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SCOTTISH BUILDING STANDARDS AGENCY

Robin Mackenzie Partnership

Design of Separating Constructions that are Resistant to the Transmission of Noise

PART 1 of 2

October 2007

Report prepared by:

Dr Sean Smith and Richard Mackenzie

RMP Acoustics
Napier University
42 Colinton Road
Edinburgh
EH10 5BT

The opinions expressed in this report are those of the authors.

Report commissioned by:
Scottish Building Standards Agency
Denholm House
Almondvale Business Park
Livingston
EH54 6GA

Tel: 01506 600 400
Fax: 01506 600 401
e-mail: info@sbsa.gsi.gov.uk
web: www.sbsa.gov.uk

This report is published electronically to limit the use of paper, but photocopies will be provided on request to the Scottish Building Standards Agency

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Executive Summary

This report provides design details for separating wall and floor constructions (termed *example constructions*) and the background to their selection. The research project was undertaken on behalf of the Scottish Building Standards Agency.

Part 1 of this report provides the background to the performance criteria and the design issues to be adopted for the separating walls and floors to achieve future recommended performance levels, for airborne sound insulation (walls and floors) and impact sound transmission (floors).

Part 2 of this report provides the *example constructions* and the relevant junction details for the separating walls and floors with other parts of the dwelling, such as external walls, foundations and roof structures. The *example constructions* provided within this report are based on field performance tested separating walls and floors in attached dwellings.

The *example constructions* are designed to achieve the recommended performance levels set by the Section 5 Working Party. The minimum airborne sound insulation performance for walls and floors is 56 dB $D_{nT,w}$. This results in an increase of 3 dB (walls) and 4 dB (floors) better than current mean levels of Section 5, and 7 dB (walls) and 8 dB (floors) better than current minimum levels when a set or group of tests are carried out.

In addition, the *example constructions* are also designed to achieve a minimum of 47 dB $D_{nT,w}+C_{tr}$ for airborne sound insulation to improve low frequency performance (100Hz to 200Hz).

The maximum impact sound transmission performance (floors) is 56 dB $L'_{nT,w}$. This results in an improvement of 5 dB better than current maximum mean targets and 9 dB better than current maximum target levels when a set or group of tests are carried out.

Current Section 5 performance levels are based around a ‘mean’ approach whereas the potential new Section 5 performance levels are intended to be a minimum (airborne) and

maximum (impact) criteria. This has a significant influence on the designers approach. The designers will require to adopt separating walls and floors which are at least typically 4 dB better than the minimum or maximum guidance performance levels. This will provide some tolerance for design, workmanship and build influences.

Thus to achieve a minimum airborne performance of 56 dB $D_{nT,w}$ will require a wall or floor to have a mean design target performance of 60 dB $D_{nT,w}$. Similarly for impact sound transmission a maximum performance criteria level of 56 dB $L'_{nT,w}$ will require a floor to have a mean target performance of 52 dB $L'_{nT,w}$.

The *example constructions* provided have been designed towards such mean target performance levels.

Dr Sean Smith BSc PhD MIOA

John B Wood BSc DA

Richard Mackenzie BSc MIOA MInstSCE

Robin Mackenzie Partnership

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1 Introduction

The following document is the Final Report outlining *example constructions* (separating wall and floor constructions) for attached dwellings for the future revision of Section 5, undertaken on behalf of the Scottish Building Standards Agency.

The scope of works were to design and develop *example constructions* based on field measured data to achieve proposed new Section 5 guidance for airborne sound insulation and impact sound transmission.

Acknowledgements

The authors wish to express their thanks to the Section 5 Steering Group and Working Party for feedback during the preparation of the report and also to Linda Stewart of SBSA for guidance provided during this contract.

The authors would also like to express there sincere thanks to Robust Details Ltd for the permission to use test data gathered during the RSD project and also for access to recent field test data undertaken by RD Inspectors in England and Wales.

2 Performance Levels

2.1 Introduction

The performance levels requested within the project brief are as follows:

First Targets

Airborne sound insulation (minimum)	58 dB $D_{nT,w}$
Impact sound insulation (maximum)	56 dB $L'_{nT,w}$

Second Target

Airborne sound insulation (minimum)	47 dB $D_{nT,w}+C_{tr}$

With regard to the SBSA research tender document, it was indicated that whilst the minimum performance of 45 dB $D_{nT,w}+C_{tr}$ may be adopted, a minimum 47 dB $D_{nT,w}+C_{tr}$ would be preferable. We have therefore based our data analysis on achieving a minimum of 47 dB $D_{nT,w}+C_{tr}$.

2.2 Guidance example constructions

Previous construction guidance for walls and floors in the former Part H (Scotland) often did not meet the required performance levels even though they were built correctly. Some of the existing constructions in Section 5 (Noise) are rarely used and design guidance details are limited in their presentation layout. It is recommended that the new Section 5 guidance or example constructions should repeatedly achieve the recommended minimum or maximum performance levels when built correctly and which are clear and transferable to design details and site working drawings.

It should also be noted that one of the project criteria states that example constructions must be generic and not utilise, describe or favour proprietary products.

2.3 Airborne performance levels (minimum 58 dB $D_{nT,w}$ and minimum 47 dB $D_{nT,w}+C_{tr}$)

As the proposed performance levels are significantly higher than the current performance levels of Section 5 and previous Part H or Part E England and Wales many current constructions may not be able to meet the target criteria. Also few constructions have historically been built which could achieve such high minimum target levels, particularly for airborne sound. This has restricted the number of potential separating walls and floors to be put forward for the new Section 5. In addition, the involvement of the criteria $D_{nT,w}+C_{tr}$ has also led to a tightening of the “available performance window” within which constructions would require to meet.

To determine the potential separating walls and floors which could achieve such performance levels an analysis was undertaken of the RMP and Building Performance Centre (BPC) database which includes field test data for the last 20 years. In addition, permission was granted from Robust Details Ltd to use field test data from the original RSD project and also to access more recent field test data.

Appendix 1A shows a range of separating wall and floor constructions and their ability to consistently achieve (when built properly) the proposed criteria for airborne (minimum 58 dB $D_{nT,w}$) and impact (max. 56 dB $L'_{nT,w}$). Also shown in the Appendix 1 are the ability of constructions to achieve a minimum of 47 dB $D_{nT,w}+C_{tr}$, a minimum of 56 dB $D_{nT,w}$ (airborne) and whether constructions have a mean performance of 60 dB $D_{nT,w}$ or more, when built correctly.

It was found that in some cases some substantial separating walls and floors could achieve a minimum of 58 dB $D_{nT,w}$ but would not achieve 47 dB $D_{nT,w}+C_{tr}$ or in some cases would require proprietary type linings and fixings, however the project brief requires generic constructions.

In terms of airborne sound insulation performance values and sound insulation complaints it is usually values of 53 dB $D_{nT,w}$ or less which are inter-related. In general airborne values of 55 dB $D_{nT,w}$ and higher are not associated with sound insulation complaints. Robust Details mean airborne performance range for their current wall and floor constructions is from 57 dB to 66 dB $D_{nT,w}$.

The construction of the separating floors has a direct link and dual function for both impact and airborne performance of floors, as such the recommended guidance constructions have been designed to address both issues simultaneously.

2.4 Separating walls

The use of a solid dense block separating wall with independent linings on both sides would achieve minimum values in excess of 58dB but this would also have strong low frequency symmetric resonances, would be limited by flanking walls and would increase current separating solid walls from 286mm to 400mm (50mm metal studs) or 440mm with (70mm metal studs) which may be required for loadings and height spans.

75mm cavity blockwork separating walls could also achieve minimum 58 dB $D_{nT,w}$ repeatedly using independent linings or 52mm mineral backed plasterboard. However, this increases the wall width from 321 mm to 435 mm (for 50mm metal studs) or 475mm (for 70mm studs) which is unlikely to be acceptable to the construction industry due to the impact on room size. The use of mineral backed plasterboard also presents problems with the stiffness of the wall surface and the load bearing capacity of the wall lining.

The most common wall finish currently used is plasterboard and fixed using plaster dabs. It is unlikely to be possible to specify a construction with this finish to achieve the SBSA criteria of 58 dB $D_{nT,w.}$ However, with additional measures, as outlined in Chapter 5, it is possible to achieve the 56 dB $D_{nT,w.}$

Previous RMP research into subjective reaction to sound insulation levels has indicated a low level of complaints at 56 dB $D_{nT,w.}$ Therefore, RMP would recommend that a minimum airborne criteria of 56 dB $D_{nT,w}$ be adopted.

In terms of timber frame separating walls the minimum width of the cavity between the linings to achieve minimum 58 dB $D_{nT,w}$ repeatedly would be 280mm. This is between 40mm and 80mm greater than current 240mm and 200mm cavities at present. RMP have no recorded complaints for airborne sound insulation involving a 240mm timber frame wall. This is one of the most predominant new build separating walls built across Scotland.

During RMP's post construction testing across Scotland we have found a small number of timber frame walls which have been below 56 dB $D_{nT,w}$. This has been due to workmanship issues related to quilt insulation and structural bridging.

For lightweight steel walls using twin metal studs these would require an increase in some wall cavity widths from 140mm to 200mm to achieve above 56 dB $D_{nT,w}$ consistently. In terms of minimum 58 dB $D_{nT,w}$ the cavity would require to be at least 240mm, an increase for some current constructions of 100mm. The mean performance for a metal frame twin wall with 200 mm cavity would be 60 dB $D_{nT,w}$, when built correctly.

For both lightweight timber and metal frame party walls one of the criticisms relating to noise is the ability for impact sound transmission to be heard from plugs being inserted into sockets. Although there are no regulations for horizontal impact sound transmission through separating walls, it is recommended that the guidance should state that such sockets and service zones, where possible, should not be located on the separating wall. It is recommended that to reduce such noise effects sockets and services that are required to be located on the separating wall should be mounted within a sacrificial service zone, formed by a timber or metal strap with a secondary gypsum based lining.

It is recommended that the guidance should discourage the use of single stud separating walls as these easily transmit horizontal impact noise to the neighbouring dwelling (from closure of kitchen cupboards, internal doors and wardrobes)

2.5 Separating Floors

In the case of concrete separating floors using precast concrete wide slabs it would be difficult to achieve the minimum of 58 dB $D_{nT,w}$ repeatedly due to flanking restrictions. Furthermore core 150mm precast slabs with isolated screeds or floating floor treatments FFTs would require at least 200mm ceiling voids, high density plasterboards and quilt in the ceiling void.

In the case of in-situ concrete separating floors the core floor slab would require to be a minimum of 250mm to consistently achieve a minimum of 58 dB $D_{nT,w}$.

Several floors could achieve a minimum of 56 dB $D_{nT,w}$ with an average performance level of 60 dB $D_{nT,w}$ or more. These are discussed further in Chapter 6.

Timber separating floors would have difficulty in achieving minimum 58 dB $D_{nT,w}$ repeatedly but could achieve a minimum 56 dB $D_{nT,w}$. Their average performance using the constructions recommended in Chapter 8 can be 62 dB $D_{nT,w}$ when built correctly. It is recommended that a minimum airborne criteria of 56 dB $D_{nT,w}$ be adopted.

Appendix 1B provides a brief summary of some of the issues in trying to achieve min. 58 dB $D_{nT,w}$ and the potential requirement to focus on singular proprietary products or influence on overall floor depths.

2.6 Impact performance levels

The impact sound transmission proposed value of maximum 56 dB $L'_{nT,w}$, is achievable and would improve the impact standard similar to the early 1980's levels under the AAD criteria. RMP support the increase in impact standards as this has been a key area of complaint from occupants for quite some time.

For floors using FFTs (floating floor treatments such as resilient battens) to achieve this criteria would not be difficult and is already incorporated within many current standard constructions.

In the case of isolated screed floors, for precast wide slabs and in-situ concrete floors, it would be difficult to consistently have an impact performance less than 56 dB $L'_{nT,w}$. However, by adopting a bonded resilient floor covering (BRC) this could be achieved (with a laminate or wood flooring layer applied to the surface). RMP would not recommend using a bonded resilient floor covering for timber or metal frame separating floors**.**

2.7 Minimum and maximum compliance versus "mean" compliance

One of the most interesting factors relating to setting new criteria and benchmarks is the influence this has on design stage. Changing from a regulatory mean requirement of performance compliance to an absolute single figure minimum or maximum (backed up by pre-completion testing) alters the design approach undertaken by acoustic consultants, house builders and developers.

The current mean airborne sound insulation requirements of Section 5 of 53 dB $D_{nT,w}$ (walls) and 52 dB $D_{nT,w}$ (floors) allow individual values, within a group of tests, to be 4 dB (e.g. 49 and 48dB) lower than the target mean value and for impact sound transmission, mean of 61 dB $L'_{nT,w}$, individual tests can be 4 dB above (e.g. 65 dB $L'_{nT,w}$).

Whilst some acoustic consultants and house builders would strive in their designs for higher performance values above the regulations targets often the separating wall or floor design was altered when costs had to be cut back. As such sometimes the primary aim of good sound insulation was watered down to "*lets meet what the regulations need*". The available tolerance due to the "mean" criteria has historically permitted separating wall and floor constructions to be designed closer to the mean value. For some previous wall and floor constructions the mean on-site performance would generally be only 1 dB to 2 dB better than the regulatory mean.

If the airborne performance requirement was set at a minimum of 56 dB $D_{nT,w}$ acoustic consultants and designers would design new constructions towards a mean performance level of 60 dB $D_{nT,w}$ to create a buffer zone (i.e. +4dB). If the airborne performance level is set as minimum 58 dB $D_{nT,w}$ then the *design target* would be 63 dB $D_{nT,w}$ (+5dB). The reason for the increased design target of +5 versus +4 would be to build in a higher buffer zone. This is because the higher the minimum standard the greater the potential drop in performance from minor workmanship effects. In terms of impact sound transmission a slightly higher buffer zone may be required due to the influence of workmanship issues surrounding the installation of flanking strips. Table 2A and 2B outline airborne and impact performance requirements, mean design targets and the effective difference for current Section 5, RMP recommended new Section 5 and draft proposed new Section 5.

