CHAPTER 7

INSULATION

The contents of this chapter outline the benefits of insulation, how insulation performance is measured and types of insulation products. Guidelines are provided for insulation selection and installation.

Insulation benefits

Insulation is the most effective way to improve the energy efficiency of a home. Insulation of the building envelope helps keep heat in during the winter, but lets heat out during summer to improve comfort and save energy.

Insulating a home can save 45–55% of heating and cooling energy. Table 7.1 shows the savings on heating and cooling energy when insulation is installed.

Table 7.1: Typical energy savings due to insulation

EXTENT OF INSULATION	HEATING	COOLING	HEATING AND COOLING
Ceiling only (added R2.5)	15–25%	30–45%	20–30%
Ceiling (added R2.5) and walls (added R1.0)	40–50%	40–55%	40–50%
Ceiling (added R2.5), walls (added R1.0) and floor (added R1.0)	45–55%	35–50%	45–55%

Benefits of insulation:

- comfort is improved year-round;
- it reduces the cost of heating and cooling by over 40%;
- it pays for itself in around five to six years;
- there is less need for heating and cooling which saves non-renewable resources and reduces greenhouse gas emissions;
- it virtually eliminates condensation on walls and ceilings; and
- some insulation materials can also be used for sound proofing.

How insulation works

An uninsulated home is subject to considerable winter heat losses and summer heat gains (see figure 7.1).

All materials allow a measure of heat to pass through them. Some, such as metal, glass or air, allow heat to pass through more easily. Others, including animal fur or wool, thick clothing and still air, are much more resistant to heat flow, and are referred to as insulators.

The term 'insulation' refers to materials which provide substantial resistance to heat flow. When these materials are installed in the ceiling, walls, and floors of a building, heat flow into and out of the building is reduced, and the need for heating and cooling is minimised.

Although ceilings and walls may be insulated, heat loss will still occur in winter if there are large areas of unprotected glass or through fixed wall vents and gaps and cracks around external doors and windows. Appropriate internal window coverings (e.g. lined drapes with pelmets) and draught proofing are vital to complement insulation.

Insulation should always be coupled with appropriate shading of windows and adequate ventilation in summer. Without shading, heat entering the home through the windows will be trapped inside by the insulation and cause discomfort.

Understanding heat transfer

There are three ways in which heat is transferred—radiation, convection and conduction.

A warm plasterboard ceiling in winter provides an example of these different methods of heat transfer.

RADIATION

Radiation is the direct heat which can be sensed by the skin, such as the sun's rays or the heat from an open fire. Heat (infra-red) radiation which is emitted from the surface of hot objects, travels in straight lines to cooler objects. With radiant heat transfer, heat is emitted from the warm plasterboard ceiling to cooler roof tiles on a cold night (see figure 7.2).

