Noise control

Noise can interfere with sleep, rest and conversation and cause fatigue, irritability, headaches and stress. Surveys show that noise is an important environmental concern for most Australians. We all need to contain and reduce noise and protect ourselves from sources of noise in order to enjoy a healthy life. Thoughtful design and practice can reduce the impact of noise on our lives and improve the quality of our living environment.

Neighbourhood noise

Common sources of neighbourhood noise include:

- road, rail and aircraft traffic
- air conditioners, evaporative coolers and refrigeration units
- pool pumps
- TVs and sound systems
- burglar and car alarms
- household appliances
- dogs and other animals
- industrial premises and backyard workshops
- music from houses, commercial premises and concerts
- road and building maintenance and construction.

Noise is measured by sound pressure level which is expressed as a power ratio and calibrated in decibels (dB). The ear has a large dynamic range in audio perception with the ratio of the quietest to the most immediately dangerous sound level (capable of causing permanent damage to the ear) being in the order of 1:1 trillion.

Some typical values are given in the following table. Note that it is not a linear scale — going from 50dB to 100dB is not twice as loud but 16 times as loud and from 60dB to 30dB is not half as loud but one eighth as loud.

Regular exposure for more than one minute to 110dB risks permanent hearing loss, and prolonged exposure to any noise at or above 85dB can cause gradual hearing loss (NIDCD 2012).

Communities usually agree about what noise volumes are acceptable and what are not. The intensity of sound can be measured objectively in decibels, but our perception of what constitutes noise is affected by subjective factors. These include the type of noise (one person's music might be another person's noise), our mood, the time of day, background noise levels and our expectations. Sudden noises such as a motorbike exhaust or screeching brakes can be more disturbing than steady or expected noises. Frequency of noise may also have different impacts.

Sound levels and their perception

Sound level (dB)	Approximate loudness relative to ordinary conversation	Perception example
0	Don't hear anything	Threshold of hearing
10	1/32 as loud	Very faint normal breathing
20	1/16 as loud	Quiet room
30	1/8 as loud	Quiet conversation/ quiet office interior
40	1/4 as loud	Moderate quiet office/ quiet rural area
50	1/2 as loud	Quiet suburban area/ dishwasher in next room
60	Ordinary conversation	Average office/ordinary conversation
70	Twice as loud	Loud busy street/ vacuum cleaner at 3m
80	4 times as loud	Noisy office/passing car at 3m
90	8 times as loud	Very loud heavy traffic/ passing bus or truck at 3m
100	16 times as loud	Loud car horn/passing subway train at 3m
110	32 times as loud	Pop group/night club with band playing
120	64 times as loud	Extreme; jet take-off at 100m

Sources: NIDCD 2011 and Trace/University of Wisconsin

Options to reduce noise

Recognising these subjective factors helps us determine when others are creating noise unfairly and how to respond. If neighbourhood noise is a genuine problem for you, or you believe that you might generate noise that could affect others there are some actions you can take:

- Choose a quiet neighbourhood.
- Reduce the noise by talking it over with whoever is causing the problem, or by lodging a complaint.
- Block the noise with barriers, sound absorbent materials and appropriate home design.
- Minimise your own contribution to neighbourhood noise.
- Carry out noisy activities during the day.
- Inform your neighbours whenever you need to generate noise, such as a party at home.
- Design your home to minimise noise transfer to your neighbours.
- Select a home that is well designed to limit noise transfer.

Traffic noise

For most Australians road noise is the most important neighbourhood noise issue as it affects a high proportion of the population, and the problem is growing as traffic levels increase. A 2003 study indicated that 20% of Sydney's population were exposed to levels of road traffic noise that were well above those recommended by the World Health Organization for reducing annoyance and sleep disturbance. Many people complain that traffic noise has the greatest direct impact. (see *Transport*)

Minimise the impact of traffic noise on your home — and your contribution to the problem:

- Cycle or walk, rather than drive.
- Buy a quiet car, and drive it less.
- Drive slowly and calmly and maintain your car.
- Shop locally and buy locally made products to reduce freight travel.
- Report noisy vehicles.

