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Owen Street, Manchester

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Internal Sound Insulation Design Review

February 2017

Report Reference: Z3-FAC-A180-Rp-XX-003

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REPORT TITLE INTERNAL SOUND INSULATION DESIGN REVIEW

CLIENT RENAKER BUILD LTD  
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## 1.0 INTRODUCTION

Fisher Acoustics Ltd has been commissioned by Renaker Build Ltd to provide acoustic design advice relating to a proposed residential development at Owen Street, Manchester, with a view to identifying and satisfying the applicable internal sound insulation performance requirements described within Approved Document E of the Building Regulations.

The numerical performance requirements of Approved Document E of the Building Regulations relating to airborne and impact sound insulation must be achieved prior to completion of the Development. Approved Document E also stipulates constructional requirements for individual items such as doors and soil & vent pipes. These requirements are discussed herein.

This report must be read in conjunction with the following documents:

- Noise & Vibration Chapter of Environmental Statement for Owen Street, Manchester
- UCW Acoustic Performance Specification, Z3-FAC-A180-Sp-XX-001, dated 24 October 2016
- Curtain Wall Acoustic Performance Specification – Non-Residential Areas, Z3-FAC-A180-Sp-XX-002, dated 11 October 2017

Others must advise on the fire and thermal requirements of the internal building elements.

This report concentrates on sound insulation between residential areas and the directly adjacent areas. The sound insulation properties between non-residential areas and other non-residential areas are not discussed in this report.

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## 2.0 DESCRIPTION OF PROPOSED DEVELOPMENT

The proposed Development includes the construction of four new apartment buildings targeted at the Private Rented Sector (PRS) market. The buildings will also include associated amenity provision, commercial and retail units, car parking and associated landscaping and access.

Basement levels are to be constructed which extend below and between the four distinct residential towers.

The proposed uses within the Development are as follows:

Basement 2:

- Car parking, Bin Stores, Wet Riser Plant, Storage rooms, Vent plant

Basement 1:

- Car parking, Domestic Tank rooms, Sprinkler Tank rooms, Comms Room, Storage rooms, Vent plant, Emergency Power Switch

Lower Ground floor:

- Retail 5, Plant room for Lobby, Office (Tower D), Lobby (Tower D), car parking, Cycle Store, Storage rooms, Vent plant

Ground floor:

- Reception Building: Entrance Lobby, Post Boxes, Parcel/Laundry Storage, Store, Male Changing Room, Bin Store, TX1, TX2
- Tower A: Entrance Lobby, Exhibition Space, Staff Room, WCs, Staff Changing Rooms,
- Tower B: Entrance Lobby, Residents Lounge, Toilet, Kitchen, Refuse Holding Area, TX2, TX3, Generator Room, Bin Store
- Tower C: Retail 3, Entrance Lobby
- Tower D: Retail 4, Reception, Staff Room, Parcels/Laundry Room, Changing Room
- Building E: Amenities Entrance, Retail 1, Retail 2, Plant/BOH, Switch Room, TX 4

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Mezzanine:

- Reception Building: void over Entrance Lobby, Residents Lounge, Seminar Rooms, TX1, TX2, TX3
- Tower A: Apartments, void over Entrance Lobby, Residents Quiet Lounge/Library, WCs
- Tower B: Apartments, void over Entrance Lobby, void over Generator Room, Cinema, Store
- Tower C: void over Retail 3, void over Entrance Lobby, Studio (gym), Beauty Cabins, Storage
- Tower D: Apartments
- Building E: Lounge, Gym, Tennis Court, Pool Plant, Car Park Vent

Level 1:

- Tower A: Apartments
- Tower B: Apartments
- Tower C: Apartments, Dance Studio, Changing Room, Gym Office, First Aid, Storage
- Tower D: Apartments
- Building E: Reception, Pool, Sauna, Gym, Changing Room, void over Tennis Court

Level 2:

- Tower A: Apartments
- Tower B: Apartments
- Tower C: Apartments, Plant
- Tower D: Apartments
- Building E: Plant, void over Pool, void over Gym, void over Tennis Court,

Level 3:

- Tower A: Apartments
- Tower B: Apartments
- Tower C: Apartments, Lounge, WC
- Tower D: Apartments
- Building E: Roof top amenity seating areas

Levels 4 to 38:

- Tower A: Apartments
- Tower B: Apartments
- Tower C: Apartments
- Tower D: Apartments

Level 39 to 43:

- Tower A: Apartments
- Tower B: Apartments
- Tower D: Apartments

Levels 44 to 45:

- Tower A: Apartments, Plant
- Tower B: Apartments
- Tower D: Apartments

Levels 46 to 51:

- Tower A: Apartments
- Tower B: Apartments

Levels 52 to 65:

- Tower A: Apartments

Each residential tower is to be provided with a refuse chute.

### 3.0 ACOUSTIC PERFORMANCE REQUIREMENTS

#### Approved Document E

The numerical performance requirements of Approved Document E of the Building Regulations, relating to airborne and impact sound insulation, must be achieved prior to completion of the development. Approved Document E also stipulates constructional requirements for individual items such as SVPs.

#### **Airborne and Impact Sound Insulation**

Table 1 gives the acoustic performance requirements of party floors and party walls stipulated by Approved Document E of the Building Regulations (2010). The stated values are a statutory requirement.

|                                                | <b>Airborne sound insulation</b><br><b><math>D_{nT,w} + C_{tr}</math></b><br><b>(Minimum values)</b> | <b>Impact sound insulation</b><br><b><math>L'_{nT,w}</math></b><br><b>(Maximum values)</b> |
|------------------------------------------------|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| <b>Purpose built dwelling houses and flats</b> |                                                                                                      |                                                                                            |
| Party Walls                                    | 45                                                                                                   | -                                                                                          |
| Party Floors                                   | 45                                                                                                   | 62                                                                                         |

**Table 1:** Performance standards for walls and floors that have a separating function

There are a number of walls that lie between residential and non-residential spaces that may require a sound insulation performance that improves upon the minimum requirement of Approved Document E.

