

Ministerial Building Standard MBS 010

Construction requirements for the control of external sound

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1.0 SCOPE AND APPLICATION

- 1.1 This Standard is published as a Ministerial Building Standard under the *Planning, Development and Infrastructure Act 2016* (the Act) and must be read in conjunction with the requirements of the Act and the Planning, Development and Infrastructure (General) Regulations 2017 (the Regulations).
- 1.2 This Standard contains provisions for reducing the intrusion of unacceptable levels of sound into *habitable rooms* of residential buildings.
- 1.3 The provisions in this Standard apply to a Class 1, 2 or 3 building, a Class 4 part of a building and a Class 9c *residential care building* located within-
- (i) a *noise attenuation area*; or
 - (ii) an *Australian Noise Exposure Forecast (ANEF) contour band* of 20 or more.
- 1.4 The requirements of this Standard are additional to those *required* by the *Building Code* and do not override any of the *Building Code* provisions.

2.0 PERFORMANCE REQUIREMENTS

- 2.1 To prevent loss of amenity for the occupants of a Class 1, 2, 3 building, a Class 4 part of a building or a Class 9c *residential care building* located within a *noise attenuation area*, the *building envelope* and any mechanical ventilation system must provide attenuation to reduce the intrusion of external airborne sound from a *designated sound source* into *habitable rooms* to an *acceptable indoor sound level*.
- 2.2 To prevent loss of amenity for the occupants of a Class 1, 2, 3 building, a Class 4 part of a building or a Class 9c *residential care building* located within an *ANEF contour band area* of 20 or more, the *building envelope* and any mechanical ventilation system must provide attenuation to reduce the intrusion of external airborne sound from aircraft into *habitable rooms* to an *acceptable indoor sound level*.

3.0 VERIFICATION METHOD

3.1 Sound transmission through the *building envelope*

- 3.1.1 Compliance with *performance requirement 2.1* to avoid the transmission of airborne sound through the *building envelope* is verified when the level of attenuation provided by the *building envelope* and its ventilation system is sufficient to provide internal sound levels not exceeding the internal sound criteria values stated in **Table 3.1**.

Table 3.1 - Internal sound criteria for sound intrusion from road, rail and mixed land uses

Type of room	Sound source	Internal sound criteria	
		Building design target averaged over the total number of rooms in the building	Maximum allowable for individual rooms in the building
Bedrooms	Road and rail	30 <i>dB(A)</i> $L_{eq, night}$	35 <i>dB(A)</i> $L_{eq, night}$
Other <i>habitable rooms</i>	Road and rail	35 <i>dB(A)</i> $L_{eq, night}$	40 <i>dB(A)</i> $L_{eq, night}$

3.1.2 Compliance with *performance requirements 2.2* to avoid the transmission of airborne sound through the *building envelope* is verified when the level of attenuation provided by the *building envelope* and its ventilation system is sufficient to provide internal sound levels not exceeding the internal sound criteria values stated in **Table 3.2**.

Table 3.2 - Internal sound criteria for sound intrusion from aircraft

Type of room	Sound source	Internal sound criteria	
		Building design target averaged over the total number of rooms in the building	Maximum allowable for individual rooms in the building
Bedrooms	Aircraft	<i>Not applicable</i>	50 dB(A) L_{max}
Other <i>habitable rooms</i>	Aircraft	<i>Not applicable</i>	55 dB(A) L_{max}

4.0 SOUND TRANSMISSION AND INSULATION

4.1 Deemed-to-Satisfy Provisions

4.1.1 Where a *Deemed-to-Satisfy Solution* is proposed, *performance requirement 2.1* will be satisfied if building elements comply with the sound insulation requirements of this section and the relevant acceptable construction practices in section **5.0**, which are deemed to achieve the airborne sound insulation requirements in **Table 4.5**.

4.1.2 Where a *Deemed-to-Satisfy Solution* is proposed, *performance requirement 2.2* will be satisfied if building elements comply with the sound insulation requirements of this section and the relevant acceptable construction practices in section **5.0**, which are deemed to achieve the airborne sound insulation requirements in **Table 4.5**.