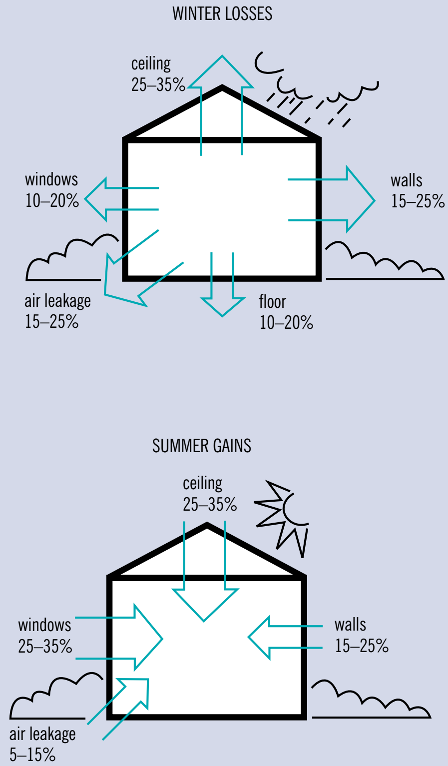


Figure 7.1: Heat flow without insulation

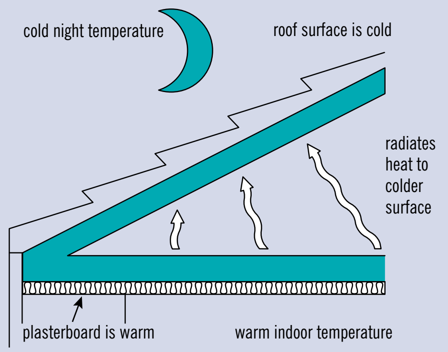


Figure 7.2: Radiant heat transfer

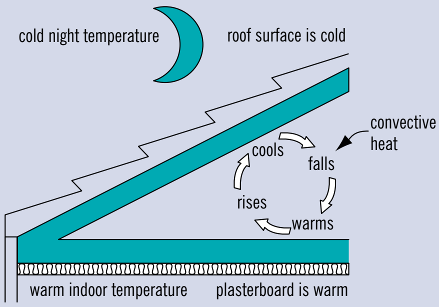


Figure 7.3: Convective heat transfer

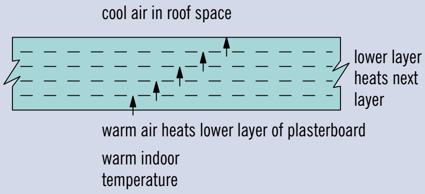


Figure 7.4: Conducted heat transfer

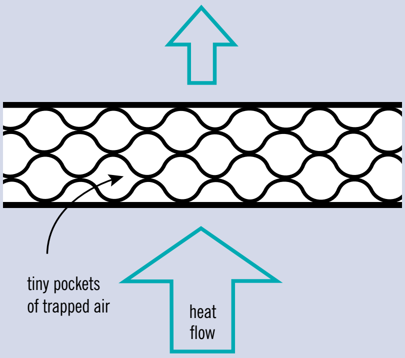


Figure 7.5: Bulk insulation and heat flow

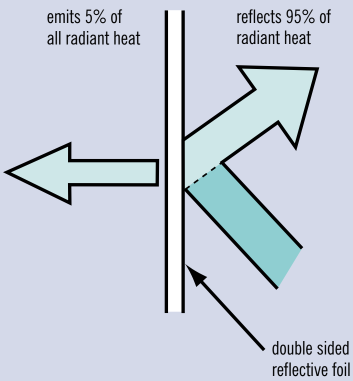


Figure 7.6: Reflective insulation and heat flow

CONVECTION

Convection transfers heat through the movement of gases or liquids. For instance, when air is warmed, it rises and is replaced by cooler air. This creates a cycle or convection current capable of transferring heat. With convective heat transfer, the warm layer of air above the ceiling rises and comes into contact with the cold roof surface, cools by losing some heat to the roof material, then falls to the plasterboard where the process repeats itself (see figure 7.3).

CONDUCTION

Conduction is heat transfer from warm to cooler areas within a material, or between two materials touching each other. Gases, such as air, do not conduct heat very well. Solids, particularly metal, conduct heat much more readily. With conductive heat transfer, heat inside the home warms the bottom layer of plasterboard ceiling which transfers heat to the next layer, and so on (see figure 7.4).

Principles of insulation

Resistance to heat flow is achieved by the use of either bulk insulation or reflective insulation, which work in different ways.

BULK INSULATION

Bulk insulation traps millions of tiny pockets of still air or other gases within its structure. These air pockets provide the resistance to heat flow. Bulk insulation reduces radiant, convective and conducted heat flow (see figure 7.5).

REFLECTIVE INSULATION

Reflective insulation works by reducing the radiant heat transfer across an enclosed space, e.g. between bricks and plasterboard in an insulated brick veneer wall. Reflective foil in walls or under the roof reflects radiant heat away from the interior in summer. It works most effectively in conjunction with a still air layer (enclosed air space) of at least 25 mm (see figure 7.6). Reflective insulation needs to remain clean and dust-free for best performance.