Table 2 gives the recommended minimum sound insulation between apartments and ancillary spaces via walls in order to achieve appropriate internal conditions.

| Wall                                  | Weighted Standardised<br>Level Difference<br>D <sub>nT,w</sub> |
|---------------------------------------|----------------------------------------------------------------|
| <b>Tower A: Mezzanine Floor</b>       |                                                                |
| Void over Entrance Lobby to Apartment | 58                                                             |
| Female WC to Apartment                | 58                                                             |
| Seminar Room to Apartment             | 58                                                             |
| <b>Tower B: Mezzanine Floor</b>       |                                                                |
| Void over Lounge to Apartment         | 58                                                             |
| <b>Tower C: Level 01</b>              |                                                                |
| Dance Studio to Apartment             | 68                                                             |
| Changing Room to Apartment            | 58                                                             |
| <b>Tower C: Level 02</b>              |                                                                |
| Plantroom to Apartment                | 58                                                             |
| <b>Tower C: Level 03</b>              |                                                                |
| Residents Lounge to Apartment         | 58                                                             |

**Table 2:** Minimum recommended weighted standardised level difference between apartments and non-residential areas via walls

## Floors

It is recommended that, in addition to the acoustic requirements of Approved Document E for party floors, the floors between apartments and non-residential areas achieve the sound insulation performance values given in Table 3.

| Floor                                 | Weighted Standardised Level Difference<br>$D_{nT,w}$ |
|---------------------------------------|------------------------------------------------------|
| <b>Tower A</b>                        |                                                      |
| Entrance Lobby to Apartment           | 58                                                   |
| WCs to Apartment                      | 58                                                   |
| Staff Facilities to Apartment         | 58                                                   |
| Residents Quiet Lounge/Library        | 58                                                   |
| <b>Tower B</b>                        |                                                      |
| Residents Lounge to Apartment         | 58                                                   |
| Void over Entrance Lobby to Apartment | 58                                                   |
| Cinema to Apartment                   | 68                                                   |
| Void over Generator Room to Apartment | 68                                                   |
| Store to Apartment                    | 58                                                   |
| <b>Tower C</b>                        |                                                      |
| Void over Retail Unit to Apartment    | 58                                                   |
| Void over Entrance Lobby to Apartment | 58                                                   |
| Dance Studio to Apartment             | 68                                                   |
| Changing Room to Apartment            | 58                                                   |
| Plantroom to Apartment                | 58                                                   |
| Residents Lounge to Apartment         | 58                                                   |
| <b>Tower D</b>                        |                                                      |
| Retail Unit to Apartment              | 58                                                   |
| Entrance Lobby to Apartment           | 58                                                   |
| Post Boxes to Apartment               | 58                                                   |

**Table 3:** Minimum weighted standardised level difference between apartments and non-residential areas via floors

Table 4 gives the recommended impact sound insulation of floors to the non-habitable rooms to achieve appropriate internal conditions in the apartments.

| Floor                     | Weighted standardised impact sound pressure level<br>$L'_{nT,w}$ dB<br>(Maximum values) |
|---------------------------|-----------------------------------------------------------------------------------------|
| Dance Studio to Apartment | 30 dB                                                                                   |
| Plant to Apartment        | 62 dB                                                                                   |

**Table 4:** Minimum weighted standardised impact sound pressure level of floors

#### 4.0 WALLS

In order to achieve the required sound insulation performances on site, it is recommended that separating walls achieve the Weighted Sound Reduction Index values given in Table 5. Weighted Sound Reduction Index is measured in a laboratory in accordance with BS EN ISO 10140-2: 2010 and rated in accordance with BS EN ISO 717-1: 2013.

| Wall                                                          | Sound Reduction Index<br>R <sub>w</sub>         |
|---------------------------------------------------------------|-------------------------------------------------|
| Apartment to Apartment                                        | 59 dB (53 dB R <sub>w</sub> + C <sub>tr</sub> ) |
| Apartment to Stairwell                                        | 59 dB                                           |
| Apartment room to corridor (wall that contains a single door) | 45 dB                                           |
| <b>Tower A: Mezzanine Floor</b>                               |                                                 |
| Void over Entrance Lobby to Apartment                         | 65                                              |
| Female WC to Apartment                                        | 65                                              |
| Seminar Room to Apartment                                     | 65                                              |
| <b>Tower B: Mezzanine Floor</b>                               |                                                 |
| Void over Lounge to Apartment                                 | 65                                              |
| <b>Tower C: Level 01</b>                                      |                                                 |
| Dance Studio to Apartment                                     | 75                                              |
| Changing Room to Apartment                                    | 65                                              |
| <b>Tower C: Level 02</b>                                      |                                                 |
| Plantroom to Apartment                                        | 65                                              |
| <b>Tower C: Level 03</b>                                      |                                                 |
| Residents Lounge to Apartment                                 | 65                                              |

**Table 5:** Minimum weighted sound reduction index of walls

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**Apartment separating walls**

In order to achieve the required sound insulation performance between apartments, it is recommended that the party wall construction between apartments achieves a minimum weighted sound reduction index (i.e. as measured in laboratory) of 59dB (53dB  $R_w$  +  $C_{tr}$ ).

**Drylined metal studwork**

Given Renaker's desire to use twin framed metal stud walls, the suggested party wall construction to achieve the performance requirements of Approved Document E is as follows:

- Twin frame wall incorporating metal 50 mm C studs spaced a minimum 20 mm apart (braced if required at 1500 mm), drylined each side with two layers of 12.5 dense plasterboard (minimum density 830 kg/m<sup>3</sup>, e.g. Knauf Soundshield Plus), with 50 mm mineral wool of minimum density 22 kg/m<sup>3</sup> within the cavity.

The following recommendations must be followed to maximise the acoustic performance of the walls on site:

1. The full perimeter of the drylining to the party walls must be acoustically sealed using non-hardening acoustic sealant. The preferred location for the acoustic sealant is at the inner layer of plasterboard, rather than below the party wall base tracks.
2. Party walls must extend full-height to the structural soffit.
3. The plasterboards of the party wall must break the plasterboard drylining of the external wall to minimise flanking transmission of noise at the interface of the party wall and external wall (i.e. the plasterboards of the inner leaf of the external wall must be discontinuous on the line of party wall). The party wall plasterboards must extend out to the insulated panel of the external curtain wall.
4. The party walls must be drylined and acoustically sealed against any concrete element prior to the drylining of the concrete, such that the concrete drylining plasterboards are discontinuous on the line of the party wall.
5. Penetrations in plasterboard party walls to accommodate mains sockets and switches must be acoustically treated to maintain the sound insulation of party walls. Intumescent putty pads (e.g. Knauf Putty Pads, Hilti CP617 etc) should be installed within all electrical

back-boxes in party walls to maintain the acoustic integrity of walls. Care must be taken to ensure that the acoustic and fire integrity of the putty pads is maintained following the installation of mains cables.

