supported by one of the twin frames forming the separating wall, with thick, laminated glass units of different thicknesses (e.g. 10.8mm and 12.8mm). It is common practice to set the glass units at an angle of typically 5 degrees off the vertical, although this is to deal with room acoustics rather than contributing to the sound insulation performance.

One option to consider is not to have physical observation windows at all, but CCTV cameras and large screens. This is likely to provide superior sound insulation performance, as the plasterboard partition is not penetrated, although clearly the studio users will probably expect to see a real window. The point is that if the sound insulation performance of a real window is inadequate, it is merely a cosmetic feature, and the cost of an affective window can be significant.

Access doors are another significant weak point. Single acoustic door sets are available at up to R_w 50 laboratory performance rating, although this is almost never realised on site, and a pair of R_w 35 – 40 doors installed back to back with a 150mm to 200mm air space is usually more effective.

3.4.3 Performance Space

This room has the benefit of being horizontally separated from the rehearsal rooms and recording suites, and the sound insulation treatments required will be dictated by how it is used.

If it is basically used in the same way as a rehearsal room, with high intensity noise generated at any time of the day, then a floating floor and acoustic ceiling should be installed as described in Section 3.4.1 above.

If loud music is only played occasionally, for example, for scheduled evening performances, noise breakout to above may be less of an issue. In that case a high performance floating floor and acoustic ceiling may be unnecessary.

Noise break-in from the corridor / social area during performances could be a significant issue, as there is only a single door, and the sound insulation would realistically be limited to around R_w 40. A lobby arrangement would therefore be advisable.

3.4.4 Control Rooms

The control rooms are noise sensitive rather than noise generating, and it should not be necessary to install acoustic floating floors as proposed for the rehearsal rooms and recording booths / live rooms. A raised floor would of course be required to match the level of the acoustic floating floor, although this could in principle be a standard pedestal type office floor system.

The control rooms should still have acoustic ceilings, but to the lower specification described at the beginning of Section 3.4 above, that is, 2 layers of plasterboard on MF grid with mineral wool overlay.

3.5 Room Finishes

The schedule of room finishes is currently undeveloped. At this stage the main principles to take into account are as follows:

3.5.1 Staff Room and Office

These rooms are reasonably simple to deal with, using a carpet floor finish and mineral fibre tiled grid ceiling rather like the existing room finishes.

3.5.2 Corridor and Social Space

With a potentially significant accumulation of students in this area, and noise sensitive rooms straight off the corridor, there is a need to control reverberation in this area. A mineral fibre tile or plank ceiling of absorption Class A is recommended, to provide the mainstay of the reverberation control. A carpeted floor finish would also be advantageous, although is expected that this would not be viable from a durability point of view.

3.5.3 Rehearsal Rooms

In these rooms the main aim is to control reverberation. A mineral fibre tiled ceiling is the simplest way to provide this, although a plasterboard acoustic ceiling is required for sound insulation as described in Section 3.4 above, so the tiled grid would need to be a secondary ceiling, which may be useful for services distribution. Carpets would again be advisable.

Acoustic wall panels could be used to refine the acoustics of the larger rooms 1 to 4 if desired.

3.5.4 Recording and Control Rooms

In these rooms the main aim is to reduce reverberation to a very low level and to prevent standing waves developing between plain walls. It will therefore be necessary consider a mixture of ceiling mounted and wall mounted sound absorbers (typically fabric faced mineral wool panels such as the Soundsorba 'Wallsorba'), and ideally some diffusion elements, which are typically formed in timber slats or randomised squares. Some examples are illustrated below:



The arrangement of sound absorptive panels and diffusers will be a detailed design issue. Carpet floors and furniture will also help to provide absorption.

3.5.5 Performance Space / Lecture Theatre

The acoustics of this room will be a compromise between the various potential uses. Classical music performances would require a relatively long reverberation time and fewer sound absorptive materials, while amplified music would require more absorption. For the lecture theatre use, the materials required would vary according to whether lectures are primarily delivered using natural speech or via an in house PA system.

It is likely that the a sound absorptive ceiling or an array of sound absorptive baffles / rafts would be required, along with some coverage of acoustic wall panels, and a carpet floor finish. The seating itself could be used to provide a reasonable proportion of the required absorption.