4.2 Application

4.2.1 The *Deemed-to-Satisfy Provisions* of this section and section **5.0** apply to a Class 1, 2 or 3 building, a Class 4 part of a building, and a Class 9c *residential care building* located within either-

- (a) a *noise attenuation area* and the building is exposed to a *designated sound source*; or
- (b) an *ANEF contour band area* of more than 20 and the building requires an aircraft noise reduction (ANR) of more than 20 dB(A) but not more than 36 dB(A).

4.2.2 For the purpose of 4.2.1(a), a part of a *building envelope* or a mechanical ventilation system is exposed to a *designated sound source* if-

- (a) it is located within a prescribed *separation distance* from a *Type A, Type B or Type R road*, as set out in **Tables 4.1, 4.2 or 4.3**; and a straight line can be drawn between a part of the *building envelope* and the *designated sound source* that is not obstructed by-
 - (i) another part of the building having a minimum (R_w+C_{tr}) of **40**;
 - (ii) another building; or
 - (iii) a noise barrier; or
- (b) it is located within an area zoned as a *mixed land use area*.

4.2.3 For a building with an ANR greater than 36 dB(A), an individual Performance Solution must be developed.

4.3 Sound exposure categories

- 4.3.1 **Road and rail** - The *sound exposure category* of a *building envelope* within a *noise attenuation area* exposed to a *Type A, Type B or Type R road* or a rail line is determined according to the *separation distance* between the building and the sound source as set out in Tables 4.1 and 4.2 for roads and Table 4.3 for rail. The *separation distance* for *Type A, B and R roads* is measured from a point 3m inside the road corridor, whereas for *tram and train lines* it is measured from the closest rail line.
- 4.3.2 **Aircraft** – The *sound exposure category* of a *building envelope* exposed to external airborne sound from aircraft is determined by-
- identifying if the site is within a projected *Australian Noise Exposure Forecast* contour band of 20 or more; and
 - locating the relevant *Aircraft Noise Reduction (ANR)* in decibels that applies to the building; and
 - determining the relevant *sound exposure category* that applies to the identified *ANR* as set out in Table 4.4.
- 4.3.3 **Mixed land use areas** – Where a building is exposed to differing levels of external airborne sound arising from a variety of activities permitted in *mixed land use areas*, and the building is not exposed to external airborne sound from *Type A, B or R roads, rail* or aircraft, the *sound exposure category* for the *building envelope* is to be taken as *sound exposure category 1*.
- 4.3.4 **Multiple sound exposure categories** - For a *building envelope* or part of a *building envelope* having multiple *sound exposure categories*, the *required category* to be applied is the most stringent one resulting from the application of Tables 4.1, 4.2, and 4.3 or Table 4.4 as relevant to the sound source.
- 4.3.5 **Shielding** – Where a part of a building facade is not exposed to a *designated sound source* but adjoins another part that is exposed, the *required sound exposure category* to be applied to the part that is not exposed may be one category less than that *required* for the exposed part.
- 4.3.6 **Non-habitable rooms adjoining habitable rooms** - non-habitable rooms adjoining *habitable rooms*, which are bounded by a part of the building facade exposed to a *designated sound source* must either-
- be completely separated from the *habitable room* with walls and doors having an R_w of not less than 40, and any doors therein having an R_w of not less than 30; or
 - be included in the *habitable room* and the most stringent *sound exposure category* resulting from the application of Tables 4.1, 4.2, 4.3, or Table 4.4 must be used.

Table 4.1 – Sound exposure category for designated sound sources - Type A and Type B roads

Separation distance* between a building and a Type A Road (metres)			Separation distance* between a building and a Type B Road (metres)			Sound exposure category
Maximum Road Speed limit [km/h]			Maximum Road Speed limit [km/h]			
50–60	70–90	100–110	50–60	70–90	100–110	
60 < 100m	95 < 150m	130 < 200m	35 < 60m	55 < 95m	75 < 130m	1
35 < 60m	45 < 95m	60 < 130m	20 < 35m	30 < 55m	35 < 75m	2
15 < 35m	25 < 45m	35 < 60m	10 < 20m	15 < 30m	20 < 35m	3
less than 15m	10 < 25m	15 < 35m	less than 10m	less than 15m	10 < 20m	4
N/A	less than 10m	less than 15m	N/A	N/A	less than 10m	5