TABLE 2A

Airborne sound insulation

Current Section 5	Required performance level	Mean design target	Difference (means)
Walls	mean 53 dB, min 49	54 dB	+1 dB
Floors	mean 52 dB, min 48	54 dB	+2 dB

RMP Recommended New Section 5	Required performance level	Mean design target	Difference
Walls	min 56 dB	60 dB or more	+4 dB
Floors	min 56 dB	60 dB or more	+4 dB

SBSA Proposed New Section 5	Required performance level	Mean design target	Difference
Walls	min 58 dB	63 dB or more	+5 dB
Floors	min 58 dB	63 dB or more	+5 dB

TABLE 2B

Impact sound transmission

Current Section 5	Required performance level	Mean design target	Difference (means)
Floors	mean 61 dB, max 65	59 dB or less	-2 dB

Proposed New Section 5	Required performance level	Mean design target	Difference
Floors	max 56	52 dB or less	-6 dB

2.8 Resultant improvements

Table 2C and 2D show the resultant improvements for the recommended new Section 5 target values and the proposed new Section 5 target values.

If the current mean target airborne levels for walls (53 dB $D_{nT,w}$) and floors (52 dB $D_{nT,w}$) is raised to minimum 56 dB $D_{nT,w}$ this results in +3 dB for walls and +4 dB for floors. If the maximum impact value is changed from (61 dB $L'_{nT,w}$) to maximum 56 dB $L'_{nT,w}$ this results in a (+5 dB) improvement. However, the change to the current permitted minimum or maximum for a set of tests is for airborne (+7 dB walls) and (+8 dB floors) and for impact (+9 dB for floors). Using the proposed criteria of minimum 58dB $D_{nT,w}$ as set out in Table 2D these values are even higher and the design target for floors (airborne) is +11 dB.

TABLE 2C

IMPROVEMENT - Current Section 5 versus RMP Recommended Section 5

[recommended values of min 56 dB (airborne) and max 56 dB (impact)]

		Recommended new minimum versus current mean	**Recommended new minimum versus current group minimum**	**Required design target versus current mean**	**Required design target versus current design target**
Airborne	Walls	+ 3 dB	+ 7 dB	+ 7 dB	+ 6 dB
	Floors	+ 4 dB	+ 8 dB	+ 8 dB	+ 6 dB
Impact	Floors	+ 5 dB	+ 9 dB	+ 9 dB	+ 7 dB

TABLE 2D

IMPROVEMENT - Current Section 5 versus Proposed "Brief" New Section 5

[proposed values of min 58 dB (airborne) and max 56 dB (impact)]

		Proposed new minimum versus current mean	**Proposed new minimum versus current group minimum**	**Required design target versus current mean**	**Required design target versus current design target**
Airborne	Walls	+ 5 dB	+ 9 dB	+ 10 dB	+ 9 dB
	Floors	+ 6 dB	+ 10 dB	+ 11 dB	+ 9 dB
Impact	Floors	+ 5 dB	+ 9 dB	+ 9 dB	+ 7 dB

3 Performance Criteria

3.1 Airborne sound insulation

The acoustic rating “or criteria” of sound insulation in buildings is defined in ISO 717 Part 1 for airborne sound and Part 2 for impact sound. ISO 140 provides the instructions of how sound insulation should be measured. ISO 140 Part 4 deals with the field measurement (testing within dwellings) for airborne sound insulation and Part 7 addresses field measurements of impact sound transmission (such as footfall noise on separating floors).

When sound insulation measurements are undertaken within completed attached dwellings data is collected for a range of 16 frequencies from 100 Hz (low frequency or low pitch sounds) to 3150 Hz (high frequency or high pitch sounds).

As it is not convenient to finally express the sound insulation of a separating wall or floor for each of the 16 frequencies between 100 Hz to 3150 Hz, ISO 717 provides a mechanism for converting these values into a singular value, which can then be compared with a regulatory minima or maxima performance level.

Currently Section 5 adopts the ISO 717 criteria of $D_{nT,w}$ for airborne sound insulation, which is a weighted standardized level difference between two dwellings rooms separated by a separating wall or a separating floor.

As part of the range of criteria that may be used to express the sound insulation ISO 717 includes “frequency weightings terms” termed spectrum adaptation terms. There are two primary frequency weightings terms within ISO 717 Part 1, these are (C and C_{tr}).

These weighting terms (as the name suggests) apply a focus or weighting of how the wall or floor is performing for certain types of frequencies and sounds.

Such terms are applied to reflect the type of location the wall or floor may be situated within or adjacent to and the type of noise source the wall is having to insulate against.

3.2 Frequency weighting terms C and C_{tr}

The weighting term C is normally used when a building is being designed to reduce transmission of mid and high frequencies. The types of noise sources which may emit mid or high frequencies are:

- Living activities (talking, music, radio, tv)
- Children playing
- Railway traffic at medium and high speed
- Highway road traffic

The weighting term C_{tr} is normally used when a building is being designed to reduce transmission of low frequencies (bass type frequencies). The types of noise sources which may emit low frequencies are:

- Urban road traffic
- Railway traffic at low speeds
- Propeller driven aircraft
- Disco music

If a façade of a building was being designed for an airport (which would have propeller driven aircraft functioning outside of the building) it is highly likely that the designers would adopt a C_{tr} weighting to try and protect (or insulate) the building's occupants from low frequencies transmitting into the building.

Most countries do not use weighting terms at present. France and Sweden use the C – weighting to represent living noise. Recently in 2003 England and Wales decided to adopt C_{tr} as a weighting to improve the sound insulation of the separating walls and floors at low frequencies. This was due to the level of noise complaints which were linked with low frequency noise sources, for example stereo music systems in houses and flats. In Scotland there are now procedures in place (such as Anti-Social Behaviour Orders) to deal with some of these low frequency noise complaint issues.

3.3 Issues relating to the use of C_{tr}

England and Wales were the first country in the world to adopt this rating for separating walls and floors. Shortly after this period Australia decided to reflect this change and also adopted C_{tr}. New Zealand released a consultation document in 2004 for new sound insulation building regulations which involved C_{tr} (following Australia's release of their new regulations). Industry and other academic experts investigated C_{tr} and following the findings which identified concerns with the criteria, requested that the proposed regulations be reconsidered. The proposed changes were placed on hold and a new consultation document is due out in 2007.

From findings from previous research (see Part 1 Appendix 2) and also recent discussions with English and Australian acoustic consultants RMP have identified that there are concerns relating to the adoption of C_{tr} within building regulations for airborne sound insulation.

One of the principle concerns about the $D_{nT,w}$ +C_{tr} criteria is that it is difficult to accurately measure, especially in smaller rooms. Recent studies by acoustic consultants have identified that measurement variation can be around +/- 4dB.

The other main concern with C_{tr} is the over emphasis on low frequencies, which significantly reduces the emphasis on mid and high frequencies. This is outlined further in Appendix 2 which is a paper recently presented at the IOA Spring Conference in Cambridge 2007. This paper highlights the emphasis placed on 100Hz to 160Hz frequencies when using C_{tr}. Whilst this does raise sound insulation performance it is specific only to this small range of frequencies.

Another related issue to consider is the relative importance of trying to target low frequencies 100Hz to 160Hz where C_{tr} has its greatest influence. Complaints regarding low frequency bass music from stereos primarily annoys and disturbs residents at frequencies below 100 Hz.

Similar to low frequency impact and deflection/stiffness issues with lightweight timber floors, these are mainly concerned with frequencies below 100Hz and therefore outside the regulation range. As such recommendations have been included to reduce the joists spacing for engineered “I-joist” floors, as shown in Chapter 8.

Already in England and Wales structures have been redesigned where, to achieve the C_{tr} performance criteria, walls and floors have been altered in design such that the resonance may be moved to 63 or 80 Hz, thus below 100Hz and not picked up by the regulation range. Such avoidance measures actually exacerbate the low frequency noise problem experienced by occupants irrespective if the regulatory criteria have been met.

Using a joint criteria of $D_{nT,w}$ and $D_{nT,w}+C_{tr}$ would address a wide range of frequencies. However, we would suggest that raising the $D_{nT,w}$ value to min. 56 dB will automatically raise the low frequency performance requirements at the same time. Also, given that the effective design target of constructions will be aimed at 60 dB, to consistently achieve a minimum of 56 dB, this will further raise the performance over all frequencies.

Therefore due to the fact that the raised $D_{nT,w}$ criteria will also significantly improve low frequency performance combined with the significant problems identified with the C_{tr} criteria, RMP would recommend to continue with the $D_{nT,w}$ criteria only for airborne sound insulation for field testing.

RMP have noted that the influence of C_{tr}, when used in England and Wales for lightweight separating floors (e.g. timber joist and metal joist separating floors), has altered the construction design and resulted in better isolation within the design. Such changes involve use of deeper resilient battens and resilient ceiling bars. This has raised the acoustic performance for timber frame floor structures at low frequencies. As such they are now achieving similar performance at low frequencies to that of masonry supported precast slab floors.

Therefore RMP recommend that C_{tr} could be adopted, but not within the on-site field testing but within the laboratory benchmark testing of floating floor treatments and resilient bars. The inclusion of C_{tr} within a laboratory test would avoid variable factors which occur on site, between testers, small dwelling room issues and problems with site low frequency noise interference during on-site testing.

3.4 Impact sound transmission

The proposed use of criteria $L'_{nT,w}$ is in line with existing criteria and RMP would support the continued adoption of this method.

4 Dense Blockwork Solid Walls

4.1 Current constructions

Current constructions for solid walls involve primarily dense aggregate blocks. There are also solid walls of lightweight aggregate and aircrete blocks but these would not achieve the required performance levels consistently.

Current dense aggregate blockwork solid walls use a 13 mm render coat each side prior to applying dry linings. Alternatively a 13 mm plaster can be applied to the block face each side. Neither of these walls would achieve a minimum 56 dB $D_{nT,w}$ or 58 dB $D_{nT,w}$.

Independent linings could be used each side but this can lead to symmetric resonances and dips at low frequencies, which are affected by C_{tr}. Also this would result in very thick walls. Alternatively a hybrid construction can be used and this involves rendering one side of the wall and dry lining with a free standing wall lining with quilt on the other side.

4.2 Proposed construction

It is proposed that the example blockwork solid separating wall for the new Section 5 guidance is a dense block solid separating wall (using solid blocks not cellular) with a 13mm render or parge coat on one side with gypsum based board (minimum 12 kg/m^2) fixed using any normal method. On the other room side a minimum 70 mm metal stud, offset from the wall by 30 mm spacing with 50 mm suspended quilt insulation and gypsum based board (minimum 12 kg/m^2).

An example of the proposed solid blockwork separating wall construction is shown in Part 2 (Example Constructions – Wall Type 1).

4.3 Performance

The mean airborne sound insulation performance is found to be 60 dB $D_{nT,w}$ with a range from 55 to 64 dB $D_{nT,w}$. Values of 55 mm have been recorded using 50mm stud and the proposed construction would use a 70 mm stud.

All airborne performance values are greater than 47 dB $D_{nT,w}$+C_{tr}.

4.4 Flanking constructions

For attached houses or apartments the inner leaf of the external should be 100mm dense block (minimum 1850 kg/m^3). These walls should be finished with gypsum based board or insulated backed plasterboard, minimum density 10 kg/m^2. The cavity can be partial or fully filled with insulation material. The wall ties to achieve various wind loadings for the external wall may be Type B as discussed further in Part 2 of this report.

The external cavity should have a non rigid cavity / fire stop at the junction between the separating walls and the external wall.

4.5 Primary construction changes

The construction changes comparing current constructions with proposed constructions are listed below:

- use of independent metal studs one side and quilt, rather than render and plasterboard
- gypsum based board changes from 8 kg/m^2 to 12 kg/m^2 on party walls and 8 kg/m^2 to 10 kg/m^2 for inner leaf walls
- total wall thickness increases from 286 mm to 362 mm

5 Dense Blockwork Cavity Walls

5.1 Current constructions

Current constructions for blockwork cavity walls in Scotland predominantly involve dense aggregate blocks. There are also a small number of cavity walls composed of standard aircrete blocks and also thin joint aircrete blocks.

Lightweight aggregate blockwork or aircrete blockwork walls would have difficulty in achieving minimum 56 dB $D_{nT,w}$ repeatedly. Also there have been difficulties for thin joint blockwork in achieving consistent performance due to the type of special wall ties required. For both of these lighter blocks a 75 mm cavity is the normal cavity width. There is ongoing research work for wider cavity walls but this has yet to be published.

Current dense aggregate blockwork walls use a minimum 50 mm cavity. These would have difficulty in achieving minimum 56 dB $D_{nT,w}$ and would require to increase their cavity width by 25 mm to a minimum of 75 mm.

Current mass per unit area of gypsum based board (such as plasterboard) varies from 7.5kg/m^2 to 8.5kg/m^2 for 12.5mm plasterboard. Over the last decade the mass per unit area of standard plasterboard has decreased from 10kg/m^2. Now more specific specialised 12.5mm boards are supplied for sound resistance, fire resistance and moisture resistance and are typically 10kg/m^2. Also standard 15mm plasterboard is 10kg/m^2. It is recommended that to achieve consistently values of 58-60 dB $D_{nT,w}$ and avoid values below 56 dB $D_{nT,w}$ and reduce the “drum effect” (or mass-spring-mass resonances) of the cavity formed behind the dry lining a higher density plasterboard would be required. A plasterboard mass per unit area of at least 12 kg/m^2 is proposed.

Current blockwork cavity wall constructions are also affected by the type of wall tie used. Due to structural regulation changes butterfly ties are no longer used in cavity blockwork separating walls.

5.2 Proposed construction

It is proposed that the example blockwork cavity separating wall for the new Section 5 guidance is a dense block cavity separating wall (solid blocks not cellular) with a 75 mm cavity, rendered on each room face with minimum 13 mm parge or render coat, (with scratch finish to assist dab adhesion) with a gypsum based board on each room face with a mass per unit area of minimum 12 kg/m^2 mounted on dabs.

An example of the proposed blockwork separating wall construction is shown in Part 2 (Example Constructions – Wall Type 2).

5.3 Performance

The mean airborne sound insulation performance is typically 59 dB $D_{nT,w}$ with a range from 56 to 65 dB $D_{nT,w}$.