Take measures in the design of your home such as using suitable window glazing, managing air leakage, and designing shared walls and floors to limit noise transfer.

Queensland identifies designated transport corridors and New South Wales has a road noise policy. Check with your planning authority to see if your property is contained in a designated transport noise corridor (rail or road) or is otherwise recognised as being subject to higher than average transport noise levels. If so, measures need to be taken to ensure that your home includes appropriate design responses to the noise corridor.

Work with your neighbourhood, local council, community organisations and government to create more livable communities with reduced traffic noise. Central to this is the creation of urban villages based on public transport, walking, cycling, traffic calming and other traffic reduction initiatives. (see *Transport*)

Noise in buildings

Non-traffic-related noise complaints are rising, particularly in medium and high density housing areas. Many new medium and high density developments are unnecessarily noisy, and the sound insulation requirements for multi-unit housing and apartment buildings are not particularly high.

It can be very difficult or expensive to do anything about a noise nuisance after a house is built or purchased. Consider potential noise problems before you buy, build or renovate.

Ask for design specifications for noise levels before buying a multi-residential unit and ask your solicitor to link them to your contract as a performance measure. This will give you more options if you discover a problem after moving in.

Part 3.8.6 of the Building Code of Australia (BCA), Volume Two, contains sound insulation requirements and technical solutions for separating walls and floors within and between dwellings.

The following design sound levels are recommended for an inner suburban house.

Recommended design levels

Activity	Satisfactory (dB)	Maximum (dB)
Recreation areas	35	40
Bedrooms	30	35
Work areas	35	40

Source: Standards Australia 2000

Types of noise

There are two types of building noise to consider: airborne and impact.

Airborne noise

Airborne noise comes from common sound sources such as voices, TVs and radios. The noise performance of a building structure is called the Sound Transmission Class (STC). The higher the STC the better the structure is at isolating airborne noise. An STC rating of 45 means that the sound passing through the building is reduced by 45dB.

> *Rooms with a lot of hard surfaces can be very noisy as they readily reflect sound. Soft furnishings, drapes and rugs can make a significant improvement. Hard floor surfaces can create impact noise.*

A change of 3 STC (or dB) in the sound level means a doubling or halving of the sound energy. As the human ear does not perceive sound in a linear way, a 3dB change is barely perceptible. The following table shows the subjective perception of sound energy. Roughly speaking, a 10dB reduction makes a sound appear to be half as loud. The next table outlines what this means in practice for a building.

Subjective perception of sound energy reductions

Reduction in dB	Percentage	Reduction in sound energy subjective perception
3	50	Barely perceptible
4–5	70	Significant
6	75	Sound appears to be reduced by about one quarter
7–9	87	Major reduction
10	90	Sound appears to be less than half original

Effect of sound transmission classes on speech perception

Sound Transmission Class	Effect on speech perception
25	Normal speech can be heard easily
30	Loud speech can be heard easily
35	Loud speech can be heard but not understood
42	Loud speech heard as murmur
45	Must strain to hear loud speech
48	Loud speech can be barely heard
53	Loud speech cannot be heard

Impact noise

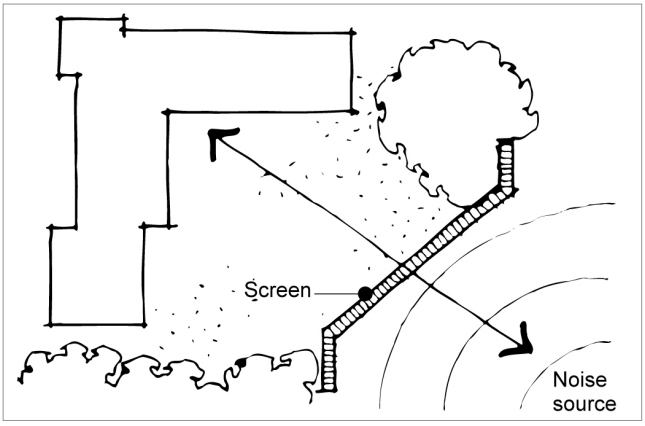
Structure-borne noise, also called impact noise, is produced when part of the building fabric is directly or indirectly affected. Energy passes through the structure and creates noise in nearby rooms. Examples are heavy footsteps (particularly on bare timber or tile floors), banging doors, scraping furniture, vibrations from loud music and plumbing noises. The Impact Insulation Class (IIC) is used to rate the impact noise insulation of floors.