How insulation performance is measured

R VALUE

All insulation materials are rated for their performance in restricting heat transfer. This is expressed as the R value, also known as thermal resistance or resistivity. The R value is a guide to its performance as an insulator—the higher the R value, the greater the insulating effect.

R values are expressed using the metric units m^2/K/W, where:

- m^2 refers to one metre squared of the material of a specified thickness;
- K refers to a one degree temperature difference (Kelvin or Celsius) across the material; and
- W refers to the amount of heat flow across the material in watts.

Products which have the same R value will provide exactly the same insulating effect as each other, provided they are correctly installed.

If manufacturers' information is not available, R values can be calculated using the data and methods contained in the following:

- Australian Standard *AS2627.1 (1993): Thermal insulation of dwellings*
- *The Australian Institute of Refrigeration, Air Conditioning and Heating handbook*

U VALUE

Sometimes insulation is rated in terms of its U value, rather than its R value. The U value measures the transfer of heat through a material or a building element (thermal transmittance), whereas the R value measures the resistance to heat transfer. U values are often used in technical literature, especially to indicate the thermal properties of glass and to calculate heat losses and gains. The U value is the reciprocal of the R value, $R=1/U$ or $U=1/R$. For example, with an R value of 2.0, the U value is 1/2 or 0.5.

The U value is expressed using the metric units ($W/m^2/K$) where:

- W refers to the amount of heat transmitted across the material in watts;
- m^2 refers to one metre squared of the material of a specified thickness; and
- K or 'degree Kelvin' refers to each °C temperature difference across the material.

Worked example

An insulated brick veneer wall with an overall R value of 1.7 has a U value of 0.588 W/m^2 (i.e. one divided by 1.7). This means that 0.588 W of heat will be transferred through each m^2 of wall if there is a one degree difference between the inside and outside temperatures (see figure 7.7).

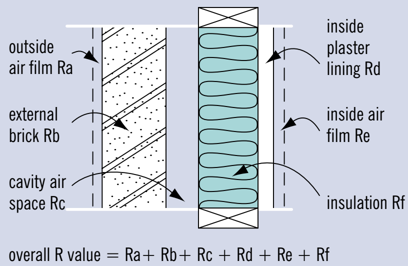


Figure 7.7: Overall R value of brick veneer wall

Types of insulation products

The following pages provide general information on the range of insulation materials available.

Australian Standards cover most insulation products. Provided the product complies with the Australian Standard, good levels of performance and reliability can be expected. If no Australian Standard exists, it is vital to ensure the product has been independently tested to ensure performance is optimised. This should be done in a National Association Testing Authorities-accredited laboratory.

BULK INSULATION

Bulk insulation contains millions of tiny pockets of still air trapped within the material. This air provides the material's insulating effect so it is important not to compress bulk insulation. Bulk insulation is available as batts, blankets and boards, or as loose fill which is pumped, blown or placed by hand into an area.

Batts and blankets

Glasswool (fibreglass)

- Made from melted glass spun into a flexible mat of fine fibres
- Available as batts or blankets
- Easy to cut and install
- Commonly sold in DIY packs with R values clearly labelled
- Should not be compressed or moistened
- All ends and edges should be butted together firmly during installation
- Blankets are manufactured in rolls for specific types of installations, e.g. under roofing in a cathedral or raked ceiling or under a flat roof
- Blankets are thinner and denser than batts, and are available with reflective foil attached to one side

Rockwool

- Made from volcanic rock melted at high temperatures and spun into a mat of fine fibres
- Available as batts or blankets
- Denser than glasswool, so R value per unit thickness is higher
- Better sound absorption qualities than glasswool
- Generally more expensive than glasswool
- Other characteristics are similar to glasswool

Glasswool and rockwool are together referred to as 'mineral wool' products. Due to their potential to irritate the skin and the upper respiratory tract, full protective clothing, including gloves and a face mask, should be worn during installation.