All airborne sound insulation performance is greater than 47 dB $D_{nT,w}+C_{tr}$.

5.4 Flanking constructions

For attached houses using blockwork cavity separating walls it would be possible to use dense block, lightweight aggregate and aircrete for the inner leaf of the external wall. These external wall inner leafs may be finished with gypsum based board or insulated backed plasterboard and the cavity may be partial or full fill. The wall ties to achieve various wind loadings may be Type B (similar to ADE 2003 and Robust Details).

For flats and apartments the inner leaf may be dense block due to limitations as a result of flanking transmission (vertically) which occur with lighter weight blocks, as discussed in Section 6.

The blockwork may be abutted and tied or toothed. The external cavity should have a non rigid cavity / fire stop at the junction between the separating walls and the external wall.

5.5 Primary construction changes

The construction changes comparing current constructions with proposed constructions are listed below:

- cavity width increase from 50 mm to 75 mm (275 mm core wall)
- cavity blockwork wall ties Type A (similar to ADE 2003)

- gypsum based board changes from 8 kg/m^2 to 12 kg/m^2
- total wall thickness increases from 321 mm to 351 mm

6 Precast Concrete Separating Floors

6.1 Current constructions

The most common types of precast concrete slab are 150 mm and 200 mm precast wide slabs with a minimum mass per unit area of 300 kg/m^2. These must be built into the perimeter walls to prevent flanking sound transmission. There are two types of floor surface constructions which predominate this market sector, these are:

- floating floor treatments (FFTs) – such as resilient battens, cradles and platform floors – all using a wood based decking layer (e.g. chipboard)
- isolated screed floors – such as sand:cement screed laid on isolating layers.

Both floors surface treatments require care and attention at the junction between the floor edge and the perimeter walls, wall linings and skirtings to reduce impact sound transmission flanking into the perimeter walls and into the apartment or flat below.

FFTs are normally placed directly onto the floor slab and have a mineral wool quilt inserted between the battens to reduce cavity resonance effects and reduce leakage through slab joints. The majority of FFT's also provide a "shield effect" to the core floor for airborne sound insulation, however, for FFT5 (shallow platform floors) this effect is limited.

For 150 mm slabs where FFT's are to be used would require a 50mm structural topping to increase the mass and resistance to airborne sound insulation to meet higher Section 5 targets.

Isolated screeds also provide a shield effect to the slab for airborne sound insulation but this is dependent on the thickness of the isolating layer and also the site workmanship.

Isolated screeds have historically not performed well for impact sound insulation. They require more care and attention to ensure that the screed is fully isolated from the perimeter walls and the supporting slab. Whilst the manufacturing industry has produced more "system approach" solutions to reduce the site workmanship effects the spread and range of impact performance values is still high and may often be above 56 dB $L'_{nT,w}$ (the proposed maximum values of proposed Section 5).

Some house builders and developers specifically want to have a hard flooring surface and not a wood based decking resting on a resilient batten or FFT type floor. If a isolated screed floor is to be recommended in the guidance it would require a minimum 4mm bonded resilient floor covering to be used as well to achieve the performance levels required.

Current ceiling frames vary from timber batten and counter timber batten (100 mm depth) to metal frame suspended ceilings (85 mm to 150 mm). The ceiling void depth may be 150 mm if there are service pipes and vents required within the ceiling zone.

Such separating floors to achieve values of typically 58 dB to 60 dB require to increase their ceiling depth to minimum 150 mm (similar to Robust Details). The ceiling board is typically 12.5 mm gypsum based board (e.g. plasterboard 8kg/m^2) and this lower mass per unit area than previous ceiling boards in the early 1990's results in a less stiff ceiling and thus reduces some of the low frequency performance. It is recommended that the Section 5 guidance should recommend that the ceiling board to be a minimum of 10kg/m^2.

6.2 Proposed construction

It is proposed that the example precast separating floor using a floating floor treatment (FFT) is composed of a 150 mm precast wide slab (mass per unit area of minimum 300kg/m^2) with a 50mm structural topping with either FFT1 (deep resilient batten), FFT2 (cradle/saddle), FFT3 (standard resilient batten) as a surface treatment with 25mm mineral wool quilt or batt (minimum 10kg/m^3) laid between FFT1, FFT2 or FFT3.

The ceiling void would require to have a minimum depth of 150 mm with a ceiling board of minimum 10 kg/m^2. Down lighters could be used with such floors and guidance is provided for this in Part 2 (Annex B). Underfloor heating may be used with FFT and isolated screed floors.

For 200mm precast slabs the structural topping or levelling screed may be a minimum of 20 mm thickness when used with FFT's but all other guidance would be similar to the 150mm precast wide slab floor and ceiling construction.

For a isolated screed floor the ceiling void and board would be the same as above. The screed would be typically 65 mm thick and laid on a 25mm insulated board (such as expanded [SD grade] or extruded polystyrene or mineral wool batt) with a 5mm polyethylene layer and a minimum 4mm bonded resilient floor covering. The bonded resilient floor covering (BRC) would be required to achieve the required impact performance with a wood based floor covering applied to the surface. Guidance for the required tests is outlined in Part 2 of this report. Examples of the proposed precast separating floors are shown in Part 2 (Example Constructions – Floor Type 2A and 2B).

6.3 Performance

The mean airborne sound insulation performance is typically 61 dB $D_{nT,w}$ with a range from 57 to 67 dB $D_{nT,w}$.

All airborne sound insulation performance is higher than 47 dB $D_{nT,w}+C_{tr}$.

The mean impact sound transmission performance is typically 45 dB $L'_{nT,w}$, with a range from 41 dB to 55 dB $L'_{nT,w}$.

6.4 Flanking constructions

Due to the limitations imposed by the structural flanking conditions the supporting blockwork would require to be dense block with minimum density of 1850kg/m^3. This is currently the most common block used in flanking construction for precast wide slabs in Scotland.

6.5 Primary construction changes

The construction changes comparing current constructions with proposed constructions are listed below:

Precast Floor with FFTs (e.g. FFT3 resilient batten 45 mm)

- structural topping of 50 mm thickness introduced for 150 mm slabs
- ceiling void increased from 85 mm to 150 mm
- timber counter battens replaced by metal frame suspended ceiling

- gypsum based ceiling board changes from 8 kg/m^2 to 10 kg/m^2
- total floor thickness increases from 340 mm to 429 mm

Precast Floor with Isolated screed and BRC

- 4mm bonded resilient floor covering introduced (*requires to be tested by the manufacturer as suggested in Appendix 3*)
- ceiling void increased from 85 / 100 mm to 150 mm
- gypsum based ceiling board changes from 8 kg/m^2 to 10 kg/m^2
- total floor thickness increases from 307 mm to 411 mm

7 Timber Frame Separating Walls

7.1 Current constructions

Current timber frame wall constructions can vary in cavity width between linings from 200mm to 240mm. In some cases mineral wool is suspended down the centre of the cavity or placed only between studs in one of the twin frames or placed between studs in each of the twin frames.

The main sound transmission mechanism is airborne but limitations are imposed by the structural ties which link the twin frames and the spacing by which they offset each of the frames.

To achieve repeated high performance above 56 dB $D_{nT,w}$ would require set minimum spacings between the frames and between the linings. It is proposed that the minimum cavity width between the linings would be 240 mm with spacing between the frames of at least 50 mm. Mineral wool quilt or batt insulation would be required to be positioned between the studs of each frame on both sides of the cavity. The current gypsum board linings with a mass per unit area of at least 22 kg/m^2 would be sufficient.

7.2 Proposed construction

It is proposed that the example timber frame separating wall is composed of twin frame timber studs with a 240 mm cavity (lining to lining), with 50 mm cavity between studs, with minimum 60 mm quilt or batt insulation (minimum 10 kg/m^3) placed in each frame between studs and lined with minimum two layers of gypsum based board with a combined mass per unit area of 22 kg/m^2.

Where service zones or sockets are required it is recommended that a sacrificial service zone is formed using a timber or metal strap and lined with gypsum based board minimum 8 kg/m^2. This avoids breaking into the separating construction for services, reduces leakage issues and reduces horizontal impact noise from plugs being inserted into the sockets.

Where sheathing board is required for structural reasons a cavity of minimum 50 mm should be formed between the internal face of the sheathing linings.

This construction is shown in Part 2 (Example Constructions – Wall Type 3).

7.3 Performance

The mean airborne sound insulation performance is typically 63 dB $D_{nT,w}$ with a range from 57 to 70 dB $D_{nT,w}$.

The airborne sound insulation performance is higher than 47 dB $D_{nT,w}+C_{tr}$.

7.4 Flanking constructions

For attached houses the inner leaf of the external wall may be lined by a single gypsum board layer of at least 8 kg/m^2 with mineral wool quilt or batt between the frames and the cavity side of the stud lined with a sheathing board.

For apartments and flats the inner leaf linings should be at least 2 layers of gypsum based board with a minimum combined mass per unit area of 16 kg/m^2.

Cavity fire stops are required at the junction between the separating wall and the external wall.

7.5 Primary construction changes

The construction changes comparing current constructions with proposed constructions are listed below. Many existing timber frame separating walls are currently being built to the proposed construction. The reference to current constructions are related to the small number of timber frame separating walls which are using 220mm cavities and quilt one side:

- cavity width between linings increased from 220 mm to 240 mm
- cavity spacing between studs increased from 30mm to 50mm
- mineral wool quilt placed both sides rather than one side
- total wall thickness increases from 280 mm to 300 mm

8 Timber Frame Separating Floors

8.1 Current constructions

Current timber frame floor constructions encompass a wide range of structural cores, floor treatments and ceiling treatments. The most common type of constructions are the engineered “I-joist” of depths varying from 235 mm to 245 mm, solid joists 220 mm to 235 mm and metal web lattice joists typically 253 mm. Solid joists are typically at 400mm centres with engineered “I-joists” at 600mm centres.

The floor treatment often has resilient battens (typically 45 mm – similar to Robust Detail FFT3) with quilt laid between the battens which rest on a sub deck board typically 11 mm to 15 mm thick. The floor upper surface is composed of a gypsum based board of 13.5 kg/m^3 with 18 – 22mm wood based board.

To achieve repeatedly the proposed required airborne performance and also achieve adequate low frequency performance it is recommended that the floating floor treatment should be an FFT deep resilient batten (70 mm FFT1). The sub deck layer should be 15 mm to reduce deflection under loading and increase the floor’s stiffness. To improve very low frequency performance below 100 Hz (outside of the building regulations) it is recommended that joist spacings for engineered “I-joists” or metal web joists should be at a maximum of 450 mm centres to reduce potential for complaints relating to low frequency airborne and impact sounds. An alternative to 450mm centres and remain at maximum 600mm centres is the use of a mid span bracing element between joists.

It is common practice to have at least 100 mm mineral wool quilt or batt insulation within the main floor cavity. Some constructions use resilient bars to increase the isolation between the joist and ceiling board. Some constructions have the gypsum ceiling boards directly connected to the joists as the current performance levels of Section 5 can be met without resilient bars. A resilient bar would be required to offset and isolate the ceiling boards and this is typically 16mm in depth.

8.2 Proposed construction

It is proposed that the example timber frame separating floor is composed of engineered “I-joists” of at least 240mm depth (or solid timber joists of at least 220mm depth), with

100 mm mineral wool in the cavity, 16mm resilient bars fixed directly perpendicular to the joists and two layers of gypsum based board of combined mass per unit area of at least 23 kg/m^2.

The upper sub deck and floor treatments should be 15mm sub deck, with a FFT1 (minimum 70mm resilient batten – after loading) with gypsum based board and 22mm wood based board.

Where downlighters are required these should be mounted in a separate service zone formed beneath the two layers of gypsum based board. The service zone is formed by a secondary layer of gypsum based board mounted via timber branders or metal straps.

This will avoid breaking into the separating construction for services, reduces leakage issues and avoids downlighters overheating when placed directly adjacent to the cavity mineral wool quilt or batt.

Examples of the proposed timber frame separating floors are shown in Part 2 (Example Constructions Floor Type 3A and 3B).

8.3 Performance

The mean airborne sound insulation performance is typically 61 dB $D_{nT,w}$ with a range from 57 to 63 dB $D_{nT,w}$.

The airborne sound insulation performance is equal to or higher than 47 dB $D_{nT,w}+C_{tr}$.

The mean impact sound transmission performance is typically 51 dB $L'_{nT,w}$,with a range from 46 dB to 58 dB $L'_{nT,w.}$

8.4 Flanking constructions

For apartments and flats the inner leaf linings should be at least 2 layers of gypsum based board with a minimum combined mass per unit area of 16 kg/m^2.

Cavity fire stops are required at the junction between the separating floor and the external wall and the junction between the separating floor and the separating wall.

8.5 Primary construction changes

The construction changes comparing current constructions with proposed constructions are listed below. The comparison is made between timber floors using FFT3 (standard depth resilient battens) and no resilient bars:

- batten changed from FFT3 to FFT1 (45 mm to 70 mm)
- sub decking changed from 11 mm to 15 mm (NB: I-joists often already adopt 15 mm)
- joist spacings changed from max 600 mm centres to max 450 mm centres (NB: solid joists already at 400 mm centres)
- incorporation of 16 mm resilient bar
- total floor thickness increases from 362 mm to 393 mm (I-joists) and 342 mm to 377 mm (solid joists)

9 Metal Frame Separating Walls

9.1 Current constructions

Current metal stud frame wall constructions use 48 mm to 72 mm depth studs. The overall cavity width between linings can vary from 140 mm to 200 mm. These constructions are typically used in high rise in-situ concrete frame apartments and the cavity spacing has often been dictated by alignment with the concrete column or shear wall width.

The twin stud frames are coupled by metal ties or straps. In some cases where the original specification has been for a 48 mm stud the stud width has then been increased to 70mm due to structural requirements, dependent on the storey height. This results in the minimum spacing between the studs being reduced and thus creating shorter length ties which reduces sound insulation performance.

Mineral wool quilt or batt is sometimes suspended down the centre of the cavity or placed only between studs in one of the twin frames or placed between studs in each of the twin frames.

