Minister's Specification

SA 78B

Construction requirements for the control of external sound

February 2013
PREFACE

This Minister's Specification must be read in conjunction with the National Construction Code Series - Building Code of Australia (Volumes One and Two) (NCC).

PURPOSE

The intent of this Specification is to protect the occupants of Class 1, 2, 3 and 4 buildings and 9c aged care buildings from the impact of existing or future road and rail sound and from mixed land use area sound sources.

SCOPE

This Specification applies to new Class 1, 2, 3 and 4 buildings and 9c aged care buildings, and to additions to existing Class 1, 2, 3 and 4 buildings and 9c aged care buildings, to be constructed in South Australia under the Development Act 1993. In this Specification, Class 1, 2, 3 and 4 buildings and 9c aged care buildings have the same meaning as defined in the NCC.

These provisions are additional to those required by the NCC and do not override any of the provisions required by the NCC.

CONTENTS

Part A GENERAL PROVISIONS
A1 Specification Structure
A2 Interpretation
A3 Referenced Standards and Documents

Part B PERFORMANCE
B1 Objective
B2 Functional Statement
B3 Performance Requirements
B4 Application
B5 Verification Method

Part C DEEMED TO SATISFY
C1 Deemed-to-Satisfy Provisions
C2 Application
C3 Sound Exposure Categories
C4 Airborne Sound Ratings
C5 Acceptable Construction Practice

APPENDIX 1 GUIDE (Informative)
PART A  GENERAL PROVISIONS

A1 SPECIFICATION STRUCTURE

The structure of this Specification is the same as that of the NCC and comprises the following:

(a) The Objectives.
(b) The Functional Statements.
(c) The Performance Requirements with which all Building Solutions must comply.
(d) The Building Solutions.

This Specification is to be applied in accordance with Part A0 of Volume One of the NCC.

A2 INTERPRETATION

Aged care building has the same meaning as defined in the NCC.
Alternative Solution has the same meaning as defined in the NCC.
Building envelope means those parts of a building’s fabric that separate an internal habitable room from the exterior of the building. Reference to building envelope includes parts of a building envelope.
Building Solution has the same meaning as defined in the NCC.
dB(A) means ’A’ weighted overall sound pressure levels expressed in units of decibels.
Cavity has the same meaning as defined in the NCC.
Deemed-to-Satisfy Provisions has the same meaning as defined in the NCC.
Designated sound source means a sound source identified in a council Development Plan.
Designated sound source level means a prescribed sound level for a transport corridor to be used in proposing an Alternative Solution.
Designated sound source spectral adjustment levels means a prescribed sound level adjustment to be made to the designated sound source level for the purpose of calculating the facade noise reduction across the building envelope.
Entertainment venue means a Class 9b assembly building as defined in the NCC that is licensed to provide live entertainment, as defined in the Liquor Licensing Act 1997 (SA) utilising amplified music.
External glass door means an external door with greater than 40% of the door area being glass.
External wall has the same meaning as defined in the NCC.
Facade sound reduction means the reduction in external to internal sound level provided by the building envelope.
Floor area means, in relation to a room, the area of the room measured within the finished surfaces of the walls, and includes the area occupied by any cupboard or other built-in furniture, fixture or fitting.
Functional Statement has the same meaning as defined in the NCC.
Habitable room has the same meaning as defined in the NCC other than an enclosed kitchen.
L_{eq,1hr} means the energy averaged equivalent sound level, averaged over a one hour time period.
Mixed land use area means those areas designated in the Noise and Air Emission Overlays in the relevant Development Plan.
Objective has the same meaning as defined in the NCC.
Performance Requirement has the same meaning as defined in the NCC.
Professional acoustic engineer means a person who is –
(a) a member of the Australian Acoustical Society (AAS) and the Institute of Engineers Australia (IEAust), or
(b) eligible to become a member of the Australian Acoustical Society (AAS) and the Institute of Engineers Australia (IEAust).
R_w (Weighted Sound Reduction Index) means a measure of the sound attenuation performance of a building element, measured in controlled conditions in a laboratory.
R_{w+R_p} means a weighted sound reduction index with spectrum adaptation placing greater emphasis on low frequency performance.
Required means required to satisfy a Performance Requirement or a Deemed-to-Satisfy Provision as appropriate.
Separation distance means the shortest distance (to the nearest metre), from an existing or future designated sound source to the nearest exposed point of the building envelope bounding a habitable room.

Sound exposure category/categories means the degree to which a habitable room within a building is likely to be affected by external sound received by the building envelope.