6. Access hatches within party walls (to allow access to the rodding points of waste pipes) must achieve a minimum weighted sound reduction index of 32dB Rw. Suitable products can be found at <https://www.profabaccesspanels.co.uk/product-category/acoustic-access-panels-for-ceiling-walls/>

If the above advice is followed, then the potential sound insulation performance between apartments is 48dB DnT,w + Ctr to 52 dB DnT,w + Ctr.

#### **Apartment separating walls – Concrete shear walls**

Where the party wall between apartments and any other spaces is formed by a concrete shear wall, the airborne sound insulation requirements can be achieved with no further acoustic treatment. As discussed in this report in relation to impact sound transfer, it is assumed that all shear walls will be drylined with plasterboard fixed using metal channels rather than 'dot and dab' adhesive plaster.

#### **Drylining of lift shaft walls**

The structural design of the Towers has determined that the walls between lift shafts and the apartments will be 600 mm thick in-situ concrete. In order to control structureborne noise via the lift shaft walls, it is recommended that the lift shaft walls are drylined in the living accommodation with a single layer of 12.5 mm dense plasterboard (minimum density 830 kg/m<sup>3</sup>) fixed to metal liner channels to create a minimum cavity of 30 mm, with 25 mm mineral wool of minimum density 10 kg/m<sup>3</sup> in the cavity.

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**Drylining of concrete columns within Dance Studio and Cinema**

In order to minimise the vertical flanking transmission of noise to the apartments above, it is recommended that concrete columns within the Dance Studio and Cinema are drylined with two layers of 12.5 mm dense plasterboard (minimum density 830 kg/m<sup>3</sup>) fixed to metal liner channels to create a minimum cavity of 50 mm, with 25 mm mineral wool of minimum density 10 kg/m<sup>3</sup> in the cavity.

**Drylining of refuse chute wall**

Section 2.28 of Approved Document E states that 'a wall separating a habitable room or kitchen and a refuse chute should have a mass per unit area (including finishes) of at least 1320 kg/m<sup>2</sup>'.

The proposed refuse chutes in the residential towers are directly adjacent to apartments. The refuse chutes and the apartments are separated by 600 mm thick concrete shear walls. The mass of the proposed shear wall is 1400 kg/m<sup>2</sup>. Therefore, no further treatment would be required to the separating wall between the refuse chutes and apartments to comply with the requirement of Approved Document E.

To provide further mitigation of noise from the refuse chute, it is suggested that consideration be given to the provision of a slow-closer mechanism to the refuse chute hopper doors. In addition, the lining of the base of the proposed metal chutes with a proprietary damping compound would be recommended to reduce noise generation due to the impact of refuse bags.

**Apartment to stairwell walls**

The proposed structural walls between the stairwells and adjacent apartments are in-situ normal-weight concrete shear walls of thickness 600 mm. The airborne sound insulation requirements between stairwells and apartments can be achieved with no further acoustic treatment.

As discussed in this report in relation to impact sound transfer, it is assumed that all shear walls will be drylined with plasterboard fixed using metal channels rather than 'dot and dab' adhesive plaster.

If a plasterboard drylining is required to the stairwell walls within common areas, then from an acoustic perspective the drylining can comprise a single layer of 12.5 mm wallboard fixed using adhesive dabs ('dot & dab').

### **Apartments to corridor**

Approved Document E advises that walls between flats and common corridors should be able to achieve the acoustic performance requirements of party walls. However, the Document recognises that 'it is likely that the sound insulation will be reduced by the presence of a door'.

The great majority of walls between the proposed apartments and the common corridors are formed by the 600 mm thick concrete shear walls. There are relatively small areas of drylined metal stud walls at the apartment entrance doors, such that the entrance door is of a larger area than the surrounding wall.

Calculations show that on the assumption that the entrance door achieves the sound insulation requirements of Approved Document E of 29dB  $R_w$  (see Section 7 below), then a jumbo stud wall that achieves a weighted sound reduction index of 40dB  $R_w$  will allow the maximum possible sound insulation to be achieved between apartments and the corridor (i.e. partition constructions that achieve performances of 40dB  $R_w$  and 70dB  $R_w$  would achieve the same sound insulation on site between the apartment entrance hallway and the corridor, therefore there is no acoustic benefit in installing a wall that achieves greater than 40dB  $R_w$ ).

Therefore, the drylined metal stud wall in which the apartment entrance door sits need only achieve a weighted sound reduction index of 40dB  $R_w$ . This performance can be achieved by the following wall construction:

- One layer of 12.5 mm dense plasterboard (minimum density 830 kg/m<sup>3</sup>) each side of 70mm C studs

The corridor wall must be acoustically sealed on both sides at the head, base and vertical interfaces with non-hardening acoustic mastic.

### **Bathrooms to corridor**

Approved Document E requires that the airborne sound insulation between bathrooms and corridors is  $43\text{dB } D_{nT,w} + C_{tr}$ .

All walls between the proposed bathrooms and the common corridors are formed by the 600 mm thick concrete shear walls. The acoustic requirements of Approved Document E can be achieved with no further acoustic treatment of the wall.

### **Internal walls within Apartments**

Approved Document E requires that internal walls between a bedroom or a bathroom and other rooms within apartments that do not contain a connecting door achieve a Weighted Sound Reduction Index of  $40\text{dB } R_w$ . Acoustic testing on site of internal walls is not required. Internal walls that contain a door between the rooms are not required to achieve a specific acoustic performance.

The suggested drylined wall constructions to achieve a sound insulation performance of  $40\text{dB } R_w$  are as follows:

- 1) 12.5 mm wallboard / 70 mm metal stud with 25 mm mineral wool (density  $12 \text{ kg/m}^3$ ) in cavity / 12.5 mm wallboard
- 2) 12.5 mm dense plasterboard ( $830 \text{ kg/m}^3$ ) / 70 mm metal stud / 12.5 mm dense plasterboard ( $830 \text{ kg/m}^3$ ) (no mineral wool in cavity)

If option 1 is taken, then the mineral wool can be omitted from internal walls that are not required to achieve a sound insulation performance of  $40\text{dB } R_w$ .