To achieve repeated high performance above 56 dB $D_{nT,w}$ would require set minimum spacings between the frames and between the linings. It is proposed that the minimum cavity width between the linings would be 200 mm with spacing between the frames of at least 50 mm. Mineral wool quilt or batt insulation would be required to be positioned between the studs of each frame on both sides of the cavity. The current gypsum board linings with a mass per unit area of at least 22 kg/m^2 would be sufficient.

9.2 Proposed construction

It is proposed that the example metal frame separating wall is composed of twin frame metal studs of minimum width 70mm, with a 200 mm cavity (lining to lining), with 60 mm cavity between studs, with minimum 50 mm quilt or batt insulation (minimum 10 kg/m^3) placed within each frame between studs and lined with minimum two layers of gypsum based board with a combined mass per unit area of 22 kg/m^2.

Where service zones or sockets are required it is recommended that a sacrificial service zone is formed using a timber or metal strap and lined with gypsum based board minimum 8 kg/m^2. This avoids breaking into the separating construction for services, reduces leakage issues and reduces horizontal impact noise from plugs being inserted into the sockets (similar to proposed timber frame separating walls).

Where a cavity sheathing board is required a cavity of minimum 60 mm should be formed between the inner face of the sheathing linings.

An example of the proposed metal frame separating wall is shown in Part 2 (Example Constructions – Wall Type 4).

9.3 Performance

The mean airborne sound insulation performance is typically 61 dB $D_{nT,w}$ with a range from 56 to 66 dB $D_{nT,w}$.

The airborne sound insulation performance is higher than 47 dB $D_{nT,w}+C_{tr}$.

9.4 Flanking constructions

Similar to timber frame separating walls for attached houses the inner leaf of the frame may be lined by a single gypsum board layer of at least 8 kg/m^2 with mineral wool quilt or batt between the frames and the cavity side of the stud lined with a sheathing board.

For apartments and flats the inner leaf linings should be at least 2 layers of gypsum based board with a minimum combined mass per unit area of 16 kg/m^2.

Cavity fire stops are required at the junction between the separating wall and the external wall.

9.5 Primary construction changes

The construction changes comparing current constructions with proposed constructions are listed below. Many existing metal frame separating walls are currently being built to the proposed construction. The reference to current constructions are related to those metal frame separating walls which are using 160mm cavities and one layer of quilt or batt:

- cavity width between linings increased from 160 mm to 200 mm
- cavity spacing between studs increased from 40mm to 60mm
- mineral wool quilt or batt placed both sides rather than one side
- total wall thickness increases from 220 mm to 260 mm

10 In-situ Concrete Separating Floors

10.1 Current constructions

In-situ concrete floors with concrete frame have a range of core floor thickness from 200mm to 285mm, dependent on spans and structural requirements. Similar to precast concrete wide slabs there are two common types of floor finish, using FFTs or isolated screeds.

Both floors surface treatments require care and attention at the junction between the floor edge and the perimeter walls, wall linings and skirtings to reduce impact sound transmission flanking into the perimeter frame, walls and thus into the apartment or flat below.

FFTs are normally placed directly onto the floor slab and have a mineral wool quilt inserted between the battens to reduce cavity resonance effects and absorb mid and high frequencies. The majority of FFT's also provide a "shield effect" to the core floor for airborne sound insulation, however, for FFT5 (shallow platform floors) this effect is limited.

For 225 mm in-situ concrete slabs where FFT's or isolated screeds are used would require a minimum of 100mm ceiling void to meet the proposed Section 5 targets.

Isolated screeds also provide a shield effect to the slab for airborne sound insulation but this is dependent on the thickness of the isolating layer and also the site workmanship.

The high mass and stiffness of the core floor provides better acoustic performance both for airborne and impact sound insulation than precast wide slabs. There is also less flanking transmission with such structures due to the frame design and composition. However, the use of continuous vertical mullions and curtain walling for the external facades is not recommended as this can lead to a significant reduction in sound insulation performance due to excessive flanking transmission.

Some house builders and developers specifically want to have a hard flooring surface and not a wood based decking resting on a resilient batten or FFT type floor. If a isolated screed floor is to be recommended in the guidance it would require a minimum

3mm bonded resilient floor covering to be used as well as an isolating layer beneath the screed to achieve the performance levels required.

Ceiling frames are commonly metal frame ceilings to allow for services and vents and depth may vary from 50 mm to 200 mm.

10.2 Proposed construction

It is proposed that the example in-situ concrete separating floor using a floating floor treatment (FFT) is composed of a minimum 225 mm in-situ core with either an FFT1 (deep resilient batten), FFT2 (cradle/saddle) or FFT3 (standard resilient batten) as a surface treatment with 25mm mineral wool quilt or batt (minimum 10kg/m^3) laid between FFT1, FFT2 or FFT3.

The ceiling void would require to be a minimum of 100 mm with a ceiling board of minimum 10 kg/m^2. Down lighters could be used with such floors and guidance will be provided for this. Underfloor heating may be used for both FFT and isolated screed floors.

For an isolated screed floor the ceiling void and board would be the same as above. The screed would be typically 65 mm thick and laid on a 5mm polyethylene layer and a minimum 3mm bonded resilient floor covering applied to the screed surface. The bonded resilient floor covering (BRC) would be required to achieve the required impact performance with a wood based floor covering applied to the surface. Guidance for benchmark laboratory testing for the BRC is provided in Part 2 of this report.

Examples of the proposed in-situ separating floors are shown in Part 2 (Example Constructions - Floor Types 1A and 1B).

10.3 Performance

The mean airborne sound insulation performance is 62 dB $D_{nT,w}$ with a range from 56 to 67 dB $D_{nT,w}$.

The airborne sound insulation performance is higher than 47 dB $D_{nT,w}+C_{tr}$.

The mean impact sound transmission performance is 43 dB $L'_{nT,w}$ with a range from 36 dB to 50 dB $L'_{nT,w}$.

10.4 Flanking constructions

Flanking construction may use dense block or lightweight metal or timber stud frames for the inner leaf. Similar to precast slabs or timber frame separating floors the floor construction must break the vertical continuity of the inner leaf, such that the inner leaf is not continuous between dwellings. Fire and cavity stops would be required for the junction between the separating floor and external wall junction.

10.5 Primary construction changes

The construction changes comparing current constructions with proposed constructions are listed below:

In-situ Concrete Floor with FFTs (e.g. FFT3 resilient batten 45 mm)

- ceiling void depth increased from 70mm to minimum 100mm
- metal frame suspended ceiling and not timber battens
- gypsum based ceiling board changes from 8 kg/m^2 to 10 kg/m^2
- total floor thickness increases from 349 mm to 404 mm

In-situ Concrete Floor with Isolated screed and BRC

- 3mm bonded resilient floor covering introduced (*requires to be tested by the manufacturer as suggested in Appendix 3*)
- ceiling void depth increased from 70 mm to minimum 100 mm
- gypsum based ceiling board changes from 8 kg/m^2 to 10 kg/m^2
- total floor thickness increases from 352 mm to 411 mm

11 Component Performance Requirements (laboratory tested)

11.1 Assisting Designers and Specifiers

One of the most common causes of failure to meet the the required or guidance sound insulation performance requirements is the incorrect specification of products or subsititution of products by designers and specifiers.

Sound insulation involves a “system approach” of combining products and components together. However, for the non-acoustician the complexity of elements and components, the vast array of acoustic product testing nomenclature and the logarithmic approach (decibels) for sound insulation performance does not lend itself forward as a straightforward design process.

To assist designers and specifiers in identifying compliant products and components the use of laboratory performance testing of components and products to achieve specific minimum levels has increased over the last decade. RMP recommend that the existing component guidance in Section 5 is expanded and that the following products could be benchmarked by a laboratory perormance to assist designers and specifiers:

- Bonded Resilient Floor Coverings (tested under a wood based floor surface)
- Floating Floor Treatments (concrete core floors)
- Floating Floor Treatments (timber core floors)
- Resilient Bars
- Downlighters

Part 1 (Appendix 3) provides an overview of the airborne or impact testing criteria.

Part 2 (Annex B) of this report outlines the recommended performance requirements for such products and details of the laboratory test methodologies.

12 Conversions

12.1 Conversion Criteria

We have compared the current database of conversion constructions and results with the proposed SBSA new build criteria discussed in the previous sections. However, with the exception of stone walls over 300 mm thick we have been unable to identify constructions which regularly and consistently would achieve either of the proposed criteria.

We would therefore recommend to SBSA working party and steering group that a separate standard for conversions should be adopted. This would be in line with methodology used in Part E England and Wales. Historically there has been a similarity of standards for new build and conversion developments on the basis that all residents should enjoy the same minimum levels of insulation. However, this may not be feasible to maintain due to the significant increase in insulation proposed and its potential impact on the retention and use of notable historic features.

The standards proposed for conversions shown in the Table below still represent a significant increase on the minimum performance currently recommended in the regulations. Whilst we do not recommend the adoption of the $D_{nT,w}+C_{tr}$ criteria, as discussed in Section 3, we have included our recommendations, should SBSA wish to adopt this criteria.

		Recommended	Change to current group minimum
Wall	Airborne sound insulation (minimum)	53 dB $D_{nT,w}$	4
Floor	Airborne sound insulation (minimum)	53 dB $D_{nT,w}$	5
	Impact sound insulation (maximum)	58 dB $L'_{nT,w}$	7

Note: it is not recommended to apply a low frequency weighting C_{tr} to conversions

It should also be noted that as with new build developments, that designers are likely to target a performance +3 to +4 dB above the minimum required criteria in order to ensure compliance.

We would further recommend that the regulations include comment to the effect that "where buildings of historic interest would be adversely affected by the introduction of sound insulation mitigation measures, that a reduction to these recommended levels may be agreed with the Local Authority".

12.2 Conversion Constructions

Given the highly variable nature of existing constructions and the resulting variation in sound insulation performance, we do not consider it possible to present a limited number of example constructions that would adequately represent the Scottish housing stock. We do not feel that the building regulations could include sufficient detailed construction advice for conversions due to high level of variability and bespoke nature of core walls and floors and all perimeter flanking walls.

12.3 Recommended Advice for Conversions

Rather than presenting construction advice we would recommend that the guidance to the standard provides information on where more detailed advice can be obtained and a recommendation to carry out pre-conversion testing. This would be in line with SBSA's current guidance.

Carrying out pre conversion testing prior to conversion is the only reliable method of establishing the existing level of sound insulation provided by existing separating walls and floors.

From analysis of the results and knowledge of the existing construction the level and methods of improvement can be clearly identified in order to ensure compliance with the regulation criteria.

Pre-conversion testing can also identify if a construction already satisfies the regulation requirements, which can provide significant benefits to the developer in terms of both cost and sustainability. This also protects many of the buildings existing 'original' interior features.

We would recommend that the guidance advises developers/architects to contact an acoustic consultant who is a member of the Association of Noise Consultants or IOA members list (Building Acoustics).

Reference could also be made to SBSA's existing publication "Housing and Sound Insulation - *Improving existing attached dwellings and designing for conversions*" which outlines in Chapter 8 recommended best practice for conversions. This is freely available on line at:

www.bpc.napier.ac.uk/sound

13 Summary

13.1 Introduction

This report has been prepared for review by the Section 5 Steering Group and undertaken on behalf of the Scottish Building Standards Agency.

The aim of the document is to design and develop example constructions to achieve new Section 5 performance recommendations for airborne sound insulation and impact sound transmission.

The findings and recommendations of this report are summarised as follows:

13.2 Performance criteria and levels

The airborne $D_{nT,w}$ criteria of min. 58 dB proposed by SBSA is unlikely to be consistently achievable by the high performance constructions for which test evidence is currently available. Timber frame separating walls have the best opportunity of achieving this performance level consistently with some minor adjustments. However, timber frame separating floors, and specifically apartments using solid blockwork and precast concrete slabs would have significant difficulty in achieving such a high level of performance. These would require more proprietary based solutions.

Given that there are almost no complaints for precast concrete floors with recorded airborne performance of 56 dB and higher, this raises a query as to whether targeting min. 58 is practical across all industry sectors.

The impact criteria proposed by SBSA is readily achievable by high performance constructions.

For conversion developments the criteria proposed by SBSA for impact and airborne is unlikely to be consistently achievable.

With regard to the measurement parameter RMP have concerns with the introduction of the $D_{nT,w}+C_{tr}$ criteria within field testing as a result of the significant measurement variance, problems with small rooms and onsite testing and the over emphasis on low frequency performance. Whilst it is recognised that low frequency noise can cause neighbour disturbance, it is felt that a significant increase in the $D_{nT,w}$ criteria would insure that sufficient low frequency insulation is provided.

However, C_{tr} can be a useful measure to raise the sound insulation performance at low frequencies for lightweight frame floors, such as timber separating floors. RMP recommend in the benchmark laboratory performance requirements that C_{tr} is used as part of the performance specification for floating floor treatments and resilient bars, which are to be used on timber joist or lightweight frame floors,.

RMP have proposed an alternative set of performance criteria for new build and conversion developments. Whilst marginally lower than the SBSA proposals the criteria are still a significant increase on the current minimum level of insulation recommended in the Technical Handbook.

The recommended criteria are set out below:

New build

Airborne sound insulation (minimum)	56 dB $D_{nT,w}$
Impact sound insulation (maximum)	56 dB $L'_{nT,w}$

Conversions

Airborne sound insulation (minimum)	53 dB $D_{nT,w}$
Impact sound insulation (maximum)	58 dB $L'_{nT,w}$

13.3 Example constructions

Part 2 provides details of the proposed “new build” example constructions and supporting supplementary information.

From our review of all available information with regard to typical performance of conversion floors and walls it has been identified that the variance in core construction performance prior to development is such that we do not consider it practical to provide sufficient example constructions. It has been recommended that rather than provide *example constructions* for conversions, guidance could be provided on best practice of carrying out conversions and encouraging pre-conversion testing where possible. This could be supported in part by the SBSA current guidance documents “Housing and Sound Insulation”. In addition, recent guidance has also been published by Historic Scotland “Conversion of Traditional Buildings”.

13.4 Conclusion

The recommended new minimum airborne sound insulation performance levels versus current guidance will increase the airborne performance by 3-4 dB above current mean levels and 7-8dB better than current permitted minimum levels, when a group of on-site tests is undertaken. The recommended new impact sound insulation performance (against footfall noise) versus current guidance will improve the impact insulation performance by 5 dB above current mean levels and 9dB better than current permitted maximum levels.