3.6 Internal Noise from New Building Services

Indicative noise design criteria for any new mechanical ventilation systems or comfort cooling are as follows:

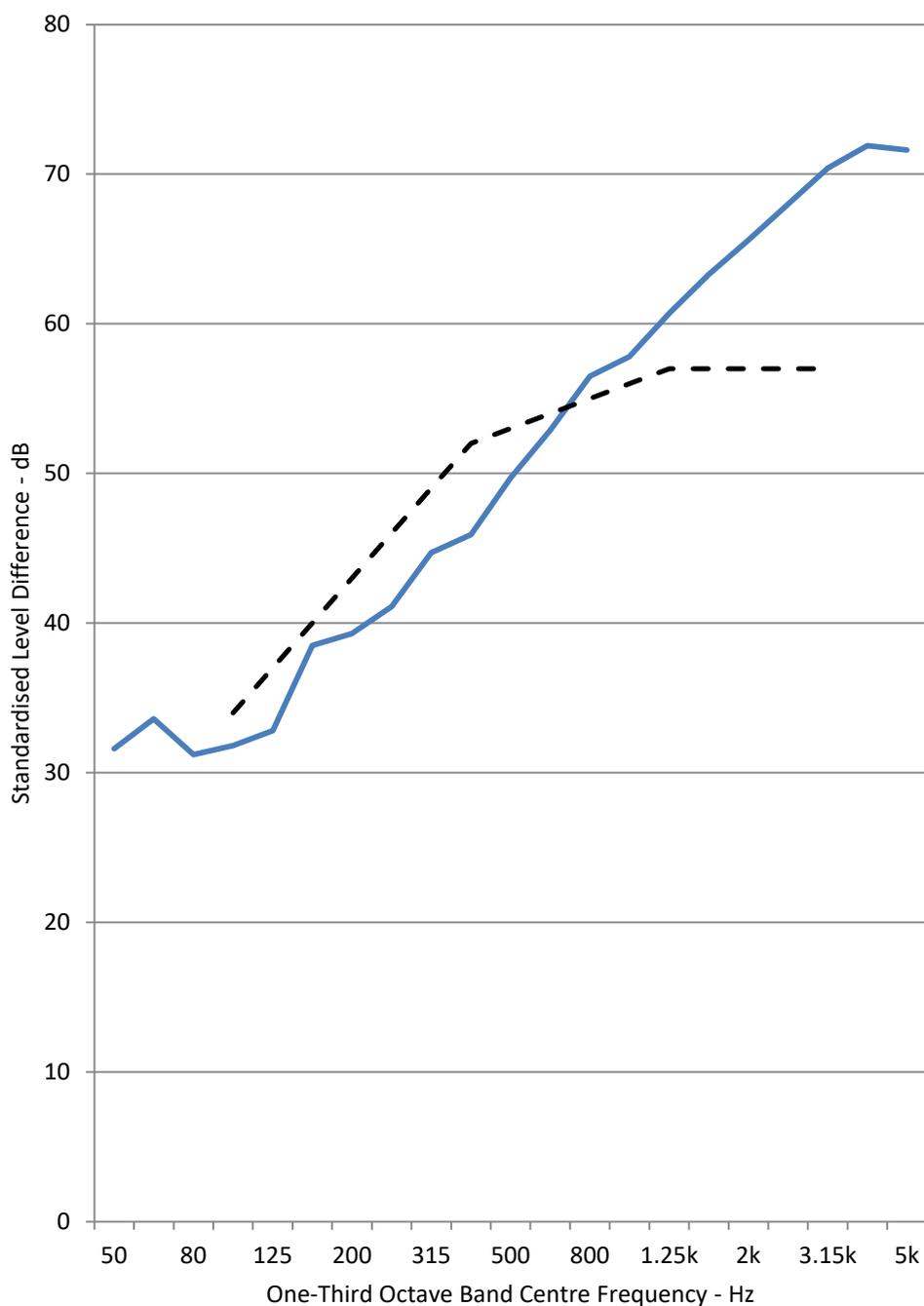
Recording rooms	NR20
Control rooms	NR25
Rehearsal rooms	NR35
Offices and staff room	NR40
General circulation	NR45
Kitchens and toilets	NR50

These are cumulative noise limits with all plant operating simultaneously, including noise from plant serving the room in question, as well as noise break in and noise transfer from building services elsewhere in the building.