Natural wool

- Made from sheep's wool formed into batts or blankets
- Should only be manufactured from new, scoured wool treated with a vermin and rot-proofing agent during the scouring process
- Moth-proofing of wool is vital—check with the manufacturer for test results to guarantee this (test results should not be more than four months old)
- Most batts and blankets are made of a wool-polyester blend to reduce settling and compression
- Naturally flame-resistant, however, the addition of synthetic fibres increases flammability—check with supplier for fire resistance testing results
- As different types of wool can provide different R values for the same thickness, check with the supplier for R value tests and certifications

Polyester

- Made from polyester fibres (including recycled PET bottles) spun into a flexible mat
- Available as batts or blankets
- Similar physical properties to mineral wool, but is non-irritable, with no known physical or health hazards
- Does not burn, but will melt if exposed to a direct flame at high temperature

Loose-fill insulation

This type of insulation consists of shredded or granulated material supplied in a loose form, and is usually installed by the supplier/manufacturer. It must be correctly installed at even depth to provide adequate insulation cover. Barriers should be installed to prevent insulation falling down through exhaust fans, wall cavities, ceiling vents and light fittings.

Loose-fill material may settle over time, reducing its effectiveness—your contractor should quote you a guaranteed 'settled R value', which is the final R value achieved after any settling has occurred.

This type of insulation is more suited to flat or shallowly-sloping ceilings of less than 25° pitch. With the exception of some rockwool products, loose-fill is only suitable for insulating ceilings.

Cellulose fibre

- Made from waste paper pulverised into a fine fluff
- Must be treated with fire retardant chemicals to reduce flammability
- Cheaper to purchase and install than other types of bulk insulation
- Quality and installation can vary greatly, so ensure the product complies with Australian Standard *AS2462 (1981): Cellulosic fibre thermal insulation*

Natural wool

- Natural sheep's wool off-cuts
- Should consist of pure, new, scoured wool only—should not contain any synthetic fibres, or dyed or recycled materials
- Cheaper grades of wool are commonly used and can include small leather fragments—this should not affect performance
- Should be treated with a vermin and rot-proofing agent during the scouring process
- Other characteristics are similar to natural wool batts and blankets

Granulated rockwool

- A loose-fill form of rockwool
- If treated with a water-repellent agent, can sometimes be used to fill cavity brick and brick veneer walls—check with the supplier to see if it is suitable

Boards

These are used mainly in walls and cathedral ceilings.

Extruded polystyrene

- Rigid, waterproof boards of closed cell polystyrene
- High compressive strength
- Contain flame-retardants, however, installation is only recommended between non-combustible surfaces (e.g. plasterboard, reflective foil or brickwork)
- Very high R value per unit thickness
- Generally more expensive than other types of bulk insulation
- Some products available with reflective foil backing

Foil-faced expanded polystyrene

- Rigid boards of polystyrene beads with reflective foil attached to both sides
- Should be installed with foil facing still air spaces of at least 25 mm width to maximise R value
- Expanded polystyrene has lower R value per unit thickness than extruded polystyrene
- Also available as boards without foil facing—these have similar properties to extruded polystyrene, but have lower compressive strength and are not water resistant

REFLECTIVE INSULATION

Reflective insulation is made of thin sheets of highly reflective aluminium foil laminate, which reflects heat from its polished surfaces while absorbing and emitting only a small amount. It must work in conjunction with a still air layer for maximum effectiveness (see figure 7.6).

An R value supplied by reflective foil insulation is equivalent to the same R value provided by bulk insulation. Reflective foil R values are influenced by the characteristics of adjacent air spaces, such as their orientation, thickness and temperature differences.

Adequate performance can be achieved by combining reflective insulation with bulk insulation and/or using specialist foil products, provided they are carefully installed. Any gaps or tears will significantly reduce performance, as will dust build-up on surfaces. Four types of reflective insulation products are currently available.