Noise and good design

Site planning

Consider noise sources such as shops, hotels, and garbage and recycling collection when siting, buying or renovating your home and locating windows.

There are proprietary fencing or 'sound wall' options designed to provide noise abatement (reportedly up to 43dB). These solutions can result in large, potentially unattractive areas of vertical hard surfaces but can be enhanced with the addition of decorative elements that also contribute to sound attenuation. Large masonry based sound walls and fences are generally appropriate on the boundary of domestic dwellings with more public areas rather than between dwellings and suburban backyards.



Place a screen between dwelling and noise source.

Dense vegetation can significantly reduce noise transmission in a number of ways — a soft earth surface reduces the intensity of low frequency sound by absorbing its energy, and leaves and stems scatter high frequency sound waves.

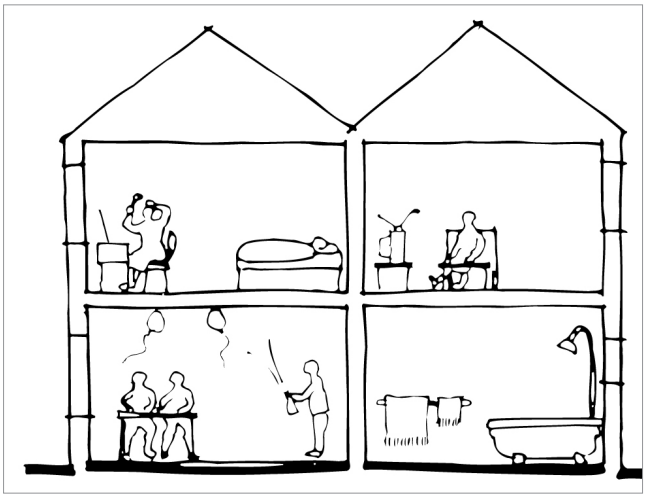
- Place walls, fences, trees and screening vegetation between the noise source and your home.
- Place driveways and garages away from bedrooms and living rooms.

Building layout and design

The best protection against noise is to avoid making it in the first place, or by ensuring that noise sources are not too close. Noise levels vary through different times of the day, so it is worthwhile to try and take account of when noise is, or might be, generated.

Sound 'leaks' through gaps surprisingly easily, so your building's construction material, design and layout can make a big difference.

- Locate quiet rooms as far away from noise sources as possible, without compromising passive solar design principles.
- Install windows away from noise sources if possible and select sound absorbing types.
- Locate noisy areas together and away from quiet areas.
- Avoid putting laundries, bathrooms or living rooms next to, above or below bedrooms without adequate sound insulation. Consider mounting noisy appliances on sound absorbing pads.
- Accommodate teenagers by providing extra soundproofing for their rooms and locate them away from adult living and sleeping areas, and neighbours.



Consider noise levels when planning the use of each room.

Noise is a particular problem within medium and high-density housing, and special care in design is needed to avoid problems. If people are unable to open windows to keep cool in summer they may need to install mechanical cooling.

- Minimise the need for noisy mechanical cooling.
- Use acoustic 'fins' (solid non-loadbearing walls) between balconies.
- Build units around quiet courtyards and face them away from roads.
- Keep pedestrian and vehicle thoroughfares away from bedrooms and living rooms.
- Avoid placing windows and doors of neighbouring units opposite or adjacent to one another.

A passive home is designed to encourage airflows that distribute heat or 'coolth' through the building. This tends to enhance sound transmission between the building's internal spaces, so careful consideration of the sound transmission and reflection qualities of internal surfaces is especially important.