FOR ACOUSTIC DESIGN TECHNOLOGY

Standardized level difference according to BS EN ISO 140-4 and Annex B to Approved Document E 2003
Field measurements of airborne sound insulation between rooms

Frequency (Hz)	D_{nT} (dB)
50	31.6
63	33.6
80	31.2
100	31.8
125	32.8
160	38.5
200	39.3
250	41.1
315	44.7
400	45.9
500	49.7
630	52.9
800	≥ 56.5
1k	≥ 57.8
1.25k	≥ 60.7
1.6k	≥ 63.3
2k	≥ 65.6
2.5k	≥ 68.0
3.15k	≥ 70.4
4k	≥ 71.9
5k	≥ 71.6



Rating according to BS EN ISO 717-1

$$D_{nT,w} (C ; C_{tr}) = 53 (-2 ; -8) \text{ dB}$$

$$D_{nT,w} + C_{tr} = 45 \text{ dB}$$

Evaluation based on field measurement results obtained by an engineering method

Source Room	WD001	Receiver Room	WD101
Test Element	Separating Floor	Test Date	31 May 2018



Description

Airborne Sound Insulation Test - Floor

Project

Gissing building, Wakefield College

Drawing No.

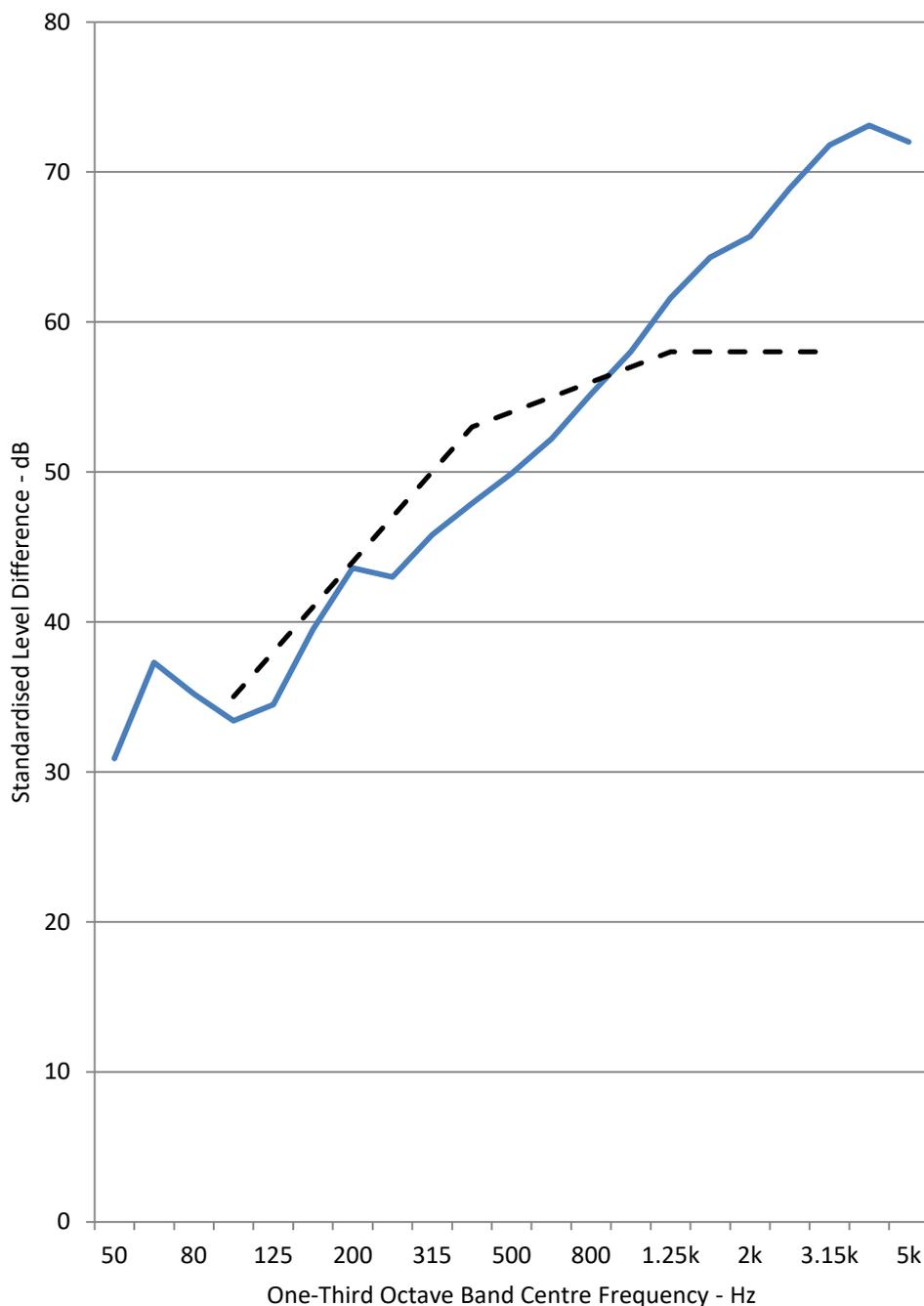
2727/A1



ACOUSTIC DESIGN TECHNOLOGY
Noise and Vibration Consultants

Standardized level difference according to BS EN ISO 140-4 and Annex B to Approved Document E 2003
Field measurements of airborne sound insulation between rooms

Frequency (Hz)	D_{nT} (dB)
50	30.9
63	37.3
80	35.2
100	33.4
125	34.5
160	39.5
200	43.6
250	43.0
315	45.8
400	47.9
500	49.9
630	52.2
800	55.2
1k	≥ 58.0
1.25k	≥ 61.6
1.6k	≥ 64.3
2k	≥ 65.7
2.5k	≥ 68.9
3.15k	≥ 71.8
4k	≥ 73.1
5k	≥ 72.0



Rating according to BS EN ISO 717-1

$$D_{nT,w} (C ; C_{tr}) = 54 (-2 ; -8) \text{ dB}$$

$$D_{nT,w} + C_{tr} = 46 \text{ dB}$$

Evaluation based on field measurement results obtained by an engineering method

Source Room	WD001	Receiver Room	WD102
Test Element	Separating Floor	Test Date	31 May 2018



Description

Airborne Sound Insulation Test - Floor

Project

Gissing building, Wakefield College

Drawing No.