Table 4.2 – Sound exposure category for designated sound source – Type R roads

Separation distance* between a building and a Type R Road (metres)			Sound exposure category
Maximum Road Speed limit [km/h]			
50–60	70–90	100–110	
25 < 35m	35 < 55m	40 < 75m	1
10 < 25m	15 < 35m	20 < 40m	2
less than 10m	less than 15m	10 < 20m	3
N/A	N/A	less than 10m	4
N/A	N/A	N/A	5

Table 4.3 – Sound exposure category for a designated sound source – rail

Separation distance* between a building and a tram line	Separation distance* between a building and a train line	Sound exposure category
10 < 20m	25 < 50 m	1
less than 10m (see Note 2)	10 < 25 m	2
Not applicable	less than 10 m (see Note 2)	3
Not applicable	Not applicable	4
Not applicable	Not applicable	5

Table 4.4- Sound exposure category for aircraft noise reduction

Applicable Aircraft Noise Reduction [dB(A)]	Sound exposure category
20 < 24	1
24 < 28	2
28 < 32	3
32 < 36	4
> 36	5

Note 1 – For the purposes of **Tables 4.1** and **4.2**, the speed limit applicable to the building is the speed limit at the point on the *transport corridor* at which the *separation distance* is measured and assessed.

Note 2 - This Standard 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 on ways to reduce the effects of unacceptable ground vibration should be sought from a professional acoustic engineer.

Note 3 – This Standard is not intended to mitigate the cumulative effects of external airborne sound from multiple sources

4.4 Determination of airborne sound insulation ratings

A form of construction *required* to have an airborne sound insulation rating must-

- (a) have not less than the *required* values for weighted sound reduction index (R_w) or weighted sound reduction index with spectrum adaptation term ($R_w + C_{tr}$) for building elements set out in Tables 4.5 and 4.6 for the relevant *sound exposure category*, determined in accordance with AS/NZS ISO 717.1 using results from laboratory measurements; or
- (b) building elements must achieve the *required* value for weighted sound reduction index (R_w) or weighted sound reduction index with spectrum adaptation term ($R_w + C_{tr}$) set out in Tables 4.5 and 4.6 for the relevant *sound exposure category* using the acceptable construction practices set out in section 5.0.

4.5 Sound insulation requirements

Tables 4.5 and 4.6 set out the *required* value for weighted sound reduction index (R_w) or weighted sound reduction index with spectrum adaptation term ($R_w + C_{tr}$) for sound insulation of building elements that are deemed to provide the *required* attenuation to meet the internal sound criteria levels *required* by Table 3.1.

Table 4.5 – Acoustic requirements for building elements

Sound exposure category	Sound insulation requirements	
1	<i>External walls</i>	$R_w + C_{tr}$ 40 for all <i>habitable rooms</i>
	<i>Windows and external glass doors</i>	See Table 4.6
	Mechanical ventilation systems	R_w 25
2	Ground Floor	$R_w + C_{tr}$ 45 for all <i>habitable rooms</i>
	<i>External walls</i>	$R_w + C_{tr}$ 45 for all <i>habitable rooms</i>
	<i>Windows and external glass doors</i>	See Table 4.6
	<i>External doors other than external glass doors</i>	R_w 27 for all <i>habitable rooms</i>
	Roof and ceilings of bedrooms	$R_w + C_{tr}$ 35
	Mechanical ventilation systems	R_w 25
3	Ground Floor	$R_w + C_{tr}$ 50 for all <i>habitable rooms</i>
	<i>External walls</i>	$R_w + C_{tr}$ 50 for all <i>habitable rooms</i>
	<i>Windows and external glass doors</i>	See Table 4.6
	<i>External doors, other than external glass doors, to all habitable rooms</i>	R_w 30
	Roof and Ceilings	$R_w + C_{tr}$ 40 for bedrooms $R_w + C_{tr}$ 35 all other <i>habitable rooms</i>
	Mechanical ventilation systems	R_w 30

Sound exposure category	Sound insulation requirements	
4	Ground Floor	$R_W + C_{tr}$ 50 for all <i>habitable rooms</i>
	External walls	$R_W + C_{tr}$ 50 for all <i>habitable rooms</i>
	Windows and external glass doors	External glass doors are not permitted in bedrooms. For elsewhere see Table 4.6
	External doors other than external glass doors	R_W 30 to all <i>habitable rooms</i> other than bedrooms
	Roof and Ceilings	$R_W + C_{tr}$ 45 for bedrooms $R_W + C_{tr}$ 40 for all other <i>habitable rooms</i>
	Mechanical ventilation systems	R_W 35 and complying with Section 5.7
5	Outside the scope of the <i>Deemed-to-Satisfy Provisions</i> .	Assess against the relevant <i>Performance Requirements</i> in Section 2.0