The example constructions provided within this report should achieve the new recommended performance levels if specified correctly and built properly.

The performance levels, example constructions and guidance will be a step change for the industry. However, this as a ‘measured step’ which still encapsulates a wide range of construction industry sectors, build, generic product material types and, at the same time, will enhance the sound insulation performance of new build attached dwellings for future household occupants.

Appendix 1A

Target criteria and separating wall and floor constructions

SEPARATING WALLS		DnT,w			DnT,w+Ctr	**Appendix 1A**
Core construction	**Construction Description**	**Min 58**	**Mean 60-62**	**Min 56**	**Min 47**	**Comments**
Blockwork 215mm Solid Walls	dense block, gypsum boards each side	NO	NO	NO	NO	
	dense block, 32mm mineral backed plbd	NO	NO	NO	NO	
	dense block, 42mm mineral backed plbd	NO	NO	NO	NO	
	dense block, 52mm mineral backed plbd	NO	YES	YES	YES	Not suitable for wall loadings
	dense block, 13mm render +plbd	NO	NO	NO	YES	
	dense block, 13mm plaster	NO	NO	NO	YES	
	dense block, 8mm render + ind. lining o/s	NO	YES	YES	YES	
	dense block, 8mm render + ind. lining b/s	YES	YES	YES	YES	
	LWA or aircrete solid walls	NO	NO	NO	NO	Even with ind. linings limited by flanking
Blockwork Walls 50mm Cavity	dense block, gypsum boards each side	NO	NO	NO	NO	
	dense block, 32mm mineral backed plbd	NO	NO	YES	NO	
	dense block, 42mm mineral backed plbd	NO	YES	YES	YES	Not suitable for wall loadings
	dense block, 52mm mineral backed plbd	NO	YES	YES	YES	Not suitable for wall loadings
	dense block, 13mm render +plbd	NO	NO	NO	NO	
	dense block, ind. linings b/s	YES	YES	YES	YES	
Blockwork Walls 75mm Cavity	dense block, gypsum boards each side	NO	NO	NO	YES	
	dense block, 32mm mineral backed plbd	NO	NO	NO	YES	
	dense block, 42mm mineral backed plbd	NO	YES	YES	YES	Not suitable for wall loadings
	dense block, 52mm mineral backed plbd	YES	YES	YES	YES	Not suitable for wall loadings
	dense block, 8mm render +plbd	NO	NO	NO	YES	
	dense block, 13mm render + HD plbd	NO	YES	YES	YES	Using HD - high density plbd
	dense block, ind. linings b/s	YES	YES	YES	YES	
	dense block, 13mm plaster	NO	YES	NO	YES	
	LWA and aircrete blocks with 75mm cavity	NO	YES	NO	YES	
Timber Frame Twin Studs	Twin studs, 200mm cavity, quilt o/s	NO	NO	NO	YES	
	Twin studs, 200mm cavity, quilt b/s	NO	NO	YES	YES	
	Twin studs, 240mm cavity, quilt o/s	NO	YES	NO	YES	
	Twin studs, 240mm cavity, quilt b/s	NO	YES	YES	YES	
	Twin studs, 240mm, quilt b/s, sheathing, 50mm cavity	NO	YES	YES	YES	
Metal Frame Twin Studs	Twin studs, 140mm cavity, quilt o/s	NO	NO	NO	YES	
	Twin studs, 140mm cavity, quilt b/s	NO	YES	NO	YES	
	Twin studs, 200mm cavity, quilt b/s	NO	YES	YES	YES	

SEPARATING FLOORS		DnT,w			DnT,w+Ctr	L'nT,w	**Appendix 1A** (cont.)
Core construction	**Construction Description**	**Min 58**	**Mean 60-62**	**Min 56**	**Min 47**	**Max 56**	**Comments**
Precast Wide slabs 150mm thick	floating screed, 50mm ceiling, plbd	NO	NO	NO	NO	NO	
	floating screed, 75mm ceiling, plbd	NO	NO	NO	NO	NO	
	floating screed, 100mm ceiling, plbd	NO	YES	NO	YES	NO	
	floating screed, 150mm ceiling, plbd	NO	YES	YES	YES	NO	
	BSFC, floating screed, 150mm ceiling, plbd	NO	YES	YES	YES	YES	
	FFT3, 25mm quilt, 50mm ceiling, plbd	NO	NO	NO	NO	NO	
	FFT3, 25mm quilt, 75mm ceiling, plbd	NO	NO	NO	NO	YES	
	FFT3, 25mm quilt, 100mm ceiling, plbd	NO	NO	NO	NO	YES	
	FFT3, 25mm quilt, 150mm ceiling, plbd	NO	NO	NO	YES	YES	
	FFT3, 25mm quilt, 50mm screed, 150mm ceiling, plbd	NO	YES	YES	YES	YES	
In-Situ Concrete Slab 225mm Thick	FFT3, 25mm quilt, 100mm ceiling, plbd	NO	YES	YES	YES	YES	
	floating screed, 100mm ceiling, plbd	NO	YES	YES	YES	NO	
	BSFC, float. screed + 5, 100mm ceil, plbd	NO	YES	YES	YES	YES	
In-situ Concrete Slab 250mm Thick	FFT3, 25mm quilt, 150mm ceiling, plbd	YES	YES	YES	YES	YES	
	floating screed, 150mm ceiling, plbd	YES	YES	YES	YES	NO	Prop. system needed
	BSFC, 150mm ceiling, plbd	YES	YES	YES	YES	YES	
Timber Frame Solid Joists 220mm	FFT3, 25mm and 100mm quilt, direct fix ceil	NO	NO	NO	NO	NO	
	FFT3, 25mm and 100mm quilt, res. bar	NO	YES	NO	YES	YES	
	FFT1, 25mm and 100mm quilt, res. bar	NO	YES	YES	YES	YES	
Timber Frame I-joists 240mm	FFT3, 25mm and 100mm quilt, direct fix ceil	NO	NO	NO	NO	NO	
	FFT3, 25mm and 100mm quilt, res. bar	NO	YES	NO	YES	YES	
	FFT1, 25mm and 100mm quilt, res. bar	NO	YES	YES	YES	YES	

KEY plbd = plasterboard, o/s = one side. b/s = both sides, FFT1 = 70mm deep resilient batten, FFT2 = 50mm cradle/saddle, FFT3 = 45mm standard resilient batten, BSFC = bonded soft floor covering, LWA = lightweight aggregate block

Appendix 1B

Designing to meet min. 58 dB $D_{nT,w}$ (Airborne sound Insulation)

The following document is an additional summary report requested by SBSA following the initial discussions of targeting minimum 58 dB.

Appendix 1B

SUMMARY

Designing to meet min. 58 dB $D_{nT,w}$ (airborne sound insulation)

Lightweight twin frame walls would achieve min. 58dB with small design changes and would not necessarily be proprietary given recent new products from different manufacturers. Solid blockwork and cavity blockwork would at present need proprietary products and/or additional linings.

Apartments using precast concrete separating floors would increase floor depth from current 280-300mm to 507mm. There would be difficulty incorporating more energy efficient blocks for the inner leaf of external walls. Timber separating floors would require to go to 302mm joists or independent ceiling joists.

SEPARATING WALLS

Timber frame twin stud separating walls

Timber frame separating walls could achieve min. 58dB quite easily with an increase in the overall cavity width. In addition the size and type of wall strap or tie, which is used to structurally connect the twin frames also plays a role. The wall straps are often spaced at min. 1200mm centres horizontally and one per storey height vertically. The cavity width would require to increase to min. 250mm between cavity face of wall linings. At present the two leading structural connector companies have both just recently launched new party wall straps that will assist the acoustic performance. So industry would not be focused towards only one company.

Very few walls are built with min. 250mm and the new proprietary acoustic wall straps have only just come onto the market in the last 2-3 months.

Lightweight metal frame twin stud separating walls

Lightweight metal frame could also achieve min. 250mm cavity but this has not been a standard build previously. Lightweight steel frame housing is now moving to 250mm cavity widths but these are often using 100mm frames for structural purposes. Lightweight steel frame separating walls for high rise in-situ concrete frames adopt typically 180 to 220mm and they also would move to 250mm min. cavity.

Blockwork cavity separating walls

To achieve such a high performance the wall cavity has to be minimum 100mm within the scope of structural limits for wall ties which are Type A acoustic ties. Going beyond 100mm will require specialist proprietary ties.

Proprietary products are required to prevent mortar collection on ties and at the base of the wall to ensure performance is achieved throughout the various storey height levels. Performance typically improves with storey height.

Inserting proprietary sound insulating board products within part of cavity can raise the performance level. At present only one product on market that can do this but others may follow.

215mm Blockwork solid separating walls

These solid walls will require to move to independent stud linings on both sides of the wall using 15mm high density boards and quilt insulation between studs. This adds min. 85mm each side but if larger studs required the wall lining with offset each side moves up to 105mm each side.

The performance is restricted by the continuous structural junction with the solid wall and inner leaf. As such the flanking path via the inner leaf is now the dominant controlling mechanism and lightweight energy efficient blocks such as aircrete would struggle with min. 56 dB but would require additional wall linings for min. 58 dB. Solid separating walls are used on many sites at present.

SEPARATING FLOORS

Timber frame separating floors

Timber frame 220mm to 240mm separating floor joists using resilient bars typically can achieve 56 dB. But min. 58 dB would require the industry to move towards min. 302mm joists or more likely independent ceiling joists to repeatedly hit min. 58 dB. Whilst one or two key timber frame suppliers have developed independent timber frame ceiling systems, the majority of the industry sector does not use independent ceiling joist systems.

The required overall floor cavity depth with independent ceiling joists may be 240mm to 300mm+ dependent on span, joist size and design.

Precast concrete separating floors (with blockwork)

To achieve min. 58dB these floors will require to be always min. 200mm slab rather 150mm slab, with 200mm ceiling voids and only dense block for flanking. Additional quilt may be required in the ceiling zone. The floating screed for the upper surface would also be required.

As with solid walls the key factor is control by the flanking path via the inner leafs. This requires proprietary products and/or additional linings dependent on the block type for more energy efficient blocks.

The density for gypsum based board linings for SVP's and services may also need to be increased from 8kg/m^2 to 10 kg/m^2.

Overall floor depth moves from current 282 mm to 507 mm for 58 dB versus 410mm for 56dB.

In-situ concrete frame

In-situ concrete frame can achieve min. 58 dB but will require a typical 250-260mm slab. The primary issue will be ceiling depth and the external wall linings. Curtain walling and glazed facades will have to substantially increase their performance at the junction with the separating floor and this will require proprietary isolator products. Glazed facades and lightweight facades are the common form of construction in such high-rise apartments.

Similarly issues of flanking with such facades for separating walls, where the junction is not at a column will require specialist isolation products.

Dr Sean Smith

Senior Acoustic Consultant
Robin Mackenzie Partnership

August 2007

Appendix 2

Paper recently published at the Institute of Acoustics Spring Conference 2007 on the ISO 717 spectrum adaptation terms

SENSITIVITY ANALYSIS OF ISO 717-1 SPECTRUM ADAPTATION TERMS

RS Smith Building Performance Centre, Napier University, Edinburgh, UK
R Macdonald KTP Associate, BCA Insulation, Shotts, UK
D Lurcock Building Performance Centre, Napier University, Edinburgh, UK
RK Mackenzie Building Performance Centre, Napier University, Edinburgh, UK

1 INTRODUCTION

Sound insulation testing within completed dwellings has been a requirement of Part E the Building Regulations (England and Wales) since July 2003 for conversions, and July 2004 for new build. The airborne sound insulation criteria of Approved Document E[1] adopts the ISO 717-1[2] spectrum adaptation term No.2, (C_{tr}), resulting in a combined single weighted criteria of $D_{nT,w}$+C_{tr}. The reason for the introduction of this new adaptation term (C_{tr}) was to raise the airborne sound insulation performance levels at low frequencies.

The requirements for sound insulation within the building regulations are primarily to protect occupants and provide a reasonable level of sound insulation for normal domestic activities. The regulation performance levels for sound insulation are set as a minimum requirement level and the accompanying guidance constructions provide design methods to achieve compliance.

During routine sound insulation testing in completed dwellings it was found that the focus afforded to the low frequencies by C_{tr} was dominating the ultimate reported single weighted performance. In some instances a reduction in performance at important mid and high frequencies, relating to speech, television and normal domestic activities were not being accounted for adequately. As a result a study was undertaken on the sensitivity of using such spectrum adaptation terms on the calculation of airborne sound insulation.

2 BACKGROUND

2.1 Housing, Planning Policy and Sound Insulation

The planning policy within England since 2000 has placed greater emphasis on increasing the plot to land area ratio, under Planning Policy Guidance 3 (PPG3). This has led to higher densities of housing[3] from 33 dwellings per hectare to 55/hectare and in some cases 71/hectare. This has resulted in dwelling living spaces, such as living rooms and bedrooms decreasing in floor area and volume. In 1997 the proportion of new build apartment developments was approximately 18% but by 2005 had increased to 53%. The reduction in room sizes leads to a lower number of modes per third octave band, reduced modal overlap and widens the measurement variation over an increasing frequency range.

The increasing use of hi-fis and electrical appliances within the home which may have a strong low frequency noise output supports the need to increase the airborne sound insulation at such frequencies for attached dwellings (such as attached houses and flats). Two methods of improving the low frequency sound insulation performance is to either raise the overall performance levels and remain with an airborne criteria of $D_{nT,w}$ / R'_w or increase the emphasis on low frequency performance. The new criteria adopted in 2003 by England and Wales opted to increase the emphasis on low frequency performance and introduce spectrum adaptation term No.2 (C_{tr}).

2.2 Measurement of Low Frequency Sound Insulation

There have been many studies which have discussed and investigated the benefits and difficulties of measuring low frequencies. However, expanding the test frequency range to below 100Hz, such as 50Hz, or emphasizing low frequencies below 250Hz may result in worsening the repeatability and reproducibility.