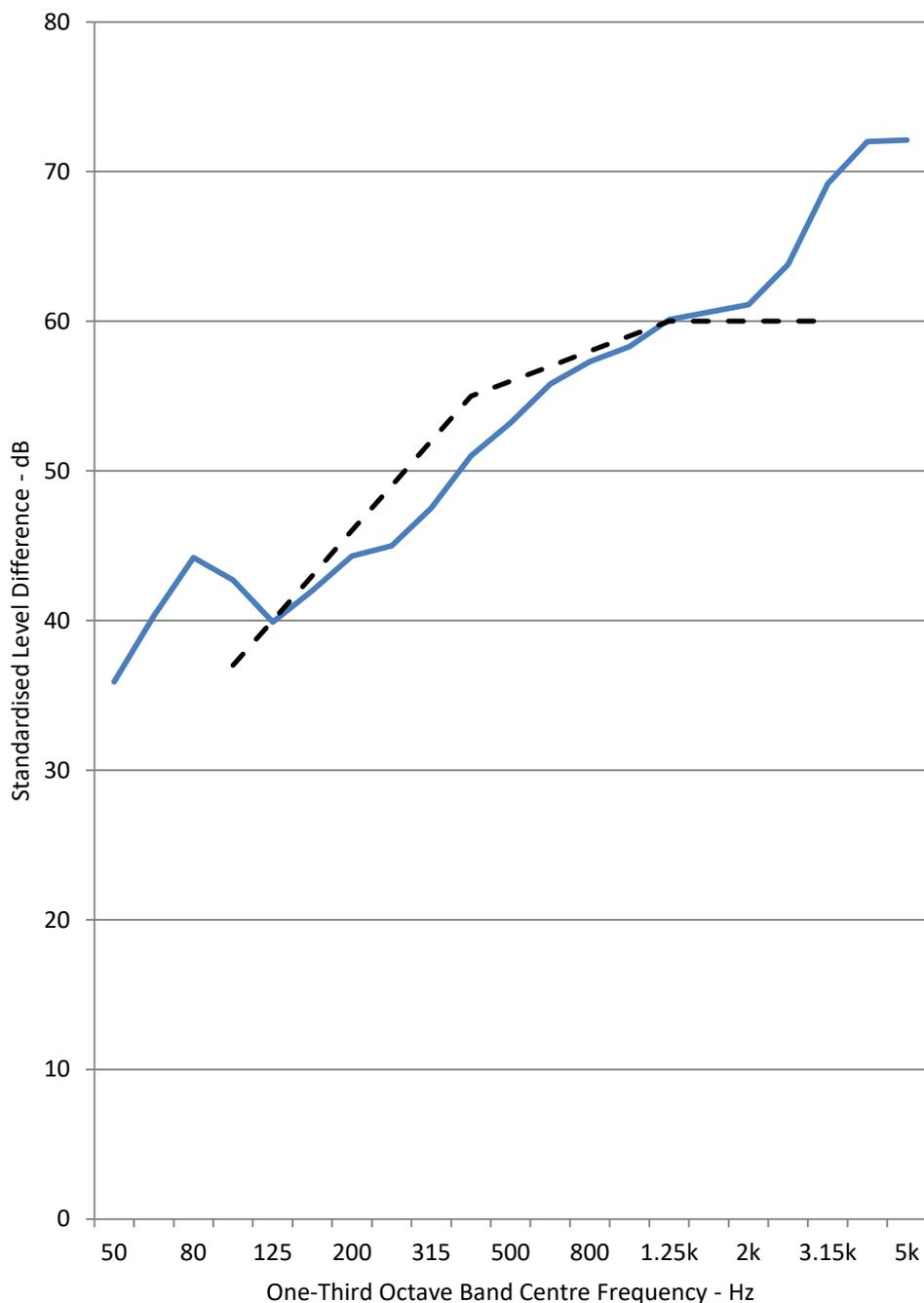
2727/A2



ACOUSTIC DESIGN TECHNOLOGY
Noise and Vibration Consultants

Standardized level difference according to BS EN ISO 140-4
Field measurements of airborne sound insulation between rooms

Frequency (Hz)	D_{nT} (dB)
50	35.9
63	40.3
80	44.2
100	42.7
125	39.9
160	42.0
200	44.3
250	45.0
315	47.5
400	51.0
500	53.2
630	55.8
800	57.3
1k	≥ 58.3
1.25k	≥ 60.1
1.6k	60.6
2k	61.1
2.5k	63.8
3.15k	≥ 69.2
4k	≥ 72.0
5k	≥ 72.1



Rating according to BS EN ISO 717-1

$$D_{nT,w} (C ; C_{tr}) = 56 (-1 ; -5) \text{ dB}$$

$$D_{nT,w} + C_{tr} = 51 \text{ dB}$$

Evaluation based on field measurement results obtained by an engineering method

Source Room	WD004	Receiver Room	WD109
Test Element	Separating Floor	Test Date	31 May 2018



Description

Airborne Sound Insulation Test - Floor

Project

Gissing building, Wakefield College

Drawing No.