Internal walls can be allowed to terminate at the internal ceiling level, if compatible with the required fire protection. Where internal walls are required to achieve a certain fire protection, the walls must be built up to and sealed against the structural soffit.

Figure 1 identifies the walls within typical Tower A apartments that must achieve a minimum sound insulation of 40dB  $R_w$ .

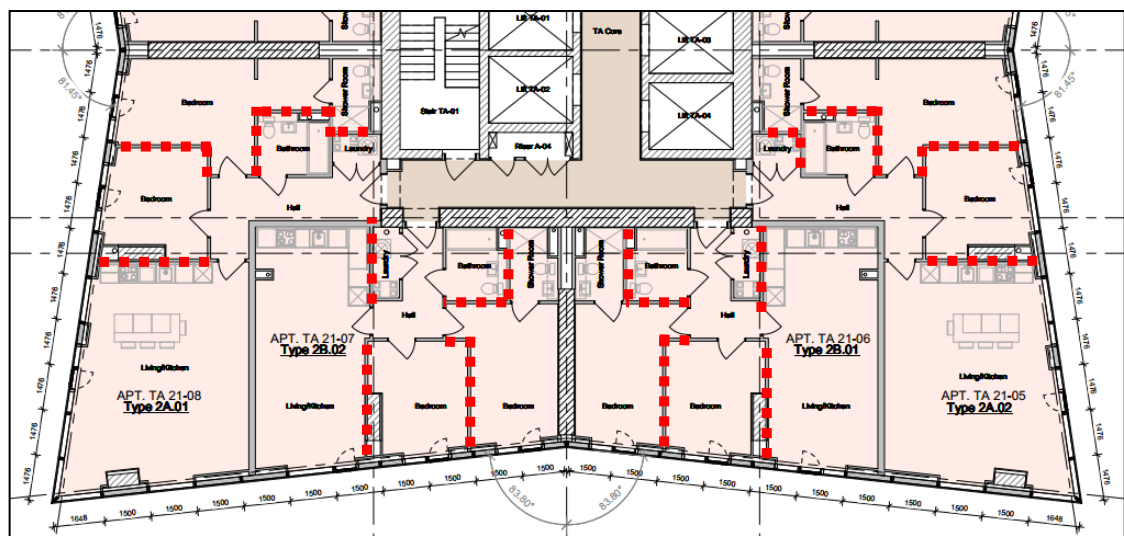


**Figure 1:** 40dB  $R_w$  internal walls within apartment

### Ancillary Spaces

The minimum recommended sound insulation performances identified in Table 5 for the ancillary spaces can be achieved by the wall constructions identified in Table 6. It should be noted that thermal considerations may require additional insulation or greater cavity sizes.

| Weighted Sound Reduction Index<br>$R_w$ | Blockwork                                                                                                                                                                                                                                                                                                                           | Metal Stud partition                                                                                                                                |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 65 dB                                   | Paint grade or standard grade blockwork of minimum mass $180 \text{ kg/m}^2$ , drylined on one side with two layers of 15 mm dense plasterboard ( $830 \text{ kg/m}^3$ ) fixed to independent studs to create minimum cavity of 70 mm, 50 mm mineral wool in cavity, drylined on other side with plasterboard on dabs, or plastered | 2 x 15 mm dense plasterboard ( $830 \text{ kg/m}^3$ ) each side of twin frame metal studs, 50 mm mineral wool within cavity of minimum depth 150 mm |
| 75 dB                                   | Paint grade blockwork of minimum mass $180 \text{ kg/m}^2$ , drylined on each side with 2 layers of 15 mm Soundshield Plus plasterboard (minimum density $830 \text{ kg/m}^3$ ) fixed to independent studwork to create a cavity of 120 mm on each side of the core wall with 100 mm Knauf Earthwool insulation in the cavity       | -                                                                                                                                                   |

**Table 6:** Suggested wall constructions to achieve acoustic requirements of walls to ancillary areas

With regard to the 75 dB  $R_w$  wall, only a blockwork option is provided as a lightweight wall would not reduce horizontal flanking transmission between the Dance Studio and adjacent apartment via the structural slab. Activity noise transfer from the Dance Studio would be elevated if a blockwork core wall was not included in the party wall build-up.

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## 5.0 PARTY FLOORS

### **Apartment to Apartment floors - airborne sound insulation**

The structural design of the building has determined that the party floor between apartments will be a 250 mm thick in-situ concrete flat slab. In addition, the slab is to be underdrawn within apartments with a plasterboard ceiling.

The predicted vertical sound insulation between apartments via the structural slab alone is 48dB  $D_{nT,w} + C_{tr}$ . The structural slab therefore provides the basis for compliance with the acoustic requirements of Approved Document E. Care will need to be taken with flanking noise transfer at the slab edge. This is discussed in Section 6.

The ceiling to party floors between apartments can comprise a single layer of 12.5 mm wallboard suspended on a metal frame. No acoustic measures would need to be taken where the ceiling is penetrated by light fittings or detectors.

### **Apartment to Apartment floors - Impact sound insulation**

Approved Document E of the Building Regulations requires that the party floor impact sound level within a habitable room does not exceed 62dB  $L'_{nT,w}$  (a lower figure signifies an improvement in the impact sound insulation of the floor).

The apartments are targeted at the Private Rented Sector (PRS) market, rather than owner/occupiers and therefore the occupants will not be free to change the floor coverings. The floor coverings can therefore be assumed to be permanent and can be allowed to contribute to the impact sound insulation of the party floors to comply with Approved Document E.

Given a flat concrete slab thickness of 250 mm, a ceiling of 1 x 12.5 mm wallboard fixed to a suspended metal frame and a floor build-up of laminate flooring within kitchens and living rooms and carpet within bedrooms, the impact sound insulation requirement of the Building Regulations can be achieved with no proprietary resilient layer on the floor slab within living rooms, kitchens and bedrooms.

If ceramic tiling rather than laminate flooring is to be installed within bathrooms, then as long as the drylining to all columns and shear walls within apartments is fixed using metal channels rather than 'dot and dab' adhesive plaster, then the impact sound insulation requirements of the Approved Document E is expected to be achieved with no proprietary resilient layer on the floor slab.