Table 4.6- Minimum sound insulation requirements for closed windows and external glass doors to *habitable rooms* - values airborne ($R_W + C_{tr}$)

Room	Area of window and external glass doors as a percentage of the floor area of the room	Designated sound exposure category				
		1	2	3	4	5
(a) Bedroom (b) A non- <i>habitable room</i> attached to (a)	Not more than 20%	25	28	30	32	PS
	More than 20% but not more than 40%	28	30	32	34	PS
	More than 40% but not more than 60%	30	32	34	35	PS
	More than 60% but not more than 80%	32	34	35	PS	PS
	More than 80%	34	35	PS	PS	PS
(c) <i>Habitable room</i> , other than a bedroom and an enclosed kitchen (d) A non- <i>habitable room</i> attached to (c)	Not more than 20%	22	25	28	30	PS
	More than 20% but not more than 40%	25	28	30	32	PS
	More than 40% but not more than 60%	28	30	32	34	PS
	More than 60% but not more than 80%	30	32	34	35	PS
	More than 80%	32	34	35	PS	PS

PS - Windows and external glass doors are outside the scope of the *Deemed-to-Satisfy Provisions* and will need to be considered as part of a *Performance Solution*.

5.0 ACCEPTABLE CONSTRUCTION PRACTICE

5.1 Application

The acceptable construction practices in this section are deemed to achieve the levels of sound insulation *required* by Tables 4.5 and 4.6.

5.2 General

Forms of construction in Section 5.3 and 5.4 that are used to achieve the *required* $R_w + C_{tr}$ ratings must be installed in accordance with the requirements for sound insulation in section 2 of Specification F5.2 of Volume One of the *Building Code* or clauses 3.8.6.4 and 3.8.6.5 of Volume Two of the *Building Code* as applicable to the relevant building classification.

5.3 Construction of floors

The following forms of construction are deemed to achieve the *required* $R_w + C_{tr}$ ratings for floors-

- (a) a floor in direct contact with the ground, such as a concrete slab-on-ground or the like; or
- (b) a suspended floor, other than an intermediate floor in a building with more than one storey and floors with an enclosed perimeter, that is-
 - (i) a minimum 150mm thick concrete slab; or
 - (ii) a 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/m²) 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/m³ or minimum 50mm thick polyester insulation with a minimum density of 20kg/m³ in the cavity; or
 - (iii) a 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/m²) 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/m³ or minimum 50mm thick polyester insulation with a minimum density of 20kg/m³ in the cavity.

Explanatory Information

1. An enclosed perimeter means that the area beneath the floor is enclosed by a ground-to-floor wall complying with 5.4. Air movement between the area beneath the floor and any wall cavities should also be stopped by the use of flashings or the like.
2. The ground-to-floor wall section can incorporate *required* sub-floor vents and still be considered to be enclosed.

5.4 Construction of external walls

The following forms of construction for walls, installed in accordance with the relevant general installation requirements for walls in clauses 3.8.6.4 and 3.8.6.5 of Volume Two of the *Building Code*, or the installation methods in section 2 of Specification F5.2 in Volume One of the *Building Code*, are deemed to achieve the following $R_W + C_{tr}$ ratings for walls as *required* by Table 4.4-