Sound source means a road, rail line or entertainment venue subject to this Specification.

Train line means rail lines designated as such in a council Development Plan.

Tram line means rail lines designated as such in a council Development Plan.

Transport corridor: means an area of land indicated in council Development Plans for an existing or future train or tram line, or an existing or future Type A, Type B or Type R road.

Type A road means a road designated as such in a council Development Plan.

Type B road means a road designated as such in a council Development Plan.

Type R road means a rural road designated as such in a council Development Plan.

Window has the same meaning as defined in the NCC.

### A3 REFERENCED STANDARDS AND DOCUMENTS

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS/NZS 1276.1 Part 1</td>
<td>1999</td>
<td>Acoustics – Rating of sound insulation in buildings and of building elements Airborne sound insulation</td>
</tr>
<tr>
<td>AS 1668.2 Part 2</td>
<td>1991</td>
<td>The use of mechanical ventilation and air-conditioning in buildings Mechanical ventilation for acceptable indoor air quality</td>
</tr>
<tr>
<td>National Construction Code (NCC)</td>
<td>As in force from time to time</td>
<td>National Construction Code Series - Building Code of Australia (Volumes One and Two)</td>
</tr>
</tbody>
</table>
PART B  PERFORMANCE

B1 OBJECTIVE

To safeguard occupants of a Class 1, 2, 3 and 4 building and 9c aged care building, from loss of amenity as a result of undue intrusion of external sound.

B2 FUNCTIONAL STATEMENT

The building envelope and any ventilation system are to be constructed to prevent undue intrusion of external sound if it separates a habitable room from outside the building.

B3 PERFORMANCE REQUIREMENTS

BP 3.1 The building envelope and ventilation system for a building must provide attenuation sufficient to prevent loss of amenity to the occupants against the intrusion of external airborne sound from the following sound sources:

- road and rail movements
- people in public places
- entertainment venues where music is played

BP 3.2 The level of attenuation provided by the building envelope and ventilation system against the intrusion of external airborne sound from road and rail, must be sufficient to provide internal sound levels not exceeding the internal sound criteria values stated in Table 2.

Table 2 Internal sound criteria for road and rail sound intrusion

<table>
<thead>
<tr>
<th>Type of room</th>
<th>Internal sound criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Building design target averaged over the total number of such rooms in the building</td>
</tr>
<tr>
<td>Bedroom</td>
<td>30 dB(A) $L_{eq}$, 9hr (transport)</td>
</tr>
<tr>
<td></td>
<td>30 dB(A) $L_{eq}$, 15min (people)</td>
</tr>
<tr>
<td>Other habitable room, other than a bedroom</td>
<td>35 dB(A) $L_{Aeq}$, 15hr</td>
</tr>
</tbody>
</table>

BP 3.3 The level of attenuation provided by the building envelope and ventilation system against the intrusion of external airborne sound from music must be sufficient to maintain sound levels not exceeding suitable internal sound criteria obtained from either the council or the South Australian Environment Protection Authority.

B4 APPLICATION

This Specification is applied to all Class 1, 2, 3, 4 or 9c aged care buildings that are in a designated area identified on the Noise and Air Emissions Overlay in the relevant Development Plan, except that the requirements of BP3.3 for music sound from an entertainment venue are only applicable to buildings which are to be located within 65m of an existing entertainment venue.
B5 VERIFICATION METHOD

(a) For Class 1, 2, 3 and 4 buildings and 9c aged care building compliance with Section B3 is verified when it is determined that the internal sound levels in the proposed building resulting from an external designated sound source will be not more than those in Table 2 and BP3.3, as appropriate, when the building is modelled with the proposed building envelope.

(b) The internal sound levels in a proposed building must be calculated using -

(i) For road and rail, the highest applicable designated sound source level provided by arithmetically adding the designated sound source levels in Table 3 and Table 4, to the corresponding designated sound source spectral adjustment levels in Table 5.

(ii) For an entertainment venue, measured music sound levels during a period when the sound at which the entertainment venue is operating is known, then adjusted to the sound level of the sound source such that it equals the maximum allowable level at which the venue can operate.

(iii) A recognised prediction method that as a minimum takes into account the distance from the sound source to the building envelope, as well as any shielding from either adjacent permanent structures or the topography.

(iv) Distance from the designated sound source to the nearest point on the building envelope, or part of the building envelope being considered taking into account any shielding from either adjacent permanent structures or from the topography.

(v) The facade sound reduction of the proposed building envelope on the basis of verifiable test data for individual facade elements.

(vi) Windows and doors being closed.