There must be no direct contact between the plasterboards (other than the plasterboard above the head track) and the soffit of the structural slabs at the head of the drylined walls.

It must be noted that the comfort margin for compliance with the impact sound performance requirement is small at between 3dB and 5dB. If there is any likelihood that the drylining to any column or shear wall within an apartment may be fixed using 'dot and dab' adhesive plaster, then it is recommended that a 3 mm thick proprietary resilient layer, such as Regupol 4515, is bonded to the slab prior to the laying of floor tiles.

The above advice assumes that contact between the laminate flooring and the surrounding elements such as columns, shear walls, plasterboard drylining to internal/external walls and skirting boards is avoided. To ensure that contact is avoided, it is recommended that a perimeter flanking strip is installed between the laminate flooring and the surrounding elements. Suitable products are 'Monarfloor flanking band' and TEXELL Acoustic Flanking Strip.

It is suggested that an impact sound insulation test is conducted at an early stage of the construction programme (e.g. when a sample room has been formed and drylined) to confirm that the required impact sound insulation performance has been achieved.

---

**Non-residential areas to Apartments - airborne sound insulation**

The minimum airborne sound insulation requirements of Approved Document E must be achieved between the non-residential areas and the vertically adjacent apartments. In addition, the airborne sound insulation of the floor must take into account the potential activity noise levels within the non-residential areas such that disturbance of residential occupants can be avoided.

The currently proposed structural floor between the residential areas and the non-residential areas below is as follows:

- 250 mm in-situ concrete flat slab

In order to achieve the acoustic requirements identified in Table 4, a plasterboard ceiling must be installed within certain rooms, as follows:

Cinema

- Two layers of 12.5 mm dense plasterboard (minimum density 830 kg/m<sup>3</sup>, e.g. Knauf Soundshield Plus), fixed to a metal frame to create a minimum cavity of 150 mm, 50 mm mineral wool of minimum density 22 kg/m<sup>3</sup> in the ceiling void.

Dance Studio

- Two layers of 12.5 mm dense plasterboard (minimum density 830 kg/m<sup>3</sup>, e.g. Knauf Soundshield Plus), fixed to a metal frame to create a minimum cavity of 150 mm, 50 mm mineral wool of minimum density 22 kg/m<sup>3</sup> in the ceiling void.

Compliance with the remaining acoustic requirements of Table 4 can be achieved by the proposed structural slab alone. Any ceiling specification to these areas need not be influenced by acoustic considerations.

### Recommended maximum allowable noise levels in non-residential areas

Given the above-recommended provision of ceilings, Table 10 identifies the maximum allowable noise levels in the non-residential areas to avoid disturbance of the residential areas.

| Room                            | Sound Pressure Level (dB)<br>@ Octave Band Centre Frequency (Hz) |     |     |     |    |    |    |
|---------------------------------|------------------------------------------------------------------|-----|-----|-----|----|----|----|
|                                 | 63                                                               | 125 | 250 | 500 | 1k | 2k | 4k |
| Cinema                          | 86                                                               | 84  | 82  | 87  | 90 | 90 | 92 |
| Dance Studio                    | 86                                                               | 84  | 82  | 87  | 90 | 90 | 92 |
| Residents Lounge                | 76                                                               | 70  | 67  | 71  | 77 | 80 | 80 |
| Residents Quiet Lounge/ Library | 83                                                               | 75  | 70  | 71  | 77 | 82 | 85 |
| Entrance Lobby                  | 83                                                               | 75  | 70  | 71  | 77 | 82 | 85 |
| Plant rooms                     | 83                                                               | 75  | 70  | 71  | 77 | 82 | 85 |
| Commercial Units                | 76                                                               | 70  | 67  | 71  | 77 | 80 | 80 |

**Table 7:** Maximum recommended sound levels in rooms

The noise levels identified in Table 7 represent reasonably loud listening levels for the Cinema and Dance Studio. Subjectively, the noise levels are substantially higher than would be deemed to be 'normal' living room listening levels. For instance, in relation to televisions, an external sound system with a subwoofer would be needed to generate the noise levels detailed. Televisions with in-built loudspeakers would not be capable of generating the noise levels identified within the movie room.

If a sound system with a subwoofer is to be provided in the Cinema or Dance Studio, then it would be possible to exceed the above noise levels with a reasonably powerful amplifier set to high volume when watching music videos or films with low-frequency sound effects or when playing music. In this case, it may be necessary to install an electronic noise limiter on any amplifier to prevent noise nuisance to the adjacent apartments.

If the tenant of a commercial unit wishes to or expects to generate greater operational noise levels than those identified in the last row of Table 7, then the fit-out of the unit to be undertaken by the Tenant must include appropriate measures to further improve the sound insulation between the commercial unit and the apartments above, such as an appropriately designed acoustic ceiling and drylining to concrete shear walls and columns. The internal

noise levels generated by any Tenant must also take into account the maximum allowable noise levels relating to noise egress to the noise-sensitive receptors at and around the site, as detailed in the Noise Impact report submitted for Planning purposes.

### **Residential Common Corridors - Impact sound insulation**

The impact sound insulation requirement between common corridors and apartments is the same as that for apartments to apartments. It is understood that the common corridors are to be provided with a carpeted floor. Compliance with the requirements of Approved Document E can therefore be achieved with no further measures required.

### **Non-residential areas to Apartments – impact sound insulation**

The only non-residential areas that lie above apartments are plant rooms. Given a 250 mm thick flat concrete slab, the proposed plasterboard ceiling within the apartments and on the basis that the drylining to all columns and shear walls within apartments is fixed using metal channels rather than 'dot and dab' adhesive plaster, then the impact sound insulation requirements of the Approved Document E is expected to be achieved with no proprietary resilient layer on the floor slab within the plant rooms.

It is expected that all M&E plant within plant areas are to be provided with appropriately specified anti-vibration mounts to minimise the transmission of structureborne noise to the apartments.

### **Dance Studio**

It is understood that the Dance Studio that is located directly below apartments is to be provided with a sprung floor. In order to achieve the recommended impact sound performance of the overall party floor construction, it is recommended that the sprung floor achieves a weighted impact sound improvement of 22dB dLw and an impact sound improvement at 100 Hz of 5dB.