Reflective foil laminate

- Foil laminated to paper with glass fibre reinforcement
- Supplied in rolls
- Typically used as roof sarking and wall insulation
- Double-sided foil is more effective than single-sided, provided that both sides face a still air space; it is also more water resistant
- Double-sided foil is typically produced with an anti-glare coating—this reduces the insulation's effectiveness by around 10%

Multi-cell reflective foil products

- Two, three or four layers of laminated foil separated by partitioning to provide a one, two or three-layered cell structure
- Can be installed over ceiling joists and between or across wall studs, depending on the product
- Should be butted firmly together to prevent air movement through gaps
- R value depends on the number of cells and the presence of still air layers between the batts and other materials

Expandable concertina-style foil

- Double-sided reflective foil formed into an expandable concertina
- Used mainly under timber floors and between wall studs
- Adjustable width to suit varying gaps
- Should be installed with an adjacent sealed air space and be well sealed against the building frame

Foil bonded to bulk insulation

- Reflective foil bonded to batts, blankets or polystyrene boards
- Increases insulation benefits if installed with the foil facing a still air space
- Blankets are a common method of insulating cathedral ceilings and under flat roofs

Soundproofing

Some insulating materials can be used for soundproofing. Bulk insulation, particularly denser materials such as rockwool, has good sound absorbing qualities. The soundproofing performance of a particular product is measured by a sound reduction index referred to as Sound Transmission Class (STC). The higher the STC rating, the greater the soundproofing performance. If soundproofing is desired between rooms (e.g. between a bedroom and a bathroom), high density insulation can be installed in internal walls or between floors in a two-storey building. Blanket type insulation installed directly under metal roofing also helps reduce external noise caused by wind, rain and hail. Specialised acoustic insulation products are also available which provide even better soundproofing performance.

Overall R value

The overall R value is the total resistance of a building element. It takes into account resistance provided by construction materials used in a wall or ceiling, internal air spaces, thermal bridging, insulation materials and air films adjacent to solid materials. Each of these components has its own inherent R value, the sum of which provides the overall R value.

ADDED R VALUE

The added R value or added thermal resistance is the value of the insulating material alone. This is the term most used when buying insulation.

The manufacturer should provide the R value of bulk insulation. Some products will trap air or gas more effectively, and so will have a higher R value for a specified thickness. For example, 45 mm thick extruded polystyrene and 80 mm thick glasswool both have an R value of approximately 1.5.

Reflective insulation must work in conjunction with enclosed air spaces between surfaces, and cannot be said to have an R value by itself. To compare the performance of bulk and reflective insulation, the resistance of any existing air space(s) must be calculated. Reputable manufacturers can supply this information. Note that the effectiveness of reflective insulation installed on horizontal or sloping surfaces will eventually be reduced due to dust build-up, which reduces reflectivity.

THERMAL BRIDGING

Thermal bridging is the transfer of heat across building elements, which have less thermal resistance than the added insulation. This decreases the overall R value (see figure 7.8).

Wall frames and ceiling joists are examples of thermal bridges, having a lower R value than the insulating material placed between them. Because of this, the overall R value of a typical ceiling is reduced. For example, adding R2.5 bulk insulation between timber joists will result in an overall R value for the whole ceiling of R2.2. Metal framing, which has lower thermal resistance, reduces the overall R value even further. Consequently, higher levels of added insulation must be installed to compensate for this.

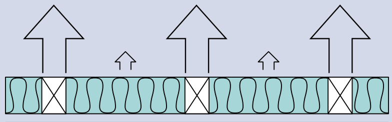


Figure 7.8: Thermal bridging through ceiling joists

Insulation levels

MINIMUM INSULATION LEVELS FOR VICTORIA

Whilst minimum thermal performance requirements are standard practice in many countries, Victoria is the only state in Australia to currently set minimum insulation levels. A national framework has been developed for House Energy Ratings which will address insulation as one of several components.

In March 1991, government regulations were introduced specifying minimum insulation levels for all new homes and extensions built in Victoria. Small alterations or renovations to existing buildings requiring a building permit may also have to comply with the regulations, depending on the local council.

The regulations ensure that a reasonable level of thermal insulation is incorporated into residential buildings. New buildings of classes I, II and III (includes all residential dwellings such as homes, flats and units, and the residential sections of hotels, motels, schools, special accommodation and health-care buildings) must reach these prescribed insulation requirements.