Construction

Thermal mass is a poor thermal insulator but can provide good acoustic insulation between rooms and apartments, or from outdoor noise, although it may also reflect sound and transmit impact noise. (see *Thermal mass*)

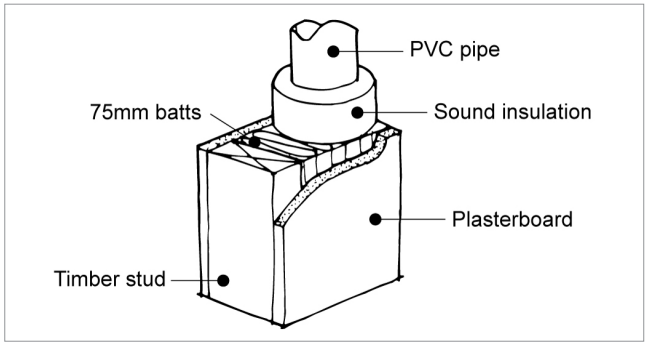
The BCA specifies the minimum STC wall and floor requirements between adjoining dwellings, but uses a sound reduction index (Rw) which is directly equivalent to STC. An increase of one Rw unit approximately equals a reduction of one decibel in noise level. An increase of 10 Rw units approximately halves the sound transmitted. (CSR 2011)

The BCA specifies the minimum required Rw (airborne) + Ctr (impact) sound values for separating wall construction in new single dwellings (Class 1 buildings). For further information please refer to Part 3.8.6 of Volume Two of the BCA. Exceeding the minimum specifications is highly recommended, particularly given the trend towards higher density living. The BCA does not specify IIC, but certain construction types are 'deemed to comply'.

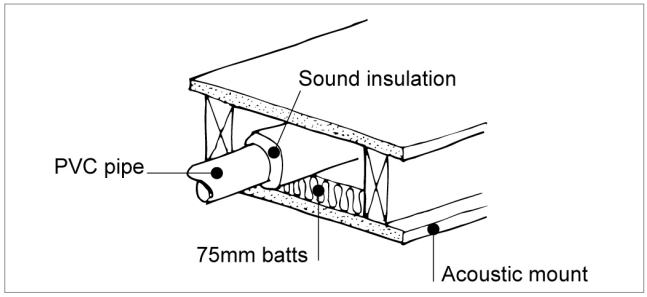
Rw levels in the BCA only consider individual building elements as measured in a laboratory. Sound transmission properties of the structure as a whole or on-site construction practices are not taken into account. These can reduce the effective value by up to 5 Rw due to flanking sound transmission paths, for example through structural components.

Good design detail and construction practice is critical to the performance of both heavy and light construction.

- Pay attention to building components such as floor and ceiling plates and to the installation of services such as plumbing and power outlets; insulate them acoustically if necessary to ensure the desired performance is achieved.
- Avoid locating plumbing and waste pipes close to quiet rooms or ensure that they are adequately soundproofed — a range of sound insulation products exists for plumbing and waste pipes in walls and floors.



Sound-insulated plumbing in a stud wall.



Sound-insulated plumbing in a floor.

- Provide extra sound insulation for noisy rooms such as laundries. Use acoustic mounts or pads for clothes washers and dryers.
- Use built-in robes as sound buffers between bedrooms.
- Use solid core doors which are more effective sound insulators than hollow core.
- Use door closers or foam/plastic strips on door frames to stop doors banging.
- Reduce sound reflection transmission through gaps with draught sealing strips.

BCA Rw requirements for walls between adjoining dwellings

Structure	Minimum reduction index (Rw)
Floors above dwellings	50
Walls between a bathroom, laundry or kitchen and a habitable room in adjoining dwelling*	50
Other walls	45

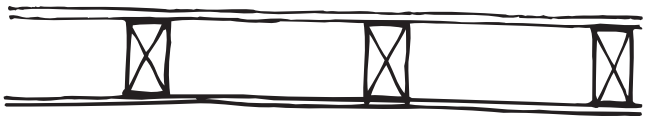
*These walls must also have a satisfactory level of impact insulation as outlined in the code
Source: ABCB 2011

For the BCA minimum requirements for Rw (airborne) + Ctr (impact) sound values for separating wall construction in new single dwellings (Class 1 building) please refer to Part 3.8.6 of Volume Two of the BCA. Although the BCA specifies no sound insulation requirements within dwellings it is important to consider sound transmission in homes now that multiple TVs, sound systems and bathrooms are common.