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Free Weights and Weights Machines

If free weights or weights machines are introduced in the future to the Dance Studio or Studio of Tower C then consideration may need to be given to the acoustic treatment of the floor. The dropping of free weights on the floor and the dropping of weight stacks can generate high levels of impact noise that could be audible in the apartments above unless specific remedial treatment is installed. It is therefore recommended that the floor in any free weights area (for weights greater than 10 kg) and in areas under any weights machine is acoustically treated such that the performance requirements stated in Table 6 are achieved.

It is recommended that the floor slab in the areas in question is overlaid with resilient layers to reduce impact noise at source. In particular, the following build-up is suggested:

- 10 mm TVS Sportec on 12.5 mm Sylomer SR42 on 12.5 mm Sylomer SR28

In addition, it is recommended that any weights machine or running machine is installed on TVS Impact absorbers. The above products can be supplied by Total Vibration Solutions (<http://www.totalvibrationsolutions.com>).



In particular, the Specifications states:

*'The airborne flanking transmission of the curtain wall when measured in accordance with BS EN ISO 10848-2: 2006 'Acoustics—Laboratory measurement of flanking transmission of airborne and impact sound between adjoining rooms' shall be not less than the values given in Table 5.*

| <b>Room Adjacency</b>                      | <b><math>D_{n,f,w}</math></b> |
|--------------------------------------------|-------------------------------|
| <i>Apartment to Apartment</i>              | <i>55 dB</i>                  |
| <i>Non-residential areas to Apartments</i> | <i>65 dB</i>                  |

**Table 5:** *Minimum flanking sound insulation of curtain wall frame'*

#### **Ancillary Areas/ Retail Units to Apartments – Interface of 'stick' curtain walling with unitised curtain walling**

Achievement of the vertical sound insulation performance requirements between the apartments and the adjacent non-residential areas will be influenced by the sound insulation achieved at the slab edge and by flanking sound transmission within the curtain wall frame. Figure 3 shows the situation in relation to vertical sound transmission.

Achievement of the horizontal sound insulation performance requirements between the apartments and the adjacent non-residential areas will be influenced by the sound insulation achieved at the junction of the party wall and the curtain wall and by flanking sound transmission within the curtain wall frames.

Figure 3 shows the situation in relation to vertical sound transmission at the junction of the 'stick' curtain wall and the Unitised Curtain Wall.

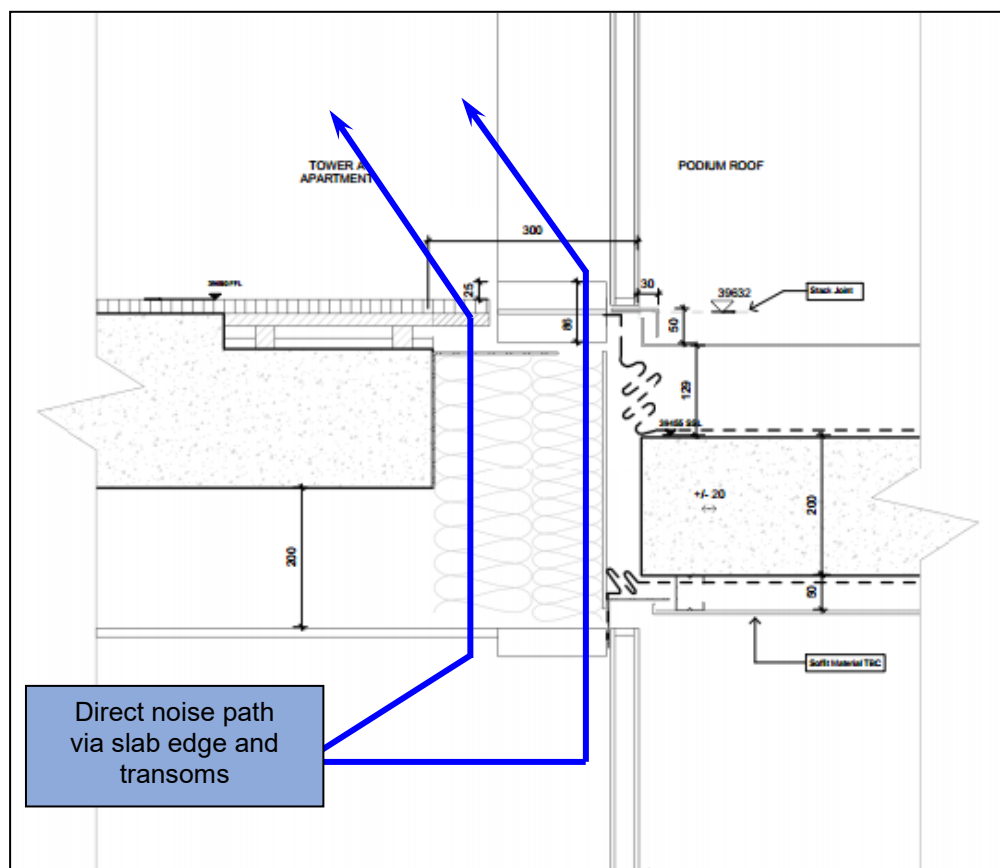


**Figure 3:** Noise transmission paths at junction of curtain wall and slab

For the situation in Figure 3, there are two separated transoms within the party floor zone at the location of the stack joint. This is acoustically beneficial when compared to a single transom solution. It is initially recommended that the slab edge barrier achieves a weighted sound reduction index of 25dB  $R_w$ . This can be achieved by a proprietary product such as 120 mm thick Siderise CW-FS120 by Siderise Insulation Limited. The slab edge barrier and the treatment of the transoms must also achieve the required fire performance.

The interface of the plasterboard ceiling or bulkhead and the curtain wall transom below the level of the structural soffit must be acoustically sealed, with thought given as to how any potential deflection of the curtain wall frame (e.g. due to wind loading) will be accommodated.

Figure 4 shows the horizontal junction of the party wall between the Dance Studio and the adjacent apartment.