The regulatory requirements may be met by:

- complying with either of the following two basic options shown in table 7.2; or
- achieving a House Energy Rating of at least 3 stars and at least equivalent to that which would be achieved using option A or B (see table 7.2), as assessed by a registered building practitioner accredited in the use of the Sustainable Energy Authority's *FirstRate* house energy rating software.

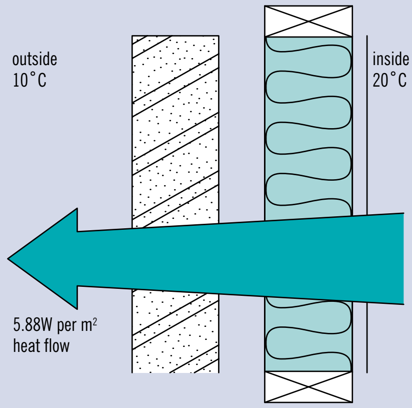
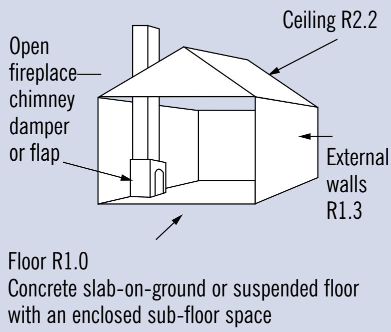
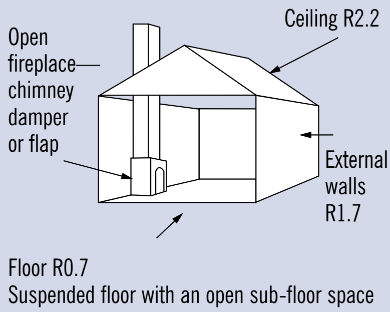


Figure 7.9: Heat transfer through R1.7 insulated brick veneer wall

Table 7.2: Minimum thermal insulation regulations

OPTION A: MINIMUM OVERALL R RATINGS		OPTION B: MINIMUM OVERALL R RATINGS	
Ceiling: R2.2	Equivalent to adding R2.5 batts between the joists	**Ceiling: R2.2**	Equivalent to adding R2.5 batts between the joists
Walls: R1.3	Equivalent to reflective foil in a framed wall	**Walls: R1.7**	Equivalent to R1.5 batts between the studs of a framed wall or R1.0 foam board over the face of the studs
Floor: R1.0	Equivalent to an uninsulated concrete slab-on-ground, or a timber floor with an enclosed sub-floor space	**Floor: R0.7**	Equivalent to a timber floor with an open sub-floor space
Open fireplace	Chimney damper or flap	**Open fireplace**	Chimney damper or flap





Common building materials, such as brick, timber or tiles have little inherent insulation value. The R values of some typical forms of wall construction are shown in Table 7.3. The regulations require a minimum R value of 1.3 for walls. Only 200 mm aerated concrete meets the Victorian minimum insulation requirements by itself. Brick veneer and weatherboard walls have R values of 0.51 and 0.53 respectively, thus needing the addition of insulation to comply with the regulations.

Table 7.3: Estimated R values* of common wall construction types

WALL CONSTRUCTION	OVERALL R VALUE
Weatherboard	0.55
Brick veneer	0.51
Cavity brick	0.53
Solid brick (230 mm thick)	0.44
Solid concrete (100 mm thick)	0.23
Solid concrete (200 mm thick)	0.30
Aerated concrete (100 mm block)	0.78
Aerated concrete (200 mm block)	1.54
Mud brick (300 mm block)	0.40

*As R value increases, the insulation benefit improves. Refer page7 for more information

Exemptions

Certain wall types have been exempted from the regulations. Cavity brick, mud brick, earth wall or other masonry walls thicker than 180 mm (excluding any cavity) are exempt from requiring wall insulation, provided the floor is of concrete or masonry in direct contact with the ground. To ensure adequate levels of energy efficiency and comfort, however, it is recommended that such walls be insulated to meet the minimum regulatory requirements.