(vii) Ventilation of habitable rooms with outside air to maintain adequate air quality.

(c) Calculated internal sound levels must be substantiated in an acoustic report that has been prepared by a professional acoustic engineer.

Table 3 Road sound source levels

<table>
<thead>
<tr>
<th>Road Source</th>
<th>Maximum Road Speed limit [km/h]</th>
<th>$L_{eq , 9hr , at , 10m}$ [dB(A)]</th>
<th>$L_{eq , 15hr , at , 10m}$ [dB(A)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>60</td>
<td>71</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>73</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>Type B</td>
<td>60</td>
<td>68</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>70</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>72</td>
<td>77</td>
</tr>
<tr>
<td>Type R</td>
<td>60</td>
<td>65</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>67</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>69</td>
<td>74</td>
</tr>
</tbody>
</table>
Construction requirements for the control of external sound

Table 4 Rail sound source levels

<table>
<thead>
<tr>
<th>Rail Source</th>
<th>$L_{eq,9hr}$ at 10m [dB(A)]</th>
<th>$L_{eq,15hr}$ at 10m [dB(A)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train</td>
<td>62</td>
<td>67</td>
</tr>
<tr>
<td>Tram</td>
<td>58</td>
<td>64</td>
</tr>
</tbody>
</table>

Note: The sound source levels in Tables 3 & 4 have been determined based upon the following assumptions -

(i) Source height of 0.5 metres above the ground plane.
(ii) Receiver height of 1.5 metres above the ground plane.

Table 5 Designated sound source spectral adjustment levels

<table>
<thead>
<tr>
<th>Designated Sound Source</th>
<th>Octave band centre frequency (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63</td>
</tr>
<tr>
<td>Road</td>
<td>-17 dB(A)</td>
</tr>
<tr>
<td>Train</td>
<td>-21 dB(A)</td>
</tr>
<tr>
<td>Tram</td>
<td>-22 dB(A)</td>
</tr>
</tbody>
</table>

Explanatory information:
For example, a Type A road with a posted speed limit of 60km/h would have the following sound spectrum, at 10m.

<table>
<thead>
<tr>
<th>Sound Source</th>
<th>Octave band centre frequency (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63</td>
</tr>
<tr>
<td>Type A, 60 km/h</td>
<td>71</td>
</tr>
<tr>
<td>Road Spectral levels</td>
<td>-17</td>
</tr>
<tr>
<td>Sound Spectrum $dB(A) L_{eq,9hr}$</td>
<td>54</td>
</tr>
</tbody>
</table>
PART C  DEEMED-TO-SATISFY

C1 DEEMED-TO-SATISFY PROVISIONS

(a) Where a Building Solution is proposed to comply with the Deemed-to-Satisfy Provisions, the Performance Requirements of B3 are satisfied by complying with C3 to C5.

(b) Where a Building Solution is proposed as an Alternative Solution to the Deemed-to-Satisfy Provisions compliance with B3 must be determined in accordance with B5.

C2 APPLICATION

The Deemed-to-Satisfy Provisions apply to Class 1, 2, 3, 4 and 9c aged care buildings that are exposed to designated sound sources.

C3 SOUND EXPOSURE CATEGORIES

C3.1 Measurement of separation distance to a sound source

(a) A part of a building envelope is exposed to a designated sound source if any of the straight lines between that part and the designated sound source are not obstructed by another part of the building that has a minimum $R_{W+C_T}$ of 50, or another building.

Explanatory Information:
If there is a direct line-of-sight between the part of the building and the designated sound source then the part is exposed.

(b) For determining the separation distance the location of the designated sound source is to be determined as follows –

(i) For roads and rail lines, the shortest distance between the building envelope and the transport corridor provided the point inside the transport corridor is not less than 3 metres from the boundary of the transport corridor closest to the building.

(ii) For entertainment venues, at the entertainment venue’s allotment boundary.

(iii) For zoned land use areas the sound is non-directional and not specific to a particular location.

C3.2 Sound exposure categories for road and rail sound

(a) The sound exposure category for a building envelope is determined from Tables 6 and 7 for road sound and Table 8 for rail sound, at the separation distance.

(b) The sound exposure category for a building envelope that is exposed to more than one transport corridor that are designated sound sources, must be determined for each transport corridor individually and the highest sound exposure category applied.

C3.3 Shielding

Where part of a building facade in the building envelope is not exposed to a designated sound source in C3.1(a) but is immediately adjoining another part of the building facade that is exposed, then the part that is not exposed must have a sound exposure category one less than the exposed part.