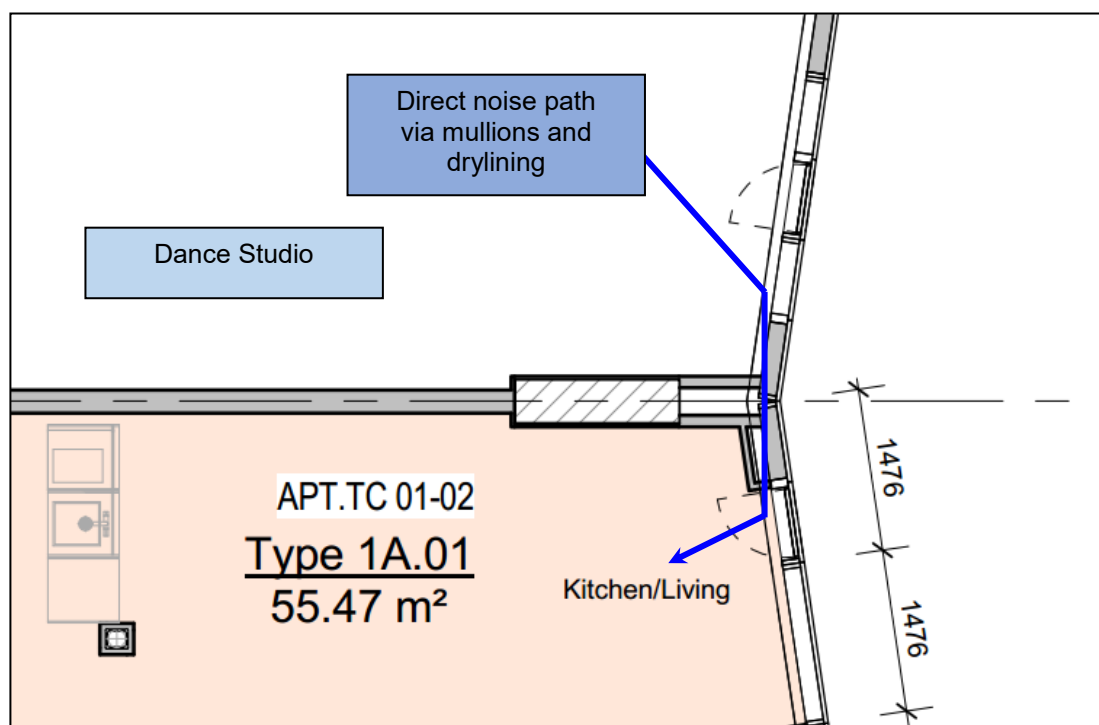


**Figure 4:** Noise transmission paths at junction of curtain wall and party wall

For the situation in Figure 4, the party wall interfaces with the curtain wall at the location of an insulated spandrel panel. This is acoustically beneficial as the drylining to the spandrel panel within the apartment will improve the sound insulation via the curtain wall frame. It is assumed that the spandrel panel within the Dance Studio will also be drylined. It is recommended that the drylining to the spandrel panels in both the Dance Studio and apartment at the junction of the party wall includes two layers of 12.5 mm dense plasterboard (minimum density 830 kg/m³), with 50 mm mineral wool within the drylining cavity.

The recommended party wall construction between the Dance Studio and apartment includes a central masonry core (see Tables 5 and 6). The blockwork leaf must extend as far as possible out to the curtain wall line. The gap between the end of the blockwork wall and the curtain wall frame must then be filled with a cavity barrier that achieves a weighted sound reduction index of 25dB  $R_w$ . This performance can be achieved by a proprietary product such as 120 mm thick Siderise CW-FS120 by Siderise Insulation Limited.

The plasterboard drylining must then extend out to, and be acoustically sealed against, the back of the insulated spandrel panel prior to the installation of the drylining to the spandrel panel, with thought given as to how any potential deflection of the curtain wall frame (e.g. due to wind loading) will be accommodated.

In order to achieve the acoustic performance requirements of Approved Document E and of Tables 2 and 3 above, it is recommended that the flanking sound insulation of the curtain wall systems between the residential and non-residential areas is no less than the values stated in Table 8.

| Room pairings                                | Dn,f,w |
|----------------------------------------------|--------|
| Dance Studio to Apartment                    | 65 dB  |
| Retail Unit to Apartment                     | 65 dB  |
| All other non-residential areas to Apartment | 58 dB  |

**Table 8:** Minimum flanking sound insulation of curtain wall

If it is considered that activity noise levels in the non-residential areas other than the Dance Studio may increase in the future (for example if part of a Resident's Lounge may become a Private Dining Room or similar 'room for hire'), then it is recommended that the curtain wall between the areas in question and the apartments above achieve a flanking sound insulation performance of 65dB Dn,f,w.

## 7.0 DOORS

### Apartment Entrance doors

Approved Document E of the Building Regulations require that main doors between living accommodation and common areas achieve a minimum weighted sound reduction index of 29dB  $R_w$ . In order to achieve this performance, entrance doors to bedrooms must be provided with acoustic seals to the full perimeter, including the threshold.

Proprietary doors are available that achieve this requirement. Alternatively, if a bespoke solution is preferred, it is recommended that the door leaf achieves a minimum mass per unit area of 25 kg/m<sup>2</sup>. A suitable combined smoke/fire and acoustic seal for the head and jambs of doors is the LP2004DS by Lorient. This is a twin-blade seal and must be installed such that one of the blades is continuous past the door ironmongery. A suitable threshold seal is the LAS 8001 si automatic recessed seal by Lorient.

If the proposed ironmongery for the doors is such that it would not be possible to maintain the acoustic integrity of the acoustic seal at the head or jambs, then it is recommended that a 'batwing' acoustic seal is included at the door frame. A suitable seal is the LAS 1212 Batwing by Lorient.

### Ancillary rooms

Table 12 identifies the minimum recommended weight sound reduction index of doors to the hub areas and ancillary rooms.

| Room                                  | Sound Reduction Index<br>$R_w$ |
|---------------------------------------|--------------------------------|
| Cinema (each door within lobby)       | 32 dB                          |
| Studio                                | 32 dB                          |
| Dance Studio to Residential Core      | 38 dB                          |
| Plant rooms within Residential Towers | 38 dB                          |
| Exhibition Space to Entrance Lobby    | 32 dB                          |

**Table 9:** Minimum weighted sound reduction index of doors

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### **Common Areas**

All doors within common areas should be fitted with a means of reducing impact noise when closing. Examples of such devices include slow closers and resilient pads on door frames.

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## 8.0 SOIL & VENT PIPES AND RAINWATER PIPES

Approved Document E of the Building Regulations requires that all pipework that passes through party floors must be separated from habitable rooms by boards that have a minimum mass of  $15\text{kg/m}^2$ . This requirement can be achieved by two layers of 12.5 mm wallboard. In addition, the Document requires that the encasement around pipework be lined internally with 25 mm thick unfaced (i.e. not foil-faced) mineral wool (minimum density  $10\text{kg/m}^3$ ). Alternatively, the pipework can be lagged with 25 mm thick unfaced mineral wool (minimum density  $10\text{kg/m}^3$ ).