Previous ‘Round Robin’ sound insulation testing studies [4,5,6,7] have demonstrated the variability of testing but also the variation and wide standard deviations which can occur at low frequencies. Fothergill[4] demonstrated that by reducing variables under the measurement methodology improvements could be made across the frequency range 100Hz – 3150Hz. Fausti et al[5] illustrated the effect of low frequency standard deviation and influence on reproducibility for both single and double stud wall systems. Lang[6] found that the repeatability and the reproducibility were higher (worse) when using C_{tr} and found the spread of results increased from 3dB (for $D_{nT,w}$) to 5dB (when incorporating C_{tr}) as shown below in Table 1.

Lang '97 Field Tests	DnT,w	C	Ctr
Repeatability	1.19	1.4	1.87
Reproducibility	1.36	1.43	2.22
Range	59 - 62	61 - 57	52 - 57
Spread	3 dB	4 dB	5 dB

Table 1 Repeatability, reproducibility, range and spread in ‘round robin’ results (Lang 1997)

Kropp *et al*[8] found that parameters which do not belong to the tested partition can have a strong influence on the airborne sound insulation. They described this situation as “*not meaning that the results were wrong, but that the validity of the results is restricted to the specific conditions under which they have been achieved*”. The effects of ‘handed rooms’ or source and receiving rooms of same dimensions and size were found to be strongly coupled and often worse case scenario, as also reported by Gibbs and Maluski[9]. The reduction in modal density, as found in smaller rooms, results in more pronounced dips in the measured sound insulation. This places an increased emphasis on the importance of the modal coupling between the source, test structure and receiving rooms at low frequencies as also demonstrated by Osipov et al[10].

2.3 Spectrum Adaptation Terms

Goydke et al[11] considered the evaluation of uncertainty values of building acoustic single number quantities. They found that for R_w an uncertainty value of 0.6 and 0.7 seem to be reasonable. However, the uncertainty values for the C_{tr} seem to be much higher. For one of their tested structures they found that the uncertainty value was very high where there was a very low result at a single third octave band (160Hz) which dominated the contribution to the single number quantity. The study investigated both windows and a heavy masonry wall (MW), as shown in Table 2.

	u(Rw)	u(c)	u(Ctr)
	dB	dB	dB
Window 3	0.6	0.8	1.1
Window 4	0.7	1.4	1.5
MW	0.7	1.2	1.3

Table 2 Associated uncertainties and ISO 717-1 (Goydke et al 2003)

Smith et al[12] also investigated the variation and spread of using C_{tr} and found that "*the impact should not be underestimated*". A change from –5dB to –12dB for C_{tr} due to slight variations in the low frequency measurement resulted in a single weighted value dropping by -7dB but without being influenced by the mid and high frequencies.

3 SENSITIVITY ANALYSIS METHODOLOGY

To assess the influence of the C_{tr}, spectrum adaptation term No.2, a sensitivity analysis was undertaken over the frequency range 100Hz to 3150Hz. Analysis was also undertaken for $D_{nT,w}$ and $D_{nT,w}$+C, involving spectrum adaptation term No.1. The data set adopted for the analysis was the ISO 140-4 airborne reference curve. This fixed "neutral" data set was used rather than measured data from lightweight or heavyweight structures.

Two methodologies were adopted for investigating the influence on reported airborne sound insulation single weighted values. The first method was to individually change the D_{nT} value for each third octave frequency band by -1dB increments from 0dB to -10dB. Table 3 shows an example of the sequence for single frequency changes of -3dB.

The second method was to systematically change the third octave band D_{nT} values from 0dB to -10dB. Table 4 shows an example of the systematic changes for -10dB.

100	*125*	*160*	*200*	*250*	*315*	*400*	*500*	*630*	*800*	*1k*	*1.25k*	*1.6k*	*2k*	*2.5k*	*3.15k*
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	**-3**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	**-3**	0	0	0	0	0	0	0	0	0	0	0	0	0
……	……	……	……	……	……	……	……	……	……	……	……	……	……	……	……
0	0	0	0	0	0	0	0	0	0	0	0	0	**-3**	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	**-3**	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**-3**

Table 3 Example of sequence for changing individually each third octave band by -3dB.

100	*125*	*160*	*200*	*250*	*315*	*400*	*500*	*630*	*800*	*1k*	*1.25k*	*1.6k*	*2k*	*2.5k*	*3.15k*
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	-10	-10	0	0	0	0	0	0	0	0	0	0	0	0	0
……	……	……	……	……	……	……	……	……	……	……	……	……	……	……	……
-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	0	0
-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	0
-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10

Table 4 Example of sequence for systematic changes for -10dB.

4 SENSITIVITY ANALYSIS

4.1 Single Frequency Changes

Table 5 shows the collective results for $D_{nT,w}$+C_{tr} of changing each third octave band frequency value by a set quantity ranging from -1 to -10dB. It can be seen that altering the individual frequency value the sound insulation reported performance for $D_{nT,w}$+C_{tr} would be significantly influenced by the changes at 100Hz with decreasing influence until 250Hz. The influence of a -1dB to -10dB drop in performance at low frequencies can be -6dB but for mid / high frequencies is only 1dB change.

The variation at individual low third octave band frequencies between different testers, on the same wall and between the same plots can be 4dB to 7dB. For the same wall type over a range of dwellings on the same site may result in individual third octave bands at low frequencies having a spread of 10dB. This variation coupled with the emphasis on low frequencies as provided by $D_{nT,w}$+C_{tr} may lead to increased risk and uncertainty.

The key frequencies most affected are from 100Hz to 250Hz, with the 100Hz band being the dominant third octave band frequency with the C_{tr} spectrum adaptation term. Annex D of ISO 140 states that "in low frequency bands (less than 400Hz) no diffuse field conditions can be expected when room volumes of 50m^3 or less are considered". Typical room sizes in attached housing in the UK are 25m^3 to 40m^3, although smaller and larger rooms are also constructed depending on dwelling type. In such circumstances additional effort is required to sample the sound field in the rooms and the number of microphone positions should be increased and spread uniformly throughout the allowable volume of the room. This suggests that standard fixed microphone measurement positions or sampling via normal rotating boom microphones would not be sufficient.

Hz	***-1***	***-2***	***-3***	***-4***	***-5***	***-6***	***-7***	***-8***	***-9***	***-10***
100	48	47	47	46	46	45	44	44	43	**42**
125	48	48	47	47	47	46	46	45	45	44
160	48	48	47	47	47	47	46	46	45	45
200	48	48	48	47	47	47	47	46	46	45
250	48	48	48	48	47	47	47	47	46	46
315	48	48	48	48	48	47	47	47	47	47
400	48	48	48	48	48	48	48	47	47	47
500	48	48	48	48	48	48	48	47	47	47
630	48	48	48	48	48	48	48	47	47	47
800	48	48	48	48	48	48	47	47	47	47
1000	48	48	48	48	48	48	47	47	47	47
1250	48	48	48	48	48	48	48	48	47	47
1600	48	48	48	48	48	48	48	48	48	47
2000	48	48	48	48	48	48	48	48	48	48
2500	48	48	48	48	48	48	48	48	48	48
3150	48	48	48	48	48	48	48	48	48	48

KEY

Change in weighted value	*0 dB*	*-1 dB*	*-2 dB*	*-3 dB*	*-4 dB*	*> -5 dB*

Table 5 Collective results for $D_{nT,w}$+C_{tr} of changing each third octave band frequency value by a set quantity ranging from -1 to -10dB

4.2 Multiple Frequency Changes

Figure 1 illustrates the influence of systematically changing the D_{nT} third octave bands by -10dB for $D_{nT,w}$, $D_{nT,w}$+C and $D_{nT,w}$+C_{tr}. As the summed deviations increases with frequency band (from 100Hz to 3150Hz) the $D_{nT,w}$ single weighted value for the summed deviation 40dB to 160dB changes by 6dB, whereas for $D_{nT,w}$+C_{tr} the change is only 1dB.

For $D_{nT,w}$+C_{tr} the sharp drop at 100Hz by a single reduction of 10dB, as also shown in Table 5 (for individual changes), would provide a sudden decrease in recorded performance versus the more gradual recorded decline in performance by $D_{nT,w}$. Interestingly the change performance due to summed deviations from the reference curve for the $D_{nT,w}$+C illustrate a mix of both slopes and degradations of $D_{nT,w}$ and $D_{nT,w}$+C_{tr}.

Whilst the aim of introducing C_{tr} to Part E and Approved Document E was to target the low frequencies the results of the sensitivity analysis suggest that the weighting is too heavily geared towards the low frequencies at the possible detriment of mid and high frequencies.

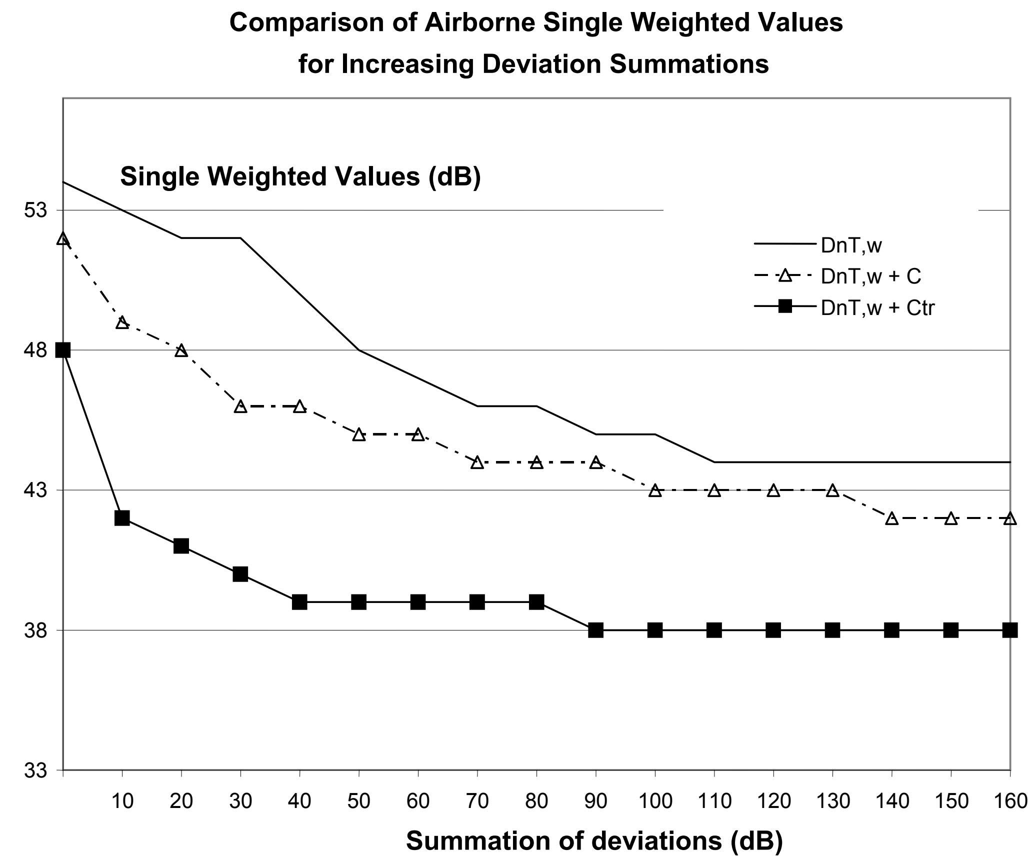

Figure 1 Influence of systematically changing the D_{nT} third octave bands by -10dB for $D_{nT,w}$, $D_{nT,w}$+C and $D_{nT,w}$+C_{tr}

5 DWELLING CONSTRUCTION

UK dwelling construction for attached dwellings incorporates a wide range of systems and materials involving dense, lightweight and aircrete blockwork, timber frame, lightweight steel frame, high-rise steel frame and in-situ concrete. The resultant range of mass, isolation, resilience, absorption and coupling junctions provide a broad range of sound insulation performance and variation over the frequency range 100Hz to 3150Hz.

Figure 2 illustrates three example field tested structures with quite different build-ups, flanking conditions and material compositions involving a dense block solid wall, a dense block cavity wall and a lightweight timber separating floor using metal web joists. All structures have similar $D_{nT,w}+C_{tr}$ performance outcomes of 48dB but significantly different $D_{nT,w}$ outcomes as shown in Table 6.

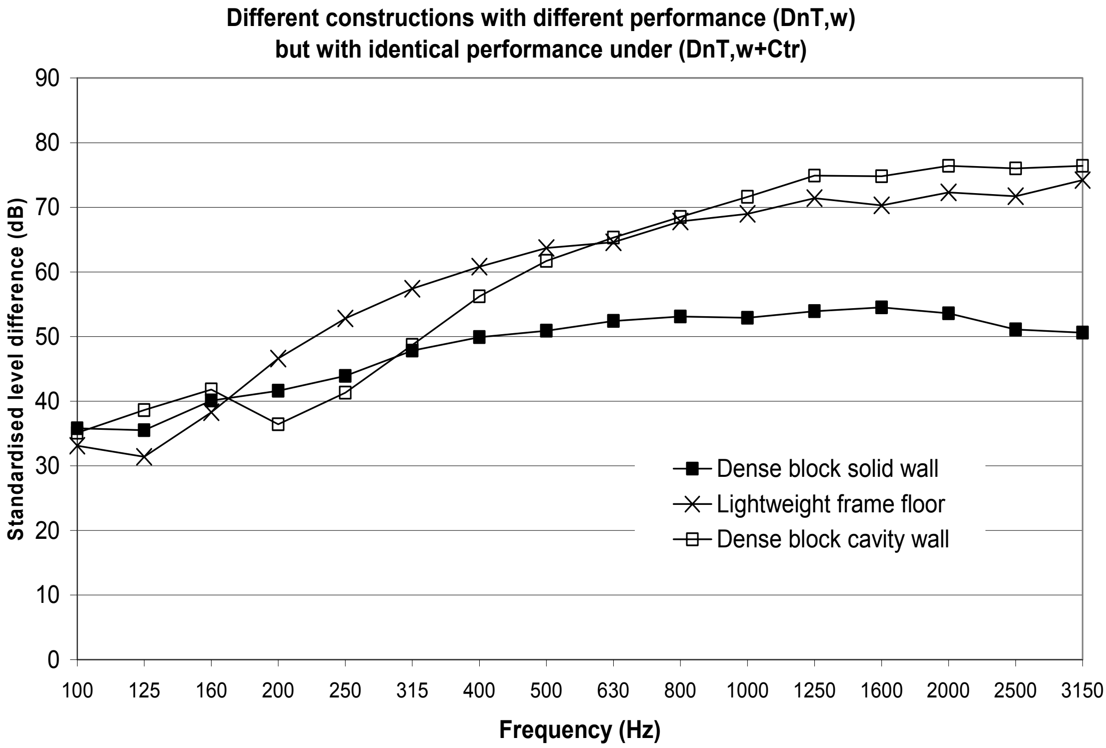

Figure 2 Two example structures involving quite different constructions with same $D_{nT,w}+C_{tr}$ performance of 48 dB.