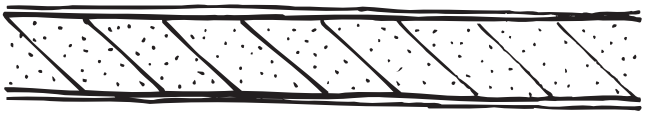
The Rw ratings of some typical wall and floor construction methods are outlined here. Heavy dense materials, such as concrete, are generally better for sound insulation but a range of lightweight solutions are also available.

Walls

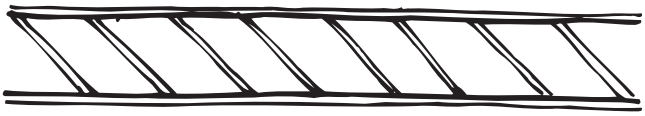
Rw32 — Using 10mm plasterboard on 100 x 50mm timber studs at 450mm centres provides very little sound insulation and is not recommended for occupied rooms.



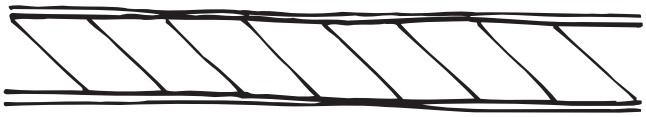
Rw42 — 100mm low density AAC block with 10mm adhered plasterboard both sides.



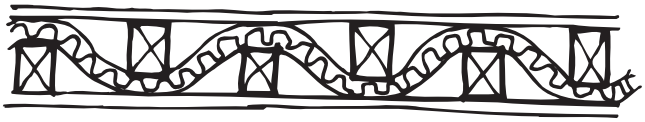
Rw45 — 90mm calcium silicate brick with adhered 10mm plasterboard both sides. This complies with the BCA minimum for adjoining dwellings.



Rw50 concrete — 90mm solid concrete block with adhered 10mm plasterboard both sides.

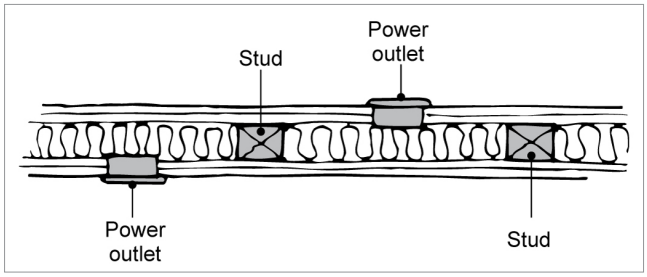


Rw50 timber frame — 16mm fire protective plasterboard on staggered timber 70 x 45mm studs at 600mm centres both sides with 120 x 35mm timber plates and 50mm glass fibre batts.



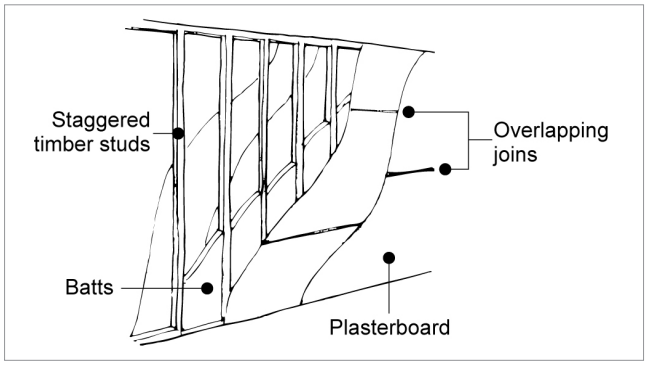
High density insulation, multiple layers of plasterboard and foam backed plasterboard also help control noise transmission — internal stud walls can be filled with high density insulation which provides acoustic insulation and also increases thermal resistance. This is particularly useful between inhabited and uninhabited spaces like laundries.