- (a) $R_W + C_{tr}$ of 50 – An external wall must comply with--
- (i) a construction technique set out in the *Building Code* that is suitable for use in external applications and achieves an $R_W + C_{tr}$ of 50; or
 - (ii) one or a combination of the following-
 - (A) two leaves of 110 clay masonry with-
 - (aa) a 50mm cavity between the masonry leaves; and
 - (bb) 50mm thick glass wool insulation with a density of 11kg/m³ or 50mm thick polyester insulation with a density of 20 kg/m³ in the cavity; or
 - (B) two leaves of 110 clay masonry with-
 - (aa) a 50mm cavity between the masonry leaves; and
 - (bb) 50mm thick glass or mineral wool insulation with a density of 11kg/m³ or 75mm thick polyester insulation with a density of 20 kg/m³ in the cavity; and
 - (cc) One layer of 13mm plasterboard battened 50mm from the inside face; or
 - (C) one leaf of 90mm thick brick masonry with-
 - (aa) a row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; and
 - (bb) a 25mm cavity between the studs and the masonry; and
 - (cc) 75mm thick glass or mineral wool insulation with a density of 11kg/m³ or 50mm thick polyester insulation with a density of 14 kg/m³ positioned between the studs; and
 - (dd) one layer of 10mm plasterboard fixed to the inside face.
 - (D) single leaf of 220mm clay brick with-
 - (aa) 13mm render on the outside face; and
 - (bb) one layer of 13mm plasterboard fixed to the inside face.
- (b) $R_W + C_{tr}$ of 45 – An external wall must comply with--
- (i) a construction technique set out in the *Building Code* or (a) that is suitable for use in external applications and achieves an $R_W + C_{tr}$ of 45 or 50; or
 - (ii) one or a combination of the following-
 - (A) one row of 90mm studs at 600 centres with-
 - (aa) resilient steel channels fixed to the outside of the studs; and
 - (bb) 9.5mm hardboard, 9mm fibre cement sheeting or 11mm fibre cement weatherboard cladding fixed to the outside of the channels; and
 - (cc) not less than 75mm thick glass or mineral wool insulation, having a minimum density of 11 kg/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; or
 - (B) one row of 90mm studs at 600 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) not less than 75mm thick glass or mineral wool insulation, having a minimum density of 11 kg/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.
- (b) **$R_W + C_{tr}$ of 40** – An *external wall* must comply with--
- (i) a construction technique set out in the *Building Code* or (a) that is suitable for use in external applications and achieves an $R_W + C_{tr}$ of **40, 45** or **50**; or
 - (ii) one or a combination of the following-
 - (A) one row of 90mm studs at 600 centres with-
 - (aa) 9.5mm hardboard, 9mm fibre cement sheeting or 11mm fibre cement weatherboard cladding fixed to the outside of studs; and
 - (bb) not less than 75mm thick glass or mineral wool insulation, having a minimum density of 11 kg/m³, or 75mm thick polyester insulation with a density of 14 kg/m³, positioned between the studs; and
 - (cc) two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs; or
 - (B) one row of 90mm studs at 600 centres with-
 - (aa) steel channels fixed to the outside of the studs; and
 - (cc) 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
 - (B) not less than 75mm thick glass or mineral wool insulation, having a minimum density of 11 kg/m³, or 75mm thick polyester insulation with a density of 14 kg/m³, positioned between the studs; and
 - (C) one layer of 16mm fire-protective grade plasterboard fixed to the inside face of the studs.

5.5 Windows and external doors

- (a) *Windows* - to achieve the $R_W + C_{tr}$ ratings *required* by Table 4.6, *windows* must be-
 - (i) one of the *window* types listed in Table 5.1 that meets the $R_W + C_{tr}$ level *required* by Table 4.6, with seals fitted to each edge of the openable *window* to restrict air infiltration; or
 - (ii) a window type that has been verified by the manufacturer as having the $R_W + C_{tr}$ level *required* by Table 4.6.
- (b) *External glazed doors* - to achieve the *required* $R_W + C_{tr}$ ratings in Table 4.6, *external glazed doors* must be-
 - (i) one of the door types listed in Table 5.1 that meets the $R_W + C_{tr}$ level *required* by Table 4.6, with seals fitted to each edge of the door to restrict air infiltration and glazing set and sealed in an airtight, non-hardening sealant or a soft elastomer gasket or glazing tape; or
 - (ii) a window type that has been verified by the manufacturer as having the $R_W + C_{tr}$ level *required* by Table 4.6.
- (c) *External doors (other than glazed doors)* - to achieve the *required* $R_W + C_{tr}$ ratings in Table 4.5, *external doors* must be-

- (i) one of the door types listed in Table 5.1 which meets the $R_W + C_{tr}$ level required by Table 4.5, with seals fitted as follows-
 - (A) external side hinged doors must have compressible seals positioned around the door perimeter and a drop seal across the bottom of the door (brush seals do not comply) to provide an air tight system when closed; and
 - (B) external sliding doors must incorporate a seal to restrict air infiltration fitted to each edge of the door.
- (d) A seal required to meet (a), (b) may be a foam or rubber compressible strip or a fibrous seal with vinyl fin interleaf or the like (brush type seals do not comply).