CONSTRUCTION	DnT,w	DnT,w+C	DnT,w+Ctr
Dense block solid wall	52	51	48
Lightweight frame floor	59	54	48
Dense block cavity wall	57	54	48

Table 6 Measured performance outcomes for three different separating constructions as found in UK attached new build dwellings.

It can be seen that the combined dip in performance at low frequencies (100Hz and 125Hz) for the lightweight structure significantly reduces the overall $D_{nT,w}+C_{tr}$ recorded value by 7dB.

Of interest is the net gain in insulation performance. The net difference or summed deviations between the lightweight floor and dense block solid wall is 178 dB. The significant emphasis on low frequency sound insulation performance by C_{tr} does not take this into account. Thus important mid and high frequency performance, encapsulating speech, television and normal living noise sound frequencies are effectively disregarded. Of interest is the important gain in performance by the lightweight floor in Figure 2 between 200Hz and 400Hz which is not reflected in the $D_{nT,w}+C$ nor the $D_{nT,w}+C_{tr}$.

6 CONCLUSIONS

The primary argument for the inclusion of a criteria or weighting for sound insulation between attached dwellings is to raise standards and create a more sustainable home environment for occupants. At the same time such inclusions should not adversely affect performance at other important frequencies.

$D_{nT,w}+C_{tr}$ used as the only criteria for airborne sound insulation is not effective enough in dealing with normal living noise issues and generates too much emphasis at low frequencies. C_{tr} significantly concentrates performance outcomes on the basis of the results at 100Hz to 160Hz. Raising the overall single weighted performance level could also increase the mid and high frequencies, but there is an effective “ceiling limit” to the possible gains at such low frequencies and an adverse situation of small room sizes with pronounced dips due to low modal density.

$D_{nT,w}+C$ may also provide a route towards addressing many issues, but it may still not effectively control the low frequencies alone (if an emphasis is required), unless the overall minimum required performance was increased.

$D_{nT,w}$ could be used alone, by increasing the regulatory minimum level, and still raise the low frequency performance at the same time.

To effectively reduce the anomaly of structures being able to have poor performance at mid and high frequencies and raise the low frequency performance (if required) suggests that a composition of $D_{nT,w}$ and $D_{nT,w}+C_{tr}$ used as a collective approach to airborne sound insulation criteria may be one of the ways forward to tackle such issues. However, this would require a more difficult and complex approach to be adopted by designers and acoustic consultants to meet the needs of “two masters”.

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APPENDIX 3
Component Performance Criteria undertaken in a laboratory

The following section outlines performance testing criteria for specific products which can be evaluated in a laboratory.

Bonded Resilient Cover (over isolated screeds)

For concrete core floors bonded resilient coverings do not specifically increase airborne performance but can significantly influence impact performance. As such only impact performance should be tested in a laboratory.

Where bonded resilient covers are used for concrete core floors they should be tested with a wood based floor covering laid over the resilient layer. This would provide a more realistic performance datum for how these materials may perform for impact sound insulation in real buildings with hard floor finishes.

The table below summarises the recommended minimum performance requirements. Part 2 Section 2.2 provides further information on recommended performance requirements, guidance notes and the test procedure is outlined in Annex B.

Performance requirements for bonded resilient covering when used with concrete core floors
Impact ΔLw
min. 17 dB

Floating Floor Treatments

Floating floor treatments can increase the airborne and impact performance for both concrete core floors and lightweight frame floors (such as timber joist separating floors).

The incorporation of C_{tr} within the laboratory test requirements for floating floor treatments for timber joist floors or lightweight frame floors would protect the low frequency performance of these structures.

The term floating floor treatments (FFT1) applies to resilient battens and cradle systems which support a timber based t&g flooring board (e.g. 18-22mm chipboard). Floating floor treatments are described by a coding (e.g. FFT1, FFT2, FFT3) which relates to their structure type, design depth and their acoustic performance. Further descriptive information relating to the relative FFT is provided in each example separating floor construction.

The table below summarises the recommended minimum performance requirements for concrete floors and timber joist or lightweight frame floors.

Part 2 Section 2.3 provides further information on recommended performance requirements, guidance notes and the test procedure is outlined in Annex B.

Performance requirements for Floating Floor Treatments when used with concrete core floors FFT1, FFT2 and FFT3	
Airborne ΔRw	Impact ΔLw
min. 5 dB	min. 22 dB

Performance requirements for Floating Floor Treatments when used with timber joist or lightweight frame floors FFT1		
Airborne ΔRw	Airborne ΔRw + Ctr	Impact ΔLw
min. 17 dB	min. 13 dB	min. 16 dB

Resilient Ceiling Bars

Resilient ceiling bars are used to support ceiling board linings and mounted perpendicular to the joist span for timber frame and lightweight frame floors. They can improve both the airborne and the impact performance of the separating lightweight frame floor.

The incorporation of C_{tr} within the laboratory test requirements for resilient ceiling bars for timber joist floors or lightweight frame floors would protect the low frequency performance of these structures.

The table below summarises the recommended minimum performance requirements for timber joist or lightweight frame floors. Part 2 Section 2.4 provides further information on recommended performance requirements, guidance notes and the test procedure is outlined in Annex B.

Performance requirements for Resilient Ceiling Bars when used with timber joist or lightweight frame floors		
Airborne ΔRw	Airborne ΔRw + Ctr	Impact ΔLw
min. 16 dB	min. 14 dB	min. 16 dB

Downlighters (recessed lighting)

Downlighters (or recessed lighting) are often mounted such that they penetrate the ceiling board lining. The junction between the ceiling board and downlighter perimeter should be well sealed. It is recommended that downlighters:

- should be at centres of not less than 0.75m
- should have openings no greater than 100mm diameter or 100x100mm
- should be installed at no more than one downlighter per $2m^2$ of total ceiling area in each room

When the test floor is tested with and without downlighters present for comparison the airborne and impact performance should be no worse than 1dB.

Downlighters may be installed at a greater density than 1 per $2m^2$ if the light fittings are supported by test evidence undertaken in accordance with Annex B.

Particular attention should also be paid to Technical Handbook (Domestic) Section 2 – Fire.

Robin Mackenzie Partnership

Design of Separating Constructions that are Resistant to the Transmission of Noise

PART 2 of 2

EXAMPLE CONSTRUCTION DETAILS

October 2007

Report prepared by:

Dr Sean Smith, John Wood* and Richard Mackenzie

RMP Acoustics
Napier University
42 Colinton Road
Edinburgh
EH10 5BT

*Building Performance Centre, Napier University

The opinions expressed in this report are those of the authors.

Report commissioned by:
Scottish Building Standards Agency
Denholm House
Almondvale Business Park
Livingston
EH54 6GA

Tel:	01506 600 400
Fax:	01506 600 401
e-mail:	info@sbsa.gsi.gov.uk
web:	www.sbsa.gov.uk

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Contents

1 INTRODUCTION

This document outlines example separating wall and floor construction details which when built correctly should comply with the sound insulation requirements as outlined in the proposed Section 5.

The constructions presented are based on field test evidence from attached houses and apartments (flats).

The following construction detail examples are provided for the most common construction types:

Separating Walls

Wall Type 1 - Masonry solid walls (dense blockwork) for use in attached houses and apartments

Wall Type 2 - Masonry cavity walls (dense blockwork) for use in attached houses and apartments

Wall Type 3 - Timber frame twin stud walls (with and without sheathing) for use in attached houses and apartments

Wall Type 4 - Metal frame twin stud walls (for use in attached metal frame houses and in-situ concrete frame apartments)

Separating Floors

Floor Type 1A - In-situ concrete slab with isolating screed and bonded resilient cover

Floor Type 1B - In-situ concrete slab with floating floor treatment

Floor Type 2A - Precast concrete slab with isolating screed and bonded resilient cover

Floor Type 2B - Precast concrete slab with floating floor treatment

Floor Type 3A - Timber frame floor with solid joists

Floor Type 3B - Timber frame floor with engineered I-joists

1.1 Aims

The main aims in providing these example constructions are to illustrate a ready means:

- to reduce sound transmission between attached dwellings and between dwellings and other parts of the same building*
- to reduce airborne sound transmission through separating walls and floors (e.g. speech, television and general living noise)
- to reduce impact sound transmission through separating floors (e.g. footstep noise)
- to reduce flanking noise transmission via other construction elements which are not part of the direct separating wall or floor (such as the inner leafs of external walls)
- to reduce low frequency sound transmission (e.g. from household appliances and other low frequency noise sources)
- to provide separating floor constructions with suitable floor finishes which can reduce impact noise transmission from wood based floor coverings
- to reduce horizontal impact sound transmission (e.g. noise from switches, plugs being inserted into sockets, doors and cupboard doors closing)

* *the performance levels of separating walls and floors between dwellings and other parts of the same building (e.g. communal stairwells and entrance halls) are influenced by the presence of dwelling main entrance doors and bridging of cavities due to wall leaf returns and door jambs.*

The common factors which are illustrated in each detail are:

- the core wall or floor construction
- the wall linings and floor isolating, resilient or floating layers
- the interaction with other building elements
- the junction with the external wall
- the junction with separating wall or floor
- the junction for the ground floor
- the junction with internal walls or floors
- the junction with ceiling and roof space
- the lining and details for vertical SVP and wall mounted service penetrations
- the separating wall between dwelling and a common area (e.g. stairwell for apartments)

Other requirements of the Scottish building regulations which are not illustrated by these details, but which should be considered by the designer include:

- thermal performance of elements
- thermal bridging and air leakage
- structural
- fire resistance and flame spread
- ventilation
- damp-proofing arrangements
- precipitation

1.2 Selection of Materials

Sound insulation within a building is achieved through a combination of addressing a number of factors simultaneously. Ultimately having a sufficient quantity of **mass** or **isolation** will be the primary key factors:

Mass: can be provided via the core structure and linings (such as in-situ concrete or solid dense block walls)

Isolation: can be provided via twin frames (such as timber frame, metal stud or blockwork cavity walls) or independent frames

In addition to having one or both of these elements the presence of one or more of the following can increase the sound insulation performance for a range of different types of living noise:

Absorption: the presence of mineral wool quilts or batts

Resilience: the presence of floating floor treatments (e.g. resilient battens or cradles) or resilient ceiling bars

Stiffness: the correct spacing and depth of joists

Damping: where noise/vibration converts to heat (e.g. bonded resilient covers, render [parge] coats for blockwork walls)

1.3 Alternative designs which are not example constructions

Where the designer is adopting separating wall or floor constructions which are not included within the example constructions the designer should always seek expert acoustic advice.

1.4 Common Design and Specification Errors

Whilst errors during construction on-site are the most common cause of non-compliance many errors also occur during the design and specification stage. It is very important to reduce later on-site errors that the design specification is correct and drawings are clearly illustrated.

Design and specification errors may include:

- wrong block density (i.e. too low and not dense block)
- wrong floating floor treatment (i.e. does not comply with specific performance requirements for airborne and/or impact performance)
- wrong resilient bar (i.e. does not comply with specific performance requirements for airborne and/or impact performance)
- wrong wall tie type for blockwork cavity separating walls, should always be Wall Tie Type A (see Section 2)
- wrong cavity width or floor cavity depth
- wrong gypsum board density (too low and thus not enough mass)
- specifying rigid insulation boards (no acoustic absorption properties) when they should in fact be mineral wool based (which have acoustic absorption properties)
- not detailing correctly the design drawings which will be used on site during build stage
- drawings incorrectly showing external wall inner leaf running through between dwellings
- drawings not showing floor slab or joists being built into wall

1.5 Common On-Site Construction Errors (Separating Walls)

The following issues are typical on-site construction errors which can lead to a reduction in the sound insulation performance.

Typical on-site errors - Wall Type 1 (Dense block solid wall)

- Not using a dense block
- Not laying the 215mm block full width (on its side)
- Not fully filling perpends and mortar joints
- Not breaking the inner leaf continuity with the separating wall
- Installing independent metal frame stud at less than 30mm offset
- Not fully filling stud width and height with quilt insulation

Typical on-site errors - Wall Type 2 (Dense block cavity wall)

- Not using a dense block
- Not fully filling perpends and mortar joints
- Not using Wall Tie Type A in the separating wall leafs (see Section 2) Allowing mortar and other debris to build up on wall ties and base of the wall cavity, thus bridging cavity wall leafs (*Always clean the cavity and keep your wall ties clean*)
- Building the cavity too small, (*Always minimum 75mm*)
- Not scratching the render, which reduces the adhesive bond for the dab and gypsum based board

Typical on-site errors - Wall Type 3 (Timber frame twin stud wall)

- Not building correct minimum width between cavity side of linings
- Building sheathed stud walls too close together (*Always 50mm min.*)
- Not fully covering the wall face of the stud bay with quilt insulation
- Not staggering the gypsum board linings
- Using too low a gypsum board density, not enough mass and may also reduce fire resistance
- Bridging twin frame incorrectly by spanning joists into wall cavity
- Bridging twin frame using rigid cavity stop incorrectly fixed to both frames (one side only for fixing)

Typical on-site errors - Wall Type 4 (Metal frame twin stud wall)

- Not maintaining the minimum width between cavity side of linings (*Always 200mm minimum*)
- Not fully covering the wall face of the stud bay with quilt insulation
- Not staggering the gypsum board linings
- Using too low a gypsum board density, not enough mass and may also reduce fire resistance
- Bridging twin frame using rigid cavity stop incorrectly fixed to both frames (one side only for fixing)

1.6 Common On-Site Construction Errors (Separating Floors)

The following issues are typical on-site construction errors which can lead to a reduction in the sound insulation performance. One of the major causes of failure to meet performance requirements is by incorrect product substitution on-site, where the site manager has failed to check whether the product or component meets specific performance criteria.