Pay special attention to details that might affect the integrity of sound insulation such as power points and plasterboard joints. Offset power outlets and locate them in different sections of the wall cavity. Use sealed power outlets to prevent air leakage. (see Sealing your home)



Offset power outlets to minimise noise leakage.

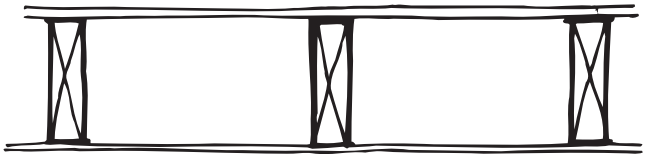
Ensure the joints overlap and offset joints on opposite sides of the wall when using double layers of plasterboard.



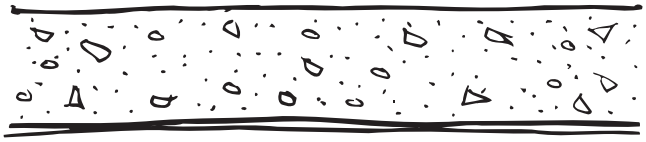
Offset plasterboard joints when layering the boards.

Internal floors

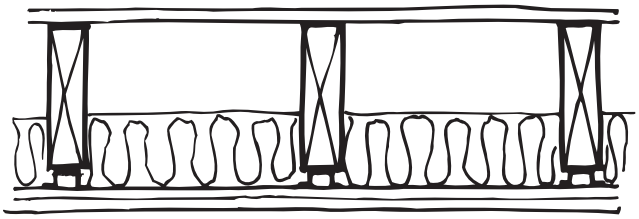
Rw35 — Bare 20mm floorboards on 200 x 50mm joists at 450mm centres, with one layer of 13mm plasterboard, provides very little sound or impact insulation and is not recommended.



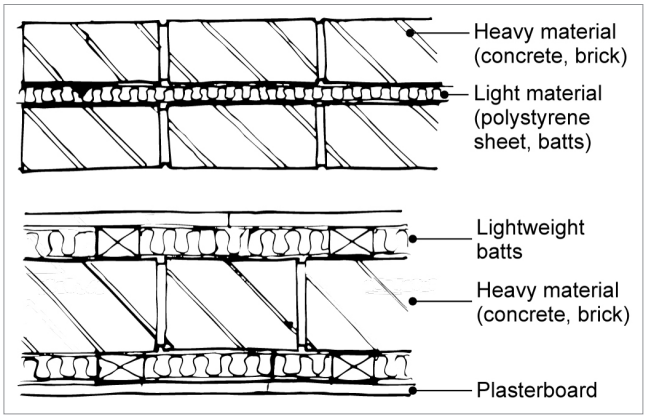
Rw48 — 150mm concrete slab (365kg/m2) with 10mm of plaster.



Rw50, IIC 50 — Bare 20mm floorboards on 200 x 50mm joists at 450mm centres, with two layers of 16mm fire protective plasterboard on furring channels and resilient mounts, and 100mm batts. Using carpet and underlay will increase the IIC to 70.



Dense materials will, however, readily transmit impact noise. Composite construction using combinations of light and heavy mass materials are best to reduce noise transmission.



Composite constructions for reducing noise transmission.

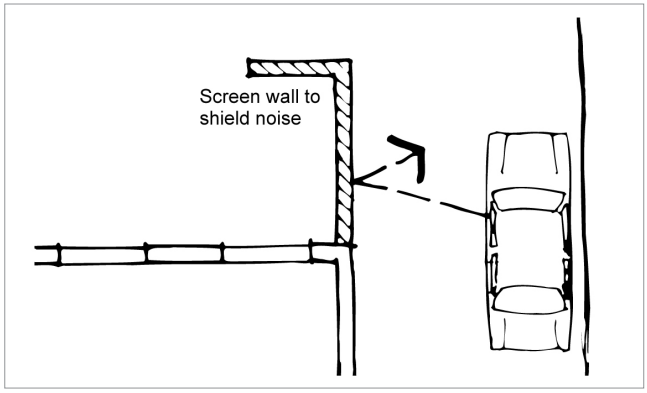
Precast concrete — sound transmission ratings for some typical precast concrete flooring and walling systems are shown below.