5.6 Roof and ceiling construction

The following form of construction is deemed to achieve the $R_W + C_{tr}$ ratings for roofs and ceilings required by Table 4.5-

- (a) the roof has metal sheet roof cladding or a tiled roof system that complies with the *Building Code*; and
- (b) the ceiling is a plasterboard ceiling selected from Table 5.2 that meets the $R_W + C_{tr}$ level required by Table 4.5, fixed to the underside of the joists or roof trusses; and
- (c) the roof space has one of the following types of insulation installed above the ceiling-
 - (i) a minimum of 165mm thick glass wool or rock wool insulation with a minimum density of 7 kg/m³; or
 - (ii) a minimum of 185mm thick polyester insulation with a minimum density of 11kg/m³.

Table 5.1 - Acceptable forms of construction for *windows* and *external doors*

Window construction type: Single glass pane	$R_w + C_{tr}$
Aluminium or timber frame, employing fixed or operable sash, with either:	
(a) 3mm thick monolithic glass with sliding or double hung type opening	22
(b) 3mm thick monolithic glass with hinged or awning type opening only	25
(c) 6mm thick monolithic or laminated glass with sliding or double hung type opening	28
(d) 6mm thick monolithic or laminated glass with awning type opening	30
(e) 10mm thick monolithic or laminated glass with awning type opening	32
(f) 10.5mm thick laminated glass with awning type opening	34
(g) 12.5mm thick laminate glass within awning type opening	35
Door construction type: Glazed, single glass pane	$R_w + C_{tr}$
Aluminium or timber frame, employing fixed or operable sash, with either:	
(a) 6mm thick monolithic or laminated glass sliding door	28
(b) 6mm thick monolithic or laminated glass side-hung door	30
(c) 10mm thick monolithic or laminated glass sliding door	30
(d) 10mm thick monolithic or laminated glass side-hung door	32
(e) 12.5mm thick laminated glass for sliding type openings	34
Door construction type: Timber solid core	R_w
40mm thick solid core door, side hinged	30
Door construction type: Timber solid core with glass inserts	R_w
40mm thick solid core door, side hinged, with:	
(a) Not less than 6mm glass inserts (monolithic or laminated glass acceptable)	30

Table 5.2 - Acceptable forms of construction for ceiling systems

Description	$R_w + C_{tr}$
(a) One layer of 10mm plasterboard	35
(b) Two layers of 10mm plasterboard	40
(c) One layer of 10mm plasterboard plus 50mm thick, 12 kg/m ³ glass fibre blanket between ceiling joists	40
(d) One layer of 16mm fire rated plasterboard	40
(e) Two layers of 13mm fire rated plasterboard fixed to furring channels to the underside of the joists or trusses	45
Explanatory information: Cathedral ceilings are not suitable where the <i>required</i> $R_w + C_{tr}$ rating is more than 40 (bedrooms in exposure category 4) unless the ceiling is supported on separate furring channels.	

5.7 Ventilation systems

Where natural ventilation is provided through windows and doors, the windows and doors must comply with the insulation requirements for windows and doors in sections 4.5 and 5.5.

Where the *sound exposure category* is 4, a mechanical ventilation system complying with Australian Standard 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 where practicable exhaust air outlets must be at a point on the building furthest from the *designated sound source*.

5.8 Penetrations

Penetrations through the *building envelope* by pipes, ducts, conduits or the like must have the space between the *building envelope* and the pipes, ducts, conduits or the like sealed air tight with flexible caulking compound or filled with mortar.