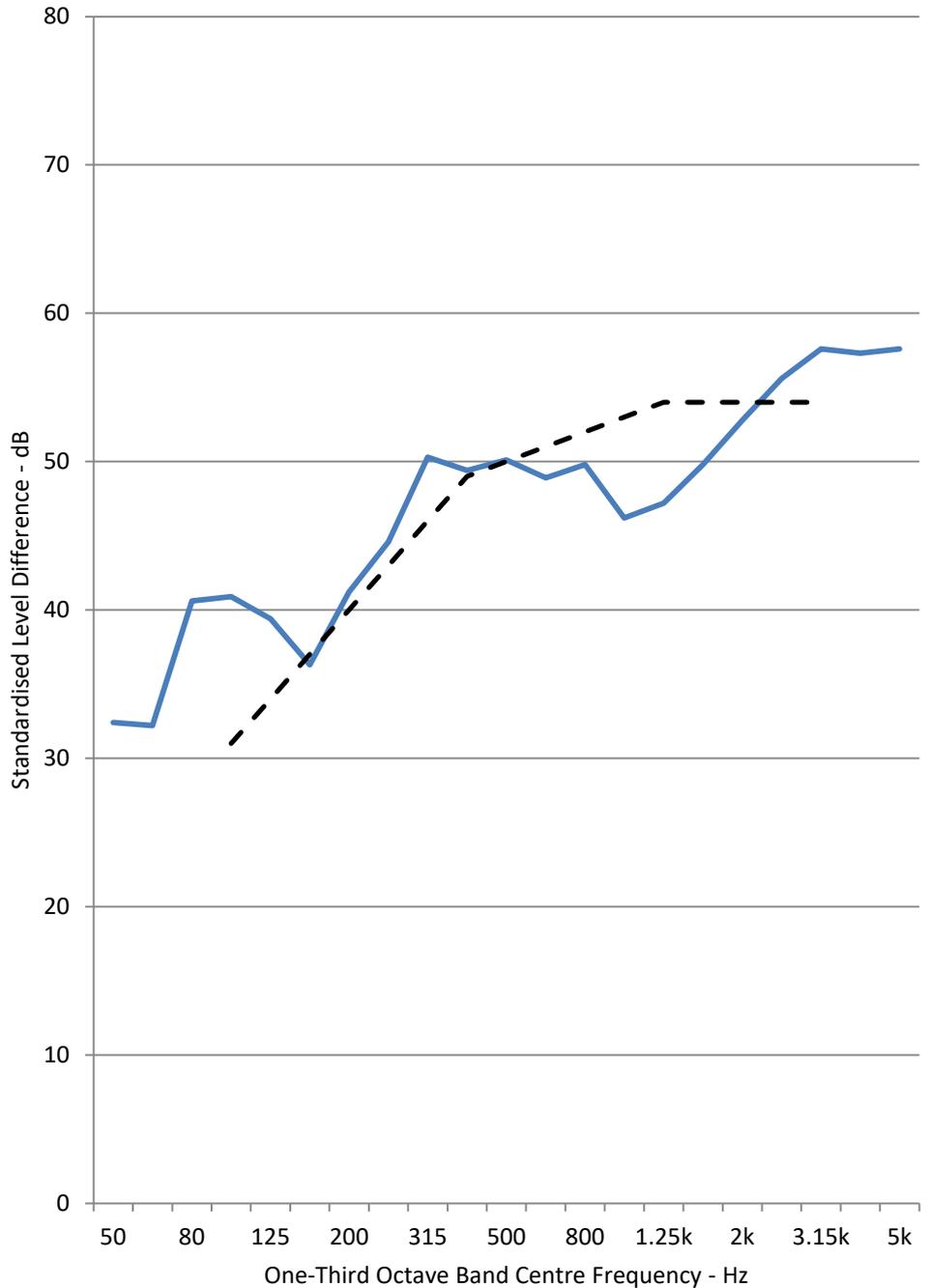
2727/A3



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Standardized level difference according to BS EN ISO 140-4
Field measurements of airborne sound insulation between rooms

Frequency (Hz)	D_{nT} (dB)
50	32.4
63	32.2
80	40.6
100	40.9
125	39.4
160	36.3
200	41.2
250	44.6
315	50.3
400	49.4
500	50.1
630	48.9
800	49.8
1k	46.2
1.25k	47.2
1.6k	49.8
2k	52.8
2.5k	55.6
3.15k	57.6
4k	57.3
5k	57.6



Rating according to BS EN ISO 717-1

$$D_{nT,w} (C ; C_{tr}) = 50 (-2 ; -5) \text{ dB}$$

$$D_{nT,w} + C_{tr} = 45 \text{ dB}$$

Evaluation based on field measurement results obtained by an engineering method

Source Room	WD008	Receiver Room	WD113
Test Element	Separating Floor	Test Date	31 May 2018



Description

Airborne Sound Insulation Test - Floor

Project

Gissing building, Wakefield College

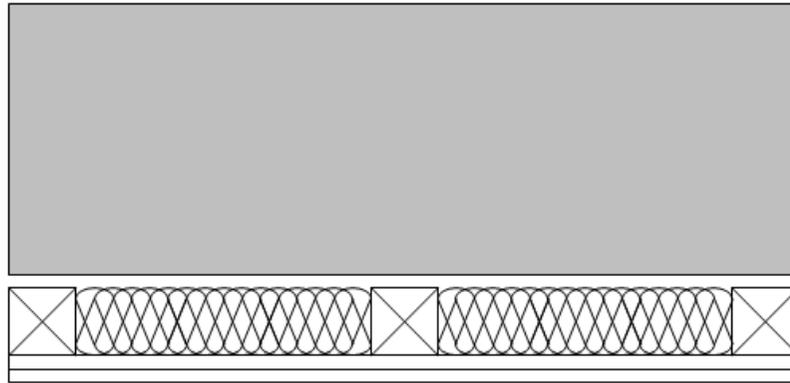
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2727/A4