1 Appendix 1. Figure 1, Figure 2, Figure 3, Figure 4, Figure 5
### Table 6 Sound exposure category - Type A and Type B roads

<table>
<thead>
<tr>
<th>Sound exposure category</th>
<th>Separation from Type A Road (metres)</th>
<th>Separation from Type B Road (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum Road Speed limit [km/h]</td>
<td>Maximum Road Speed limit [km/h]</td>
</tr>
<tr>
<td></td>
<td>50–60</td>
<td>70–90</td>
</tr>
<tr>
<td>1</td>
<td>60 &lt; 100m</td>
<td>95 &lt; 150m</td>
</tr>
<tr>
<td>2</td>
<td>35 &lt; 60m</td>
<td>45 &lt; 95 m</td>
</tr>
<tr>
<td>3</td>
<td>15 &lt; 35m</td>
<td>25 &lt; 45m</td>
</tr>
<tr>
<td>4</td>
<td>less than 15m</td>
<td>10 &lt; 25m</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>less than 10m</td>
</tr>
</tbody>
</table>

### Table 7 Sound exposure category - Type R roads

<table>
<thead>
<tr>
<th>Sound exposure category</th>
<th>Separation from Type R Road (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum Road Speed limit [km/h]</td>
</tr>
<tr>
<td></td>
<td>50–60</td>
</tr>
<tr>
<td>1</td>
<td>25 &lt; 35m</td>
</tr>
<tr>
<td>2</td>
<td>10 &lt; 25m</td>
</tr>
<tr>
<td>3</td>
<td>less than 10m</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: For the purposes of Tables 6 and 7 the speed limit applicable to a building is the road speed limit at the point on the transport corridor at which the separation distance is assessed.

### Table 8 Sound exposure category - Rail

<table>
<thead>
<tr>
<th>Sound exposure category</th>
<th>Separation from Tram line (metres)</th>
<th>Separation from Train line (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 &lt; 20m</td>
<td>25 &lt; 50 m</td>
</tr>
<tr>
<td>2</td>
<td>less than 10m*</td>
<td>10 &lt; 25 m</td>
</tr>
<tr>
<td>3</td>
<td>N/A</td>
<td>less than 10 m*</td>
</tr>
<tr>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A – Not applicable
Construction requirements for the control of external sound

*Note: This Specification does not consider ground-borne vibration from road or rail sound sources. Buildings closer than 10m to a road or 20m to a rail line may be exposed to perceptible ground vibration. Advice should be sought from a professional acoustic engineer for such buildings.

C3.4 Sound exposure category for mixed land use areas
All buildings in a mixed land use area must have a minimum sound exposure category of 1 at the building facade in the building envelope.

C3.5 Sound exposure categories for music sound
Buildings in a mixed land use area that are exposed to music sound from an entertainment venue have a sound exposure category of 5 at the building envelope.

C3.6 Multiple sound exposure categories
For a building envelope or part of a building envelope having multiple sound exposure categories the required category is the most stringent resulting from the application of Table 6, Table 7, Table 8 and C3.5.

C3.7 Non-habitable rooms adjoining habitable rooms
Non-habitable rooms that adjoin a habitable room and are bounded by a part of the building facade that is exposed to a designated sound source must either be:

(a) completely separated from the habitable room with walls and doors having an Rw of at least 45, or
(b) must be included in the habitable room and the most stringent category resulting from the application of Table 6, Table 7 and Table 8 must be used.

Explanatory Information
Non-habitable rooms include walk-in wardrobes, en-suites and enclosed kitchens. Where these spaces are part of an open plan arrangement with adjoining habitable rooms, such as a living/dining area or bedroom, they need to be treated as part of the habitable room.

C4 AIRBORNE SOUND INSULATION RATINGS

C4.1 Determination of airborne sound insulation ratings
The building envelope and ventilation system to habitable rooms in a building must be constructed to comply with the minimum Rw and Rw+Ctr in Table 9 and Table 10 for the sound exposure category determined by C3.