APPENDIX A – PERFORMANCE SOLUTIONS

- A1.1** A *Performance Solution* can be achieved by demonstrating compliance with *performance requirement 2.1* or *2.2* in accordance with the methods outlined in Parts **A2** and **A5** of the *Building Code*.
- A1.2** In a *Performance Solution*, internal sound levels for a proposed building can be calculated-
- (a) using the highest applicable *sound spectrum level* identified by adding the applicable *sound source level* for a *designated sound source* given in Tables **A1.2** and **A1.3** to the applicable *spectral adjustment levels* given in Table **A1.4** herein; and
 - (b) using a recognised acoustic prediction method that takes into account-
 - (i) the distance the *building envelope* is from the *designated sound source*, which for road and rail is to be taken as the *acoustic centre* of the *transport corridor*. For wide roads with a central median strip separating lanes (or similar), the equivalent energy of the *designated sound source* may be split across two line sound sources on either side of the road in accordance with standard modelling practice;
 - (ii) any shielding provided by adjacent permanent structures or topography (eg a solid wall or fence, mounding of soil, dense vegetation etc);
 - (iii) the *facade sound reduction* properties of the proposed *building envelope* on the basis of verifiable test data for elements of the *building envelope*;
 - (iv) windows and doors being closed; and
 - (v) ventilation being provided with outside air to maintain air quality in *habitable rooms*.
- A1.3** For buildings adjacent to *Type A*, *Type B* and *Type R roads* and *rail lines*, the *sound source levels* set out in Tables **A1.2** and the *spectral adjustment levels* set out in Table **A1.4** must be used to determine the applicable sound spectrum levels to be used in developing a *Performance Solution*.
- A1.4** Alternatively, external *sound exposure categories* for a proposed building in a *noise attenuation area* can be calculated by-
- (a) using the highest applicable *sound source level* for a *designated sound source* given in Tables **A1.2** and **A1.3** and using a recognised acoustic prediction method that takes into account-
 - (i) the distance the *building envelope* is from the *designated sound source*, which is measured from-
 - (A) for roads - from a point 3m inside the *transport corridor* boundary; and
 - (B) for rail - from the closest rail line as shown on the mapping; and
 - (ii) any shielding provided by adjacent permanent structures or topography; andcomparing the predicted sound levels to the *sound exposure category* levels provided in Table **A1.1**.
- A1.5** For buildings subject to aircraft noise by their location within an ANEF contour band, the sound exposure levels set out in Table **A1.3** and the *spectral adjustment levels* set out in Table **A1.4** must be used to determine the applicable sound spectrum levels to be used in developing a *Performance Solution*.

Table A1.1 – Sound exposure levels at the facade for Road and Rail

DTS Sound exposure categories	Road and Rail Sound exposure level at the facade [dB(A)]
1	59 < 63
2	63 < 67
3	67 < 71
4	71 < 75
5	75 or greater

Table A1.2 - Sound source levels for Road and Rail

Sound Source	Maximum Road Speed limit [km/h]	L_{eq} night at 10m [dB(A)]
Road (Type A)	60	71
	90	73
	110	75
Road (Type B)	60	68
	90	70
	110	72
Road (Type R)	60	65
	90	67
	110	69
Train	N/A	62
Tram	N/A	58

Table A1.3 - Sound source levels for Aircraft

Sound Source	L_{max} [dB(A)]
Aircraft	Aircraft Noise Reduction (ANR) value for the site + 50

Table A1.4 - Spectral adjustment levels for different sound sources

Sound source	Octave band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
Road	-18 dB(A)	-14 dB(A)	-10 dB(A)	-7 dB(A)	-4 dB(A)	-6 dB(A)	-11 dB(A)
Train	-21 dB(A)	-10 dB(A)	-11 dB(A)	-6 dB(A)	-4 dB(A)	-8 dB(A)	-14 dB(A)
Tram	-22 dB(A)	-15 dB(A)	-8 dB(A)	-7 dB(A)	-8 dB(A)	-5 dB(A)	-9 dB(A)
Aircraft	-5 dB(A)	-2 dB(A)	-3 dB(A)	-1 dB(A)	-5 dB(A)	-8 dB(A)	-18 dB(A)

Note – The *sound source levels* in Table A1.2 have been determined based on the following assumptions-

- (a) the sound source originates at a height of 0.5m above finished ground level; and
- (b) the sound is received at the facade at a height of 1.5m above finished ground level.

Explanatory - Worked example for a Type A road

A *Type A road* with a posted speed limit of 60km/h would have the following sound spectrum at 10m.

Sound Source	Octave band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
Type A, 60 km/h	71						
Road spectral levels	-18	-14	-10	-7	-4	-6	-11
Sound spectrum dB(A) $L_{eq, night}$	53	57	61	64	67	65	60

Explanatory - Worked example for Aircraft

An aircraft would have the following sound spectrum at the building facade.