Sound transmission class and mass for slabs and walls

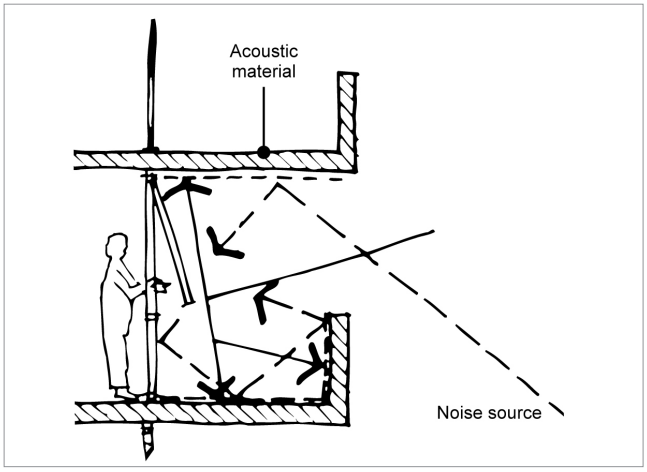
Slab/wall type	Mass kg/m²	STC
Solid slabs or walls		
50mm	115	43
70mm	161	47
100mm	230	50
150mm	345	52
200mm	460	58
Hollowcore slabs		
150mm	220	48
200mm	278	50
250mm	312	50

Screens — Provide screen walls to shield noise and use acoustic materials to reduce reflection of airborne noise.

- Avoid hard floor surfaces that are above ceilings without good sound insulation. Use cork, carpet or impact absorbing finishes instead of bare timber or tiles.
- Use low density coverings such as carpet which will have little effect on STC but will greatly reduce both impact noise (increasing the IIC by about 20 points) and internal sound reflection.
- Use proprietary noise reduction underlay to increase both STC and IIC ratings of floors. They are ideal for reducing sound transmission on existing floors within a home.
- Install bulk insulation under floors to damp down noise and reduce noise transfer.
- Encourage people to remove their shoes in the home.



A screen wall shields outdoor living space from vehicle noise.



Use acoustic material to reduce reflection of airborne noise.

Glass and noise

A 3mm single glazed window has a very low STC, and windows can let in a lot of noise, open or closed. The potential sound reduction from a highly insulating wall can be substantially reduced by poor window design.

Double glazing and laminated glass are both effective at reducing noise provided the windows are closed and the frames are well sealed.

The table below shows the percentage noise reduction compared to 3mm glass. Note that these percentage reductions are not the same as STC values.

Noise reduction for glazing compared to 3mm glass

Glazing type	Voice noise reduction (percentage)	Traffic noise reduction (percentage)
Single glazing		
6.38mm laminated	13	24
10mm glass	24	38
10.38mm laminated	29	43
Double glazing		
4mm/12mm space /4mm	19	
10mm/12mm space/ 6.38mm laminated		46
10mm/12mm space/6mm	34	
6mm/100mm space/4mm		57
6.38mm laminated/ 8mm space/4mm	46	

Source: Pilkingtons

NOTE: Thicker glass generally does not improve thermal insulation. For a combination of sound and thermal insulation use double glazing. Bear in mind that the acoustic insulation of any window is severely compromised when it is open. (see *Glazing*)