Table 9 Minimum airborne sound attenuation ratings (Rw and Rw+Ctr) for habitable rooms

<table>
<thead>
<tr>
<th>Sound exposure category</th>
<th>Acoustic requirements</th>
</tr>
</thead>
</table>
| 1                       | External walls
                         | Rw+Ctr 45 for all habitable rooms |
|                         | Windows and external glass doors
                         | See Table 10 |
|                         | Ventilation system – openable windows
                         | See Table 10 and C5.6.1 |
|                         | Note: A ventilation system provided in addition to openable windows must have a minimum Rw 40. |
### Construction requirements for the control of external sound

<table>
<thead>
<tr>
<th>Sound exposure category</th>
<th>Acoustic requirements</th>
</tr>
</thead>
</table>
| 2                       | Ground Floor  
$R_W + C_T > 40$ for all habitable rooms  
**External walls**  
$R_W + C_T > 50$ for all habitable rooms  
**Windows and external glass doors**  
See Table 10  
**External doors other than external glass doors**  
$R_W > 27$ for all habitable rooms  
**Roof and Ceiling**  
$R_W + C_T > 35$ for bedrooms  
**Ventilation system - openable windows**  
See Table 10 and C5.6.1  
*Note: A ventilation system provided in addition to openable windows must have a minimum $R_w$ 40.* |
| 3                       | Ground Floor  
$R_W + C_T > 40$ for all habitable rooms  
**External walls**  
$R_W + C_T > 50$ for all habitable rooms  
**Windows and external glass doors**  
See Table 10  
**External doors other than external glass doors**  
$R_W > 30$ for all habitable rooms  
**Roof and Ceiling**  
$R_W + C_T > 40$ for bedrooms;  
$R_W + C_T > 35$ for all other habitable rooms  
**Ventilation system – openable windows**  
See Table 10 and C5.6.1  
*Note: A ventilation system provided in addition to openable windows must have a minimum $R_w$ 40.* |
| 4                       | Ground Floor  
$R_W + C_T > 40$ for all habitable rooms  
**External walls**  
$R_W + C_T > 50$ for all habitable rooms  
**Windows and external glass doors**  
*External glass doors are not permitted in bedrooms*  
See Table 10  
**External doors other than external glass doors**  
$R_W > 30$ for all other habitable rooms  
**Roof and Ceiling**  
$R_W + C_T > 45$ for bedrooms;  
$R_W + C_T > 40$ for all other habitable rooms  
**Ventilation system – a mechanical or non-powered system with an $R_w$ 40 must comply with C5.6.2.*  
*Note: Openable windows provided in addition to the ventilation system must comply with Table 10.* |
| 5                       | Outside the scope of the Deemed-to-Satisfy Provisions. Buildings are **required** to be assessed against the Performance Requirements in B3 in accordance with B5. |
### Construction requirements for the control of external sound

#### Table 10 Minimum airborne ($R_{W} + C_{tr}$) for closed windows and external glass doors to habitable rooms

<table>
<thead>
<tr>
<th>Room</th>
<th>Area of window and external glass doors as a percentage of the floor area of the room</th>
<th>Designated sound exposure category</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Bedroom</td>
<td>Not more than 20%</td>
<td>25  28  31  34  Note 1.</td>
</tr>
<tr>
<td>(b) A non-habitable room attached to (a)</td>
<td>More than 20% but not more than 40%</td>
<td>28  31  34  Note 1. Note 1.</td>
</tr>
<tr>
<td></td>
<td>More than 40% but not more than 60%</td>
<td>31  34  Note 1. Note 1. Note 1.</td>
</tr>
<tr>
<td></td>
<td>More than 60% but not more than 80%</td>
<td>34  Note 1. Note 1. Note 1. Note 1.</td>
</tr>
<tr>
<td></td>
<td>More than 80%</td>
<td>37  Note 1. Note 1. Note 1. Note 1.</td>
</tr>
<tr>
<td>(c) Habitable room, other than a bedroom and an enclosed kitchen</td>
<td>Not more than 20%</td>
<td>22  25  28  31  34</td>
</tr>
<tr>
<td>(d) A non-habitable room attached to (c)</td>
<td>More than 20% but not more than 40%</td>
<td>25  28  31  34  Note 1.</td>
</tr>
<tr>
<td></td>
<td>More than 40% but not more than 60%</td>
<td>28  31  34  Note 1. Note 1.</td>
</tr>
<tr>
<td></td>
<td>More than 60% but not more than 80%</td>
<td>31  34  Note 1. Note 1. Note 1.</td>
</tr>
<tr>
<td></td>
<td>More than 80%</td>
<td>34  Note 1. Note 1. Note 1. Note 1.</td>
</tr>
</tbody>
</table>

Note 1: Windows and external glass doors are outside the scope of the Deemed-to-Satisfy Provisions and must comply with B5.