Sound Source	Octave band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
dB(A) L_{max} at facade	Aircraft Noise Reduction 30 + 50 = 80						
Aircraft spectral levels	-5	-2	-3	-1	-5	-8	-18
Sound spectrum dB(A) L_{max}	75	78	77	79	75	72	62

APPENDIX B – INTERPRETATION

Acceptable indoor sound level means a sound level not exceeding the *required* internal sound criteria specified in Table 3.1 of this Standard.

Acoustic centre means the centre of the existing or future envisaged *transport corridor* line sound source.

Australian Noise Exposure Forecast (ANEF) contour band area means an area identified as such on the Aircraft Noise Exposure Overlay in the Planning and Design Code, where buildings are exposed to higher levels of external airborne sound from aircraft, and need attenuation to achieve *acceptable indoor sound levels*.

Aircraft Noise Reduction (ANR) value means the difference in dB(A) between an identified representative maximum aircraft noise level and the *required* internal sound criteria. ANR values are mapped on a reference layer under 'Building Code' in SAPPA.

Building Code means Volume One and Volume Two of the National Construction Code published by the Australian Building Codes Board as amended from time to time.

Building envelope means those parts of the building fabric that separate an internal *habitable room* from the exterior of the building. Reference to the *building envelope* includes parts of a *building envelope*.

dB(A) means A-weighted overall sound pressure levels expressed in units of decibels.

Deemed-to-Satisfy Provisions has the same meaning as defined in the *Building Code*.

Designated sound source means sound arising from-

- (a) a *Type A, Type B or Type R road*, identified as such on a Planning Reference Layer titled 'Designated Roads Polygon' in the Planning and Design Code;
- (b) a rail corridor that is a *train line* or a tram line; or
- (b) activities that may occur in a *mixed land use area*.

Exposed facade means the elevation or external wall of a building facing the main *designated sound source*.

External glass door means an external door with more than 40% of the area of the door being glass.

External wall has the same meaning as defined in the *Building Code*.

Facade sound reduction means the reduction in external to internal sound level provided by the *exposed facade*.

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.

Habitable room has the same meaning as defined in the *Building Code*, other than an enclosed kitchen.

L_{eq,night} means the averaged equivalent sound energy level in decibels (dB_A) at night time, which is taken to be between the hours of 10.00pm -7.00am local time.

L_{max} means the maximum sound level.

Mixed land use areas means areas within a *noise attenuation area* where residential buildings require attenuation due to external airborne sound that may arise from non-residential uses permitted in these areas, where the sound is non-directional and not specific to a particular location.

Noise attenuation area – means an area identified as such on the Noise and Air Emission Overlay to the Planning and Design Code, where buildings may be exposed to higher levels of external airborne sound and need attenuation to achieve *acceptable indoor sound levels*.

Performance Requirement has the same meaning as defined in the *Building Code*.

Performance Solution has the same meaning as defined in the *Building Code*.

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+C_{tr} 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.

Residential care building has the same meaning as defined in the *Building Code*.

Separation distance means the shortest distance (to the nearest metre), from an existing or future *designated sound source* to the nearest point of the *building envelope* bounding a *habitable room* that is exposed to the *designated sound source*.

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

Road or rail sound source means a road or rail line subject to this Standard.

Sound source level means a prescribed sound level for a *designated sound source* to be used in proposing a *Performance Solution*.

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 sound reduction* across the *building envelope*.

Train line means a railway identified as a *designated sound source* in a Noise and Air Emissions Overlay to the Planning and Design Code.

Tram line means a tramway identified as a *designated sound source* in a Noise and Air Emissions Overlay to the Planning and Design Code.

Transport corridor: means an area of land identified in the Noise and Air Emissions Overlay to Planning and Design Code 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 metropolitan road identified as such in a Planning Reference layer to the Planning and Design Code.

Type B road means a metropolitan road identified as such in a Planning Reference layer to the Planning and Design Code.

Type R road means a rural road identified as such in a Planning Reference layer to the Planning and Design Code.

Window has the same meaning as defined in the *Building Code*.

APPENDIX C – REFERENCED DOCUMENTS

Unless otherwise indicated, a reference to an Australian Standard in this Standard is to the edition that is current for the purposes of the *Building Code* at the time of application.

Table C1.1 – Schedule of referenced standards and documents

No	Title
AS 1668.2 Part 2	The use of ventilation and air-conditioning in buildings – Mechanical ventilation in buildings
ISO 717.1 Part 1	Acoustics – Rating of sound insulation in buildings and of building elements – Airborne sound insulation