ACOUSTIC DESIGN TECHNOLOGY
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PLAN

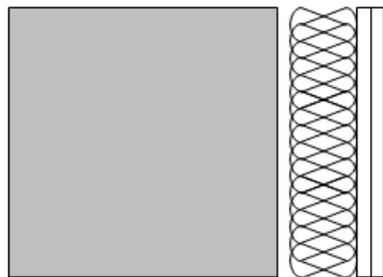


Original wall

Independent studs set minimum 5mm to 10mm away from original wall. 50mm mineral wool laid between studs

2 layers of 12.5mm high density plasterboard e.g. British Gypsum 'Soundbloc' or Knauf 'Soundshield'

SECTION



Notes:-

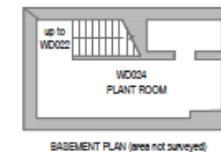
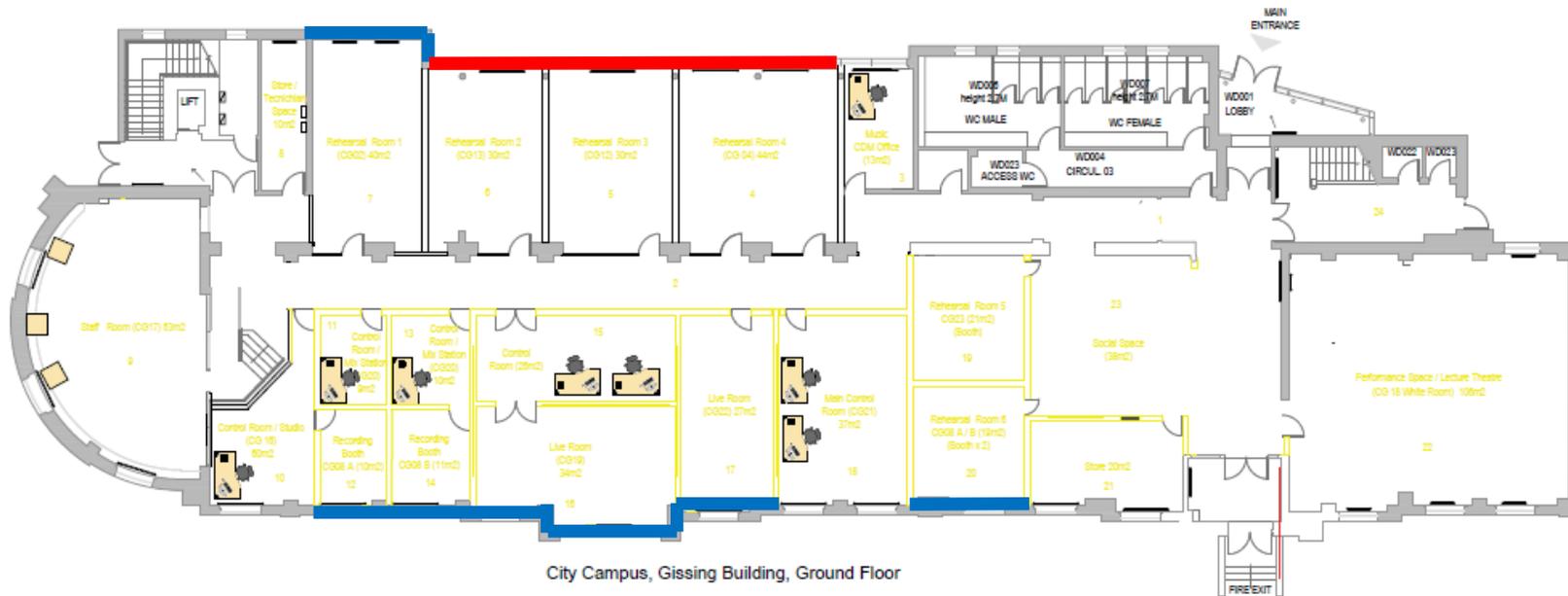
Independent wall lining

Drawing no:- ADT 2727/SK1



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Noise and Vibration Consultants

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Notes:-

Basic acoustic lining, typically 2 layers of 12.5mm Soundbloc on 50mm independent frame, with 50mm mineral wool

High performance acoustic lining, typically 3 layers of 15mm Soundbloc on 100mm independent frame, with 100mm mineral wool

Extents of acoustic linings

Drawing no:- ADT 2727/SK2



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