It may be more cost-effective to install the mineral wool within the studwork frame as part of the drylining sub-contract package, rather than include an unfaced mineral wool pipe lagging within the M&E sub-contract package.

It must be noted that the proposed wall type IWS -151 that currently encases pipework within apartments does not comply with the above requirement.

It must be ensured that no part of the metal stud frame that supports the encasement is in direct contact with any part of the pipe. Pipe penetrations through the slab must be acoustically sealed. This can be achieved with expanding foam such as FM410 by Illbruck.

It is understood that access to SVPs is required within apartments from one side of the encasement. The access hatch must exhibit a minimum mass of  $15\text{kg/m}^2$  and must achieve a minimum weighted reduction index, as tested in an accredited acoustic laboratory, of 32dB Rw.

Where SVPs or RWP undergo a change in direction (from vertical to horizontal), increased noise levels due to flow within the pipes can be expected. It is therefore recommended that consideration be given to the acoustic lagging of pipework for three metres each side of a change of direction. It is recommended that the acoustic pipe lagging includes 50 mm of mineral wool and an outer barrier of mass  $10\text{kg/m}^2$ . A suitable pipe lagging is SuperLag Technowrap 2/10 by CMS Danskin.

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## 9.0 APPROVED DOCUMENT E REQUIREMENT E3

Requirement E3 of Approved Document E is as follows:

*'The common internal parts of buildings which contain flats or rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable'.*

Requirement E3 only applies to corridors, stairwells, hallways and entrance halls which give access to a flat or room for residential purposes.

This requirement is aimed at minimising the potential for disturbance caused to occupants due to activity noise in common areas. The underlying principle of Requirement E3 is to provide sound absorbent finishes within the spaces such that the reverberant noise level in common areas is reduced.

### Appraisal Methods and assessment - Corridors

Section 7 of Approved Document E gives guidance on providing 'reasonable' conditions in common parts.

Two possible assessment methods are described in Section 7 for corridors. Method A recommends the covering of an area equal to or greater than the floor area with an acoustically absorptive material of specified acoustic properties. Typically, this would be achieved by the installation of a ceiling of absorption Class C over the full ceiling area. Method B recommends that, in corridors, a minimum of 0.25m<sup>2</sup> total absorption area per cubic metre of the total volume is provided. This recommendation applies to frequencies between 250 Hz and 4 kHz inclusively.

It is understood that the architectural preference is for the residential corridors that give access to the apartments to be provided with solid plasterboard ceilings. Solid plasterboard ceilings would not fulfil the requirements of either Method A or Method B of Section 7. However, an equivalent acoustic benefit of acoustic absorption within the corridors can be provided, as discussed below.

If 0.25 m<sup>2</sup> total absorption area per cubic metre of the total volume of the corridors is provided, then the resultant reverberation time (RT) in the corridor would be approximately 0.64 seconds. Thus the effective recommendation of Method B of Section 7 is that the RT in a corridor should be 0.64 seconds at each octave band between 250Hz and 4kHz.

The fundamental reason for providing a certain reverberation time in common parts is to reduce the reverberant noise level in these spaces, so that the noise able to intrude into apartments is reduced.

It has been determined that the reverberant noise level in a corridor of similar dimensions to those proposed within the residential towers would increase by 2 dB(A) if a plasterboard ceiling was provided in lieu of strict compliance with Method B of Section of Approved Document E. This change in noise level is not significant, as it is generally accepted that a noise level must change by 3dB(A) before a subjective increase or decrease noise level is perceived by listeners 'in the field'.

Therefore, strict compliance with the requirements of Section 7 of Approved Document E is not expected to provide a subjectively noticeable reduction in noise transfer from corridors to apartments.

In addition, there is a more effective method of reducing noise transfer to apartment rooms than the provision of acoustic absorption within the corridors. In particular, Approved Document E does not strictly require that threshold acoustic seals are provided to apartment entrance doors. However, the provision of threshold acoustic seals to a door can improve the sound insulation of the door by approximately 7dB.

Therefore, the provision of threshold acoustic seals to the apartment doors and solid plasterboard ceilings to the corridors would lead to noise levels in apartments from the corridors that are 5 dB lower than if acoustically absorptive ceilings were provided but acoustic threshold seals were omitted from apartment entrance doors (as is allowed under the Building Regulations).

It is therefore suggested that the effective requirement E3 of the Building Regulations can be satisfied by the provision of carpets and solid plasterboard ceilings to corridors, and perimeter acoustic seals, including the threshold, to apartment entrance doors

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This alternative approach to requirement E3 of the Building Regulations must be approved by the Building Inspector.

Appraisal Methods and assessment – Stairwells

The proposed stairwells do not provide direct access to the habitable rooms. There is therefore no requirement under Section 7 of Approved Document E to provide acoustically absorptive finishes within the proposed stairwells.

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## 10.0 ACOUSTIC TREATMENT OF CINEMA

In order to provide appropriate listening conditions, consideration may need to be given to acoustic treatment of the Cinema to achieve appropriate reverberation times.

The furniture within the Cinema will provide a certain level of acoustic absorption, but additional acoustic treatment may be required to achieve sufficient control of reverberation.

Such acoustic treatment would normally take the form of wall-hung panels of approximate depth 50 mm to 100 mm. The panels can be finished with a variety of surface treatments, such as fabric (plain or screen-printed), perforated metal or slotted timber.

Where curtains are to be provided to the Cinema, it is recommended that only directly adjacent walls are curtained to avoid flutter echoes between two parallel and acoustically reflective walls. If curtains are to be installed to only one wall, then it may be necessary to introduce absorptive or sound diffusing elements to the adjacent wall to avoid flutter echoes. To provide reasonable acoustic absorption, the area of curtain fabric per wall should be at least twice the area of that wall. The curtain fabric should exhibit a minimum mass of 0.5 kg/m<sup>2</sup>. A serge or velour fabric would be preferred.

As acoustic panels can be retro-fitted, it may be appropriate to assess the acoustic quality of the Cinema after final furnishing to determine if additional acoustic treatment is necessary.