Typical on-site errors

Isolated Screeds

- Not installing both isolating layers
- Not isolating the screed properly and allowing the screed to connect or touch the core slab (known as bridging)
- Not isolating the screed properly and allowing the screed to connect or touch the perimeter wall, wall linings and skirting (known as bridging)
- Not using correct depth of sand:cement screeds (minimum 65mm)

Bonded Resilient Covers

- Using the wrong resilient cover which does not meet the performance requirements of Section 2
- Using a resilient cover which claims to meet Section 2 but has not been tested with a wood based floor covering present during the lab test (this leads to artificially high performance)

Floating Floor Treatments (FFT)

- Not using the correct FFT depth as specified in the detail
- Not using a FFT that meets the performance requirements for airborne and/or impact (see Section 2)
- Not installing the perimeter flanking strip to isolate flooring boards from skirtings and wall linings
- Using too long screws or nails and bridging the resilient layer
- Installing services which bridge the resilient layer by touching timber batten and core floor
- Not following the manufacturer’s instructions

Suspended Ceiling Treatments

- Not using a metal frame ceiling where required
- Not building to the correct ceiling void depth
- Not using correct ceiling board, too low a mass per unit area

Resilient Ceiling Bars

- Using resilient ceiling bar that does not comply with Section 2
- Using ceiling board screw fixings which are too long and thus allowing board screws to touch joist (these should never touch)

2 COMPONENT SPECIFICATION AND ACOUSTIC PERFORMANCE REQUIREMENTS

2.1 WALL TIES FOR BLOCKWORK CAVITY WALLS

Specification of the correct wall tie is important. If the wall tie is too thick or too stiff sound transmission can easily transmit. In the case of blockwork cavity separating walls incorrect specification can significantly affect the sound insulation performance.

In addition, the build up of mortar or debris on wall ties can also increase sound transmission leaf to leaf. As such it is important that wall ties and cavities are regularly cleaned to avoid mortar or debris collecting on the ties leading to increased acoustic bridging.

2.1.1 Separating Walls – Wall Tie Type A

For the purposes of wall tie specification for separating walls involving cavity blockwork ONLY Type A wall ties should be used.
Wall ties used in separating walls must be Tie Type A which have an appropriate measured dynamic stiffness for the cavity width. The specification for wall ties of dynamic stiffness, K_{Xmm} in MN/m with a cavity width of X mm and *n* ties/m2 is $n.k_{Xmm}$<4.8 MN/m^3. Contact wall tie manufacturer for product specification details which comply for wall tie Type A for separating walls.

2.1.2 External Walls - Tie Type A or B

Wall ties used in external blockwork cavity walls can be Tie Type A (as above) or Tie Type B (depending on strength requirements), which have an appropriate measured dynamic stiffness for the cavity width. The specification for wall ties of dynamic stiffness, K_{Xmm} in MN/m with a cavity width of X mm and *n* ties/m2 is $n.k_{Xmm}$<4.8 MN/m^3 (Tie Type A) or <113 MN/m^3 (Tie Type B). Contact wall tie manufacturer for product specification details which comply for Tie Type A or Tie Type B for external walls.

2.2 Bonded Resilient Covers (over isolated screeds)

Isolating layers underneath screeds can improve airborne and impact performance. However, isolating layers on their own are not sufficient to repeatedly achieve the required impact insulation performance against impact noise such as footsteps. In addition, the increasing use of wood based floor coverings directly laid on a screed finish without a resilient underlay (between wood based floor covering and screed) can increase noise transmission into the dwelling below.

As such a bonded resilient covering should also be used. The bonded resilient covering may be a minimum of 3mm thick and should cover the entire room floor surface.

Where specified in the example constructions for concrete core floors the bonded resilient covering:

- must be tested in an acoustic laboratory, as outlined in Annex B
- and must achieve the required impact sound insulation performance as described in Table 2.2

Table 2.2

Performance requirements for resilient floor covering when used with concrete core floors
Impact ΔLw
min. 17 dB *(see Note 2)*

Notes:
1) Designers, specifiers and site managers should ensure that products selected and being installed on site conform to all of the above requirements.
2) The above performance requirement is based on a resilient floor covering which has been tested in accordance with Annex B under a wood based floor covering.
3) Annex B outlines the laboratory test requirements for resilient floor coverings with concrete core floors.

Note that the performance requirement must be achieved when the resilient cover has been laboratory tested under a wood based floor finish. Testing directly onto the resilient cover is not sufficient evidence as this leads to exaggerated performance which does not reflect its performance under a wood based floor covering as may be found in real apartments and flats.

2.3 Floating Floor Treatments

Floating floor treatments applies to resilient battens and cradle systems which support a timber based t&g flooring board (e.g. 18-22mm chipboard). Floating floor treatments are described by a coding (e.g. FFT1, FFT2, FFT3) which relates to their structure type, design depth and their acoustic performance. Further descriptive information relating to the relative FFT is provided in each example separating floor construction.

In addition to the physical description of the floating floor treatment it is important that the acoustic insulation performance is also achieved. Floating floor treatments can increase both the impact and airborne sound insulation performance of the separating floor.

2.3.1 Floating Floor Treatments (for concrete core floors)

Where specified in the example constructions for concrete core floors the floating floor treatments:

- must be tested in an acoustic laboratory, as outlined in Annex B
- and must achieve the required impact sound insulation performance as described in Table 2.3A

Table 2.3A

Performance requirements for Floating Floor Treatments when used with concrete core floors FFT1, FFT2 and FFT3	
Airborne ΔRw	Impact ΔLw
min. 5 dB	min. 22 dB

Notes:
1) Designers, specifiers and site managers should ensure that products selected and being installed on site conform to all of the above requirements.
2) Annex B outlines the laboratory test requirements for floating floor treatments on concrete core floors.

2.3.2 Floating Floor Treatments (for timber joist or lightweight frame core floors)

Where specified in the example constructions for concrete core floors the floating floor treatments:

- must be tested in an acoustic laboratory, as outlined in Annex B
- and must achieve the required impact sound insulation performance as described in Table 2.3B

Table 2.3B

Performance requirements for Floating Floor Treatments when used with timber joist or lightweight frame floors FFT1		
Airborne ΔRw	Airborne ΔRw + Ctr	Impact ΔLw
min. 17 dB	min. 13 dB	min. 16 dB

Notes:
1) Designers, specifiers and site managers should ensure that products selected and being installed on site conform to all of the above requirements.
2) Annex B outlines the laboratory test requirements for floating floor treatments with timber joist or lightweight frame floors

2.4 Resilient Ceiling Bars

Resilient ceiling bars are used to support ceiling board linings and mounted perpendicular to the joist span. To obtain the best acoustic performance on site for both airborne and impact sound insulation the ceiling board fixings must not come into direct contact with the joist. Care should be taken to ensure the correct screw length is used when fixing on site.

Where specified in the example constructions for timber joist floors the resilient ceiling bars:

- must be tested in an acoustic laboratory, as outlined in Annex B
- and must achieve the required impact sound insulation performance as described in Table 2.4

Table 2.4

Performance requirements for Resilient Ceiling Bars when used with timber joist or lightweight frame floors		
Airborne ΔRw	Airborne ΔRw + Ctr	Impact ΔLw
min. 16 dB	min. 14 dB	min. 16 dB

Notes:
1) Designers, specifiers and site managers should ensure that products selected and being installed on site conform to all of the above requirements.
2) Annex B outlines the laboratory test requirements for resilient ceiling bars with timber joist or lightweight frame core floors.

2.5 Downlighters (recessed lighting)

Downlighters (or recessed lighting) are often mounted such that they penetrate the ceiling board lining. The junction between the ceiling board and downlighter perimeter should be well sealed.

Downlighters:

- should be at centres of not less than 0.75m
- should have openings no greater than 100mm diameter or 100x100mm
- should be installed at no more than one downlighter per $2m^2$ of total ceiling area in each room

Downlighters may be installed at a greater density than 1 per $2m^2$ if the light fittings are supported by test evidence undertaken in accordance with Annex B.

Particular attention should also be paid to Technical Handbook (Domestic) Section 2 – Fire.

3 EXAMPLE CONSTRUCTION DETAILS

Separating Walls

Table 3.1 lists the separating wall example construction details

Wall Type 1 (Details 1.01 to 1.08)
Masonry solid walls (dense blockwork) for use in attached houses and apartments

Wall Type 2 (Details 2.01 to 2.09)
Masonry cavity walls (dense blockwork) for use in attached houses and apartments

Wall Type 3 (Details 3.01 to 3.11)
Timber frame twin stud walls (with and without sheathing) for use in attached houses and apartments

Wall Type 4 (Details 4.01 to 4.12)
Metal frame twin stud walls (for use in attached metal frame houses and in-situ concrete frame apartments)

Separating Floors

Table 3.2 lists the separating floor example construction details

Floor Type 1A (Details 5.01 to 5.07)
In-situ concrete slab with isolating screed and bonded resilient cover

Floor Type 1B (Details 6.01 to 6.07)
In-situ concrete slab with floating floor treatment

Floor Type 2A (Details 7.01 to 7.07)
Precast concrete slab with isolating screed and bonded resilient cover

Floor Type 2B (Details 8.01 to 8.07)
Precast concrete slab with floating floor treatment

Floor Type 3A (Details 9.01 to 9.08)
Timber frame floor with solid joists

Floor Type 3B (Details 10.01 to 10.08)
Timber frame floor with engineered I-joists

Table 3.1 – Separating Wall Example Details

SEPARATING WALLS	DETAIL	
Wall Type 1	**1.00**	**DENSE BLOCK SOLID WALL**
	1.01	Isometric and construction details
	1.02	External wall junction
	1.03	Separating floor junction: Floor Type 2A
	1.04	Separating floor junction: Floor Type 2B
	1.05	Ground floor junction: floating floor treatment
	1.06	Ground floor junction: isolated screed
	1.07	Ceiling and roof junction
	1.08	Separating wall (dwelling to common area)

Wall Type 2	**2.00**	**DENSE BLOCK CAVITY WALL**
	2.01	Isometric and construction details
	2.02	External wall junction
	2.03	Separating floor junction: Floor Type 2A
	2.04	Separating floor junction: Floor Type 2B
	2.05	Ground floor junction
	2.06	Internal floor junction: floor joists on hangers
	2.07	Internal floor junction: floor joists built-in
	2.08	Ceiling and roof junction
	2.09	Separating wall (dwelling to common area)

Wall Type 3	**3.00**	**TIMBER FRAME TWIN STUD WALL**
	3.01	Isometric and construction details
	3.02	External wall junction
	3.03	Separating floor junction: Floor Type 3A
	3.04	Separating floor junction: Floor Type 3B
	3.05	Ground floor junction
	3.06	Ground floor junction: raft foundation
	3.07	Internal wall junction
	3.08	Internal floor junction
	3.09	Ceiling and roof junction
	3.10	Services and sockets
	3.11	Separating wall (dwelling to common area)

Wall Type 4	**4.00**	**METAL FRAME TWIN STUD WALL**
	4.01	Isometric and construction details
	4.02	External wall junction: metal stud framing
	4.03	External wall junction: in-situ concrete framing
	4.04	Separating floor junction: Floor Type 1A
	4.05	Separating floor junction: Floor Type 1B
	4.06	Ground floor junction
	4.07	Ground floor junction: raft foundation
	4.08	Internal wall junction
	4.09	Internal floor junction
	4.10	Ceiling and roof junction
	4.11	Services and sockets
	4.12	Separating wall (dwelling to common area)

Table 3.2 – Separating Floor Example Details

SEPARATING FLOORS	DETAIL	
Floor Type 1A	**5.00**	**IN-SITU CONCRETE: with isolated screed and bonded resilient cover**
	5.01	Isometric and construction details
	5.02	Isolated screed and bonded resilient cover
	5.03	Ceiling treatment
	5.04	External wall junction: metal stud inner leaf
	5.05	External wall junction: dense block inner leaf
	5.06	Separating wall junction: Wall Type 4
	5.07	Services: vertical SVP's

Floor Type 1B	**6.00**	**IN-SITU CONCRETE: with floating floor treatment**
	6.01	Isometric and construction details
	6.02	Floating floor treatment
	6.03	Ceiling treatment
	6.04	External wall junction: metal stud inner leaf
	6.05	External wall junction: dense block inner leaf
	6.06	Separating wall junction: Wall Type 4
	6.07	Services: vertical SVP's

Floor Type 2A	**7.00**	**PRECAST CONCRETE SLAB: with isolated screed and bonded resilient cover**
	7.01	Isometric and construction details
	7.02	Isolated screed and bonded resilient cover
	7.03	Ceiling treatment
	7.04	External wall junction: dense block inner leaf
	7.05	Separating wall junction: Wall Type 1
	7.06	Separating wall junction: Wall Type 2
	7.07	Services: vertical SVP's

Floor Type 2B	**8.00**	**PRECAST CONCRETE SLAB: with floating floor treatment**
	8.01	Isometric and construction details
	8.02	Floating floor treatment
	8.03	Ceiling treatment
	8.04	External wall junction: dense block inner leaf
	8.05	Separating wall junction: Wall Type 1
	8.06	Separating wall junction: Wall Type 2
	8.07	Services: vertical SVP's

Floor Type 3A	**9.00**	**TIMBER FRAME FLOOR: with solid joists**
	9.01	Isometric and construction details
	9.02	Floating floor treatment
	9.03	Ceiling treatment
	9.04	External wall junction: timber frame inner leaf
	9.05	Separating wall junction: Wall Type 3
	9.06	Internal wall junction: loadbearing
	9.07	Internal wall junction: non-loadbearing
	9.08	Services: vertical SVP's

Floor Type 3B	**10.00**	**TIMBER FRAME FLOOR: with engineered I-joists**
	10.01	Isometric and construction details
	10.02	Floating floor treatment
	10.03	Ceiling treatment
	10.04	External wall junction: timber frame inner leaf
	10.05	Separating wall junction: Wall Type 3
	10.06	Internal wall junction: loadbearing
	10.07	Internal wall junction: non-loadbearing
	10.08	Services: vertical SVP's