### C5 ACCEPTABLE CONSTRUCTION PRACTICE

A building required to comply with this Specification must –

(a) have the required value from Table 9 and Table 10 for $R_{W}$ or $R_{W} + C_{tr}$ determined in accordance with AS/NZS 1276.1 or ISO 717.1 using results from laboratory measurements; or

(b) comply with C5.1 to C5.7

#### C5.1 General

Where sheeting materials, such as plasterboard or the like, are used to comply with this Specification, they must –

(a) be installed so that if two layers are required, the second layer must be fastened over the first layer so that the joints do not coincide with those of the first layer; and

(b) have all joints between sheets or between sheets and any adjoining construction, taped and filled solid.
C5.2 Flooring systems

To achieve the required $R_W + C_{tr}$ of 50, a flooring system must –

(a) be in direct contact with the ground, such as a concrete slab-on-ground or the like.

(b) for a suspended floor, other than an intermediate floor in a building with more than one storey, and floors with an enclosed perimeter, comply with one of the following:

(i) minimum 150mm thick concrete slab; or

(ii) lightweight floor consisting of–

   (A) 2 layers of minimum 25mm thick structural grade particleboard flooring (or other solid flooring with surface mass not less than 35 kg/m$^2$) installed on minimum 150mm high floor joists; and

   (B) 1 layer of minimum 6mm thick fibre cement sheeting resiliently mounted to the underside of the floor joists with rubber isolation clips; and

   (C) minimum 50mm thick glass wool or rock wool insulation with a minimum density of 11kg/m$^3$ or minimum 50mm thick polyester insulation with a minimum density of 20kg/m$^3$ in the cavity; or

(iii) lightweight floor consisting of–

   (A) 1 layer of minimum 25mm thick structural grade particleboard flooring (or other solid flooring with surface mass not less than 17.5 kg/m$^2$) installed on minimum 150mm high floor joists; and

   (B) 2 layers of minimum 6mm thick fibre cement sheeting resiliently mounted to the underside of the floor joists with rubber isolation clips; and

   (C) minimum 50mm thick glass wool or rock wool insulation with a minimum density of 11kg/m$^3$ or minimum 50mm thick polyester insulation with a minimum density of 20kg/m$^3$ in the cavity.

Explanatory Information

1. An enclosed perimeter means that the area beneath the floor is enclosed by a ground-to-floor wall that meets the $R_W + C_{tr}$ of 50 as described in C5.3. Air movement between the area beneath the floor and any wall cavities should also be prevented by flashing or the like.

2. The ground-to-floor wall can have the sub-floor vents required by the NCC and still be considered to be enclosed.

C5.3 External walls

(a) To achieve the required $R_W + C_{tr}$ rating of 50 an external wall must comply with -

(i) The construction techniques that are suitable for use in external applications specified in Table 2 of Specification F5.2 of the NCC; or

(ii) One or a combination of the following;

   (A) two leaves of 110mm clay brick masonry with –

      aa) a 50mm cavity between leaves; and

      bb) 50mm thick glass wool insulation with a density of 11kg/m$^3$ or 50mm thick polyester insulation with a density of 20 kg/m$^3$ in the cavity.

   (B) two leaves of 110mm clay brick masonry with –

      aa) a 50mm cavity between leaves; and

      bb) 50mm thick glass wool insulation with a density of 11kg/m$^3$ or 50mm thick polyester insulation with a density of 20 kg/m$^3$ in the cavity; and

      cc) one layer of 13mm plasterboard battened 50mm from the inside face.
Construction requirements for the control of external sound

(C) single leaf of 90mm clay brick masonry with –
   aa) a row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; and
   bb) a cavity of 25mm between leaves; and
   cc) 75mm thick glass or mineral wool insulation with a density of 11kg/m³ or 75mm thick polyester insulation with a density of 14kg/m³, positioned between studs; and
   dd) one layer of 10mm plasterboard fixed to the inside face.

(D) single leaf of 220mm clay brick masonry with –
   aa) 13mm render on the outside face; and
   bb) one layer of 13mm plasterboard fixed to the inside face.

(b) To achieve the required $R_W + C_T$ rating of 45, an external wall must comply with one or a combination of the following;

(i) one row of 90mm studs at 600mm centres with -
   aa) resilient steel channels fixed to the outside of the studs; and
   bb) 9.5mm hardboard or 9mm fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside of the channels; and
   cc) 75mm thick glass or mineral wool insulation with a density of 11kg/m³ or 75mm thick polyester insulation with a density of 14 kg/m³, positioned between the studs; and
   dd) two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs.