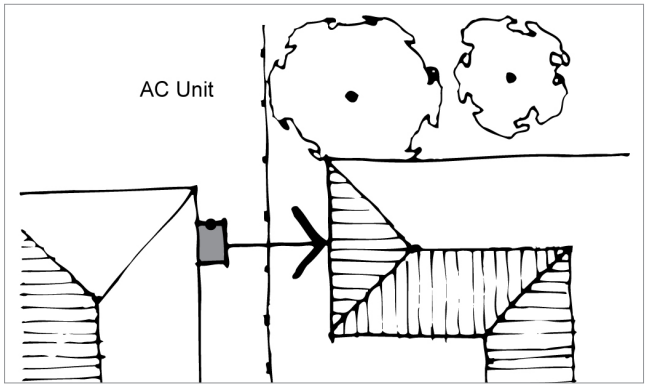
To maintain effective ventilation with doors and windows closed, consider installing acoustic wall vents which are designed to provide ventilation while minimising noise transmission. (see *Sealing your home*).

Outdoor noise sources

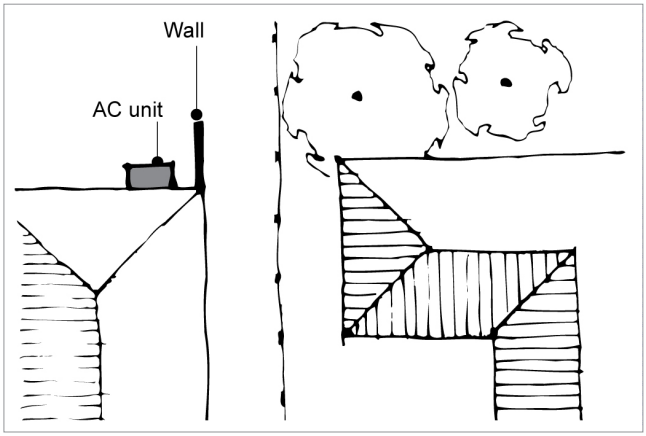
- Site noisy areas like swimming pools and outdoor living areas away from neighbours' windows.
- Avoid using hard exterior surfaces such as concrete paving, which reflects sound rather than absorbs it. Softer surfaces are more desirable, particularly in higher density housing, as they absorb sound. Permeable surfaces also reduce stormwater runoff. (see *Stormwater*)
- Make sure outdoor noise sources (air conditioning units, pool pumps) are not going to be a nuisance for neighbours. If pumps can't be placed far enough away, build a noise reduction enclosure, but make sure it does not undermine the efficiency of the equipment by blocking air flow.

There are laws governing noisy air conditioners and pumps that may annoy neighbours. Buy the quietest air conditioner suited to your needs, and install it as far as possible from your neighbour or in a well-shielded location.

Most air conditioners in Australia have a label that specifies the amount of noise they make. The smaller the dBA number on the label, the quieter the air conditioner. Get specialist advice from the supplier or installer. Evaporative coolers on roofs can be a major noise problem: choose a quiet model and locate it on a roof slope away from neighbours.



Unsuitable location for an air conditioner.



Air conditioning unit faces away from neighbours and is screened by a wall.

Erect appropriate sound barriers and plant vegetation to reduce or modify the impact of noise both from and to your home.

References and additional reading

Contact your state, territory or local government for further information on noise control in residential areas: www.gov.au

Anderson, L, Mulligan, B and Goodman, L. 1984. Effects of vegetation on human response to sound. Journal of arboriculture 10(2).

CSR. 2011. The red book: fire and acoustic design including green building systems. North Ryde, NSW. www.gyprock.com.au

Ecotect community WIKI. 2012. Sound: barriers. http://wiki.naturalfrequency.com/wiki/Traffic_Noise

National Institute on Deafness and Other Communication Disorders. 2012. Bookmark, NIDCD, National Institutes of Health, Bethesda, MD. www.nidcd.nih.gov

NSW Department of Environment, Climate Change and Water. 2011. NSW road noise policy. www.environment.nsw.gov.au/noise/traffic.htm

Queensland Department of Housing and Public Works. 2012. Transport noise corridors. www.acoustics.asn.au

Authors

Principal author: Geoff Milne

Contributing authors: Kendall Banfield, Chris Reardon

Updated by Paul Downton, 2013