(ii) one row of 90mm studs at 600mm centres with -
   aa) resilient steel channels fixed to the outside of the studs; and
   bb) one layer of 19mm board cladding fixed to the outside of the channels and 6mm fibre cement sheets fixed to the inside of the channels; and
   cc) 75mm thick glass or mineral wool insulation with a density of 11kg/m³ or 75mm thick polyester insulation with a density of 14 kg/m³, positioned between the studs; and
   dd) two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs.

C5.4 Windows and external doors

(a) To achieve the required $R_W + C_T$ rating, windows and external glass doors must;

   (i) comply with Table 11; and
      (A) have a seal to restrict air infiltration fitted to each edge of an opening window
      (B) glass in external doors must be set and sealed in an airtight non-hardening sealant, or a soft elastomer gasket or glazing tape; or
   (ii) be verified by the manufacturer to comply with the relevant $R_W + C_T$ rating determined from Table 10.

(b) To achieve the required $R_W$ rating, external doors, other than external glass doors, must comply with Table 12, and be sealed in accordance with the following;

   (i) external side hinged doors must have compressible seals positioned around the door perimeter and a drop seal for the door bottom (no brush type seals allowed) to provide an airtight system when closed; and
   (ii) external sliding doors must incorporate a seal to restrict air infiltration, fitted to each edge of the sliding door; and
   (iii) glass in external doors must be set and sealed in an airtight non-hardening sealant, or a soft elastomer gasket or glazing tape; and
A seal required by (a) and (b) may be a foam or rubber compressible strip, fibrous seal with vinyl fin interleaf or the like (brush type seals are not allowed).

**(Table 11) Acceptable forms of construction for windows and external glass doors**

<table>
<thead>
<tr>
<th>Description</th>
<th>$R_{W,Cr}$ (not less than)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Window construction type: Single glass pane</strong></td>
<td></td>
</tr>
<tr>
<td>Aluminium or timber frame, employing fixed or operable sash, with either:</td>
<td></td>
</tr>
<tr>
<td>(a) 3mm thick monolithic or laminated glass with sliding or double hung type opening</td>
<td>22</td>
</tr>
<tr>
<td>(b) 3mm thick monolithic or laminated glass with awning type opening</td>
<td>25</td>
</tr>
<tr>
<td>(c) 6mm thick monolithic or laminated glass with sliding or double hung type opening</td>
<td>28</td>
</tr>
<tr>
<td>(d) 6mm thick monolithic or laminated glass with awning type opening</td>
<td>31</td>
</tr>
<tr>
<td>(e) 10mm thick monolithic or laminated glass with awning type opening</td>
<td>34</td>
</tr>
<tr>
<td><strong>External glass door construction type: Single glass pane</strong></td>
<td></td>
</tr>
<tr>
<td>Aluminium or timber frame, employing fixed or operable sash, with either:</td>
<td></td>
</tr>
<tr>
<td>(a) 5mm or 6mm thick monolithic or laminated glass sliding door</td>
<td>28</td>
</tr>
<tr>
<td>(b) 5mm or 6mm thick monolithic or laminated glass side-hung door</td>
<td>31</td>
</tr>
<tr>
<td>(c) 10mm thick monolithic or laminated glass sliding door</td>
<td>31</td>
</tr>
<tr>
<td>(d) 10mm thick monolithic or laminated glass side-hung door</td>
<td>34</td>
</tr>
</tbody>
</table>

**(Table 12) Acceptable forms of construction for external doors**

<table>
<thead>
<tr>
<th>Description</th>
<th>$R_{W,Cr}$ (not less than)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Door construction type: Timber solid core</strong></td>
<td></td>
</tr>
<tr>
<td>40mm thick solid core door, side hinged</td>
<td>30</td>
</tr>
<tr>
<td><strong>Door construction type: Timber solid core with glass inserts</strong></td>
<td></td>
</tr>
<tr>
<td>40mm thick solid core door, side hinged, with:</td>
<td></td>
</tr>
<tr>
<td>(a) Not less than 6mm glass inserts (monolithic or laminated glass acceptable)</td>
<td>30</td>
</tr>
<tr>
<td><strong>Door construction type: Glass sliding door</strong></td>
<td></td>
</tr>
<tr>
<td>Aluminium frame, sliding door, with:</td>
<td></td>
</tr>
<tr>
<td>(a) 6mm thick monolithic or laminated glass</td>
<td>27</td>
</tr>
<tr>
<td>(b) 10mm thick monolithic or laminated glass</td>
<td>30</td>
</tr>
</tbody>
</table>
C5.5 Roof and ceiling systems

To achieve the required $R_W + C_T$ rating, the roof and ceiling system must comply with the following:

(a) The roofing material must be roof tiles or metal sheet roofing that complies with the NCC.

(b) The ceiling must have plasterboard that complies with Table 13 fixed to the underside of the joists or trusses, and a minimum:
   (i) 165mm thick glass wool or rock wool insulation with a minimum density of 7 kg/m$^3$ or 
   (ii) 185mm thick polyester insulation with a minimum density of 11kg/m$^3$ installed above the plasterboard.

<table>
<thead>
<tr>
<th>Description</th>
<th>$R_W + C_T$ (not less than)</th>
</tr>
</thead>
<tbody>
<tr>
<td>one layer of 10mm plasterboard</td>
<td>35</td>
</tr>
<tr>
<td>two layers of 10mm plasterboard</td>
<td>40</td>
</tr>
<tr>
<td>one layer of 16mm fire rated plasterboard</td>
<td>45</td>
</tr>
<tr>
<td>two layers of 13mm fire rated plasterboard fixed to furring channels to the underside of the joists or trusses</td>
<td>45</td>
</tr>
</tbody>
</table>

Explanatory Information

Cathedral ceilings will not be suitable for roof and ceiling systems where the required $R_W + C_T$ rating is more than 40 (bedrooms in sound exposure category 4) unless the ceiling is supported on separate furring channels.

C5.6 Ventilation systems

C5.6.1 Natural ventilation

In sound exposure categories 1, 2 and 3, natural ventilation must be provided in accordance with F4.6 and F4.7 of Volume One and 3.8.5.2 of Volume Two of the NCC.

C5.6.2 Mechanical ventilation

In sound exposure category 4, a mechanical ventilation system that complies with AS 1668.2 - The use of mechanical ventilation and air-conditioning in buildings must be provided; and

(a) Relief air paths (or evaporative air conditioning) must be fully ducted to allow for the operation of the system with windows and external doors closed; and

(b) The fresh air (or make up air) inlets and exhaust air outlets must be at a point on the building furthest from the designated sound source where practicable.

C5.7 Penetrations

(a) Where a part of the building envelope has a sound exposure category, any plant or service, such as an air-conditioning unit, ventilation device or ductwork that pass through that part, or any permanent opening in that part, must not diminish the $R_W + C_T$ of the part.

(b) Penetrations of the building envelope by pipes, ducts, or conduits or the like must have the space between the building envelope and the pipes, ducts, or conduits or the like caulked or filled with mortar.
1. MEASUREMENT OF SEPARATION DISTANCE

The separation distance between the building envelope and the sound source is measured as the shortest straight line (i.e. 'line-of-sight').

Determination of separation distance for roads and rail lines

The separation distance for a road or rail line is the shortest straight line between the building envelope and the transport corridor provided the point inside the transport corridor is not less than 3 metres from the boundary of the transport corridor closest to the building.

Figure 1: Road or rail line separation distance definition

Figure 2: Road or rail line separation distance definition
Figure 3: Road or rail line separation distance definition
No exposure of facades 1 and 2 at 3m

Residential 2

Residential 1

Facade exposed

Facade exposed

Separation distance 2

Separation distance 1

ROAD

Ground Level

3m

Transport Corridor

Figure 4: Road or rail line separation distance definition
Determination of *separation distance to an entertainment venue*

The *separation distance* for an *entertainment venue* is taken from the allotment boundary of the *entertainment venue*.

![Illustration](image)

**Figure 5: Entertainment venue separation distance definition**

### 2. SOUND EXPOSURE CATEGORIES

The *sound exposure categories* are based on 4 dB increments increasing from a base reduction of 20 dB(A) for standard construction.

<table>
<thead>
<tr>
<th>Sound exposure category</th>
<th>Sound attenuation dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
</tr>
</tbody>
</table>

Knowing the external sound level at the facade and the desired internal sound level then determines the reduction *required* as expressed in the *sound exposure category*. 
3. WINDOWS AND DOORS

The weak point in any facade will be the doors and windows.
- Ability of the glazing to provide the necessary sound attenuation
- The quality of the sealing around the whole of the frame and round any openable sections.

As amount of window area increases, the benefits of the rest of the facade (for providing sound insulation) are progressively compromised to the point where the window is the whole of the facade.

4. SOUND EXPOSURE CATEGORIES FOR FACADES

Where the designated sound source is a transport corridor the most exposed facades are those that have line of sight to the transport corridor.

Facades that are not exposed to the designated sound source (generally the facade opposite the most affected facade) are to have a sound exposure category one less than an adjoining facade that is exposed.

Figure 6: Examples of sound exposure categories for facades
Figure 7: Exposed facades and facade categories example