Garages, where separated from the residential section of a house, are not subject to the regulations. Connecting walls between a garage and a house must still be insulated.

HIGHER INSULATION LEVELS RECOMMENDED

The insulation levels prescribed by the Victorian regulations are minimum requirements only. Higher levels of insulation will increase energy savings and comfort levels. In Melbourne for instance, adding R3.0 to ceilings and R1.5 to walls can save an additional 12% on energy bills each year. At a certain point, depending on the climate, the cost of adding extra insulation is not reflected in substantial savings on energy bills.

AS2627.1 (1993) contains recommended levels of insulation for locations throughout Australia. Table 7.4 is an extract of recommended levels of ceiling and wall insulation for Victoria. Note that many locations would benefit from installing more than the mandatory levels for greater energy efficiency and comfort, especially in areas which experience extreme temperatures.

Ceilings and walls

Added R3.5–R4.0 in ceilings and added R2.0 insulation in walls should be installed if:

- the home is in colder areas such as Ballarat, Macedon, Eildon or alpine areas.
- higher levels of comfort and energy savings are desired.

Added R1.0 polystyrene boards should be installed to all solid masonry and cavity brick walls. Insulation should be placed on the outside of the inner wall leaf where there is a cavity.

Floors

The minimum insulation regulations do not require floor insulation for concrete slab-on-ground construction. However energy savings will accrue from R1.0 polystyrene board slab-edge insulation, particularly if:

- building in cold climate areas; or
- slab heating is used.

Timber floors will benefit from additional insulation where:

- there is no carpet over timber floors;
- the underfloor space is open or well ventilated;
- they overhang garages, balconies, etc.; or
- you are building in cooler areas.

Table 7.4: Recommended levels of ceiling and wall insulation (Victoria)

LOCALITY	ADDED R VALUE		LOCALITY	ADDED R VALUE		LOCALITY	ADDED R VALUE	
	CEILINGS	EXTERNAL WALLS		CEILINGS	EXTERNAL WALLS		CEILINGS	EXTERNAL WALLS
Alexandra	3.0	2.0	Lakes Entrance	2.5	1.5	Shepparton	2.5	1.5
Ararat	3.0	2.0	Lismore	2.5	1.5	St Arnaud	2.5	1.5
Avoca	3.0	2.0	Lorne	2.5	1.0	Stawell	2.5	1.5
Bairnsdale	2.5	1.5	Macedon	3.5	2.0	Swan Hill	2.5	1.5
Ballarat	3.5	2.0	Maffra	2.5	1.5	Tatura	2.5	1.5
Beechworth	3.5	2.0	Maldon	3.0	2.0	Terang	3.0	2.0
Benalla	2.5	1.5	Mangalore	2.5	1.5	Tooradin	2.5	1.5
Bendigo	2.5	1.5	Maryborough	2.5	2.0	Warrnambool	2.5	1.5
Bogong	3.5	2.0	Melbourne	2.5	1.5	Wangaratta	2.5	1.5
Bright	3.0	2.0	Mildura	2.5	1.0	Warragul	2.5	1.5
Camperdown	2.5	1.5	Mitta Mitta	3.0	2.0	Wilsons Prom	2.5	1.5
Castlemaine	3.0	2.0	Mt Beauty	3.0	2.0	Wodonga	2.5	1.5
Colac	3.0	2.0	Mt Buffalo	4.0	2.0	Wonthaggi	2.5	1.5
Corryong	3.0	2.0	Mt Dandenong	3.5	2.0	Yallourn	2.5	1.5
Creswick	3.5	2.0	Mt St Leonard	3.5	2.0	Yarrawonga	2.5	1.5
Donald	2.5	1.5	Nhill	2.5	1.5			
Dookie	2.5	1.5	Noojee	3.0	2.0			
Echuca	2.5	1.5	Numurkah	2.5	1.5			
Erica	3.0	2.0	Omeo	3.5	2.0			
Euroa	2.5	1.5	Orbost	2.5	1.5			
French Island	2.5	1.5	Ouyen	2.5	1.5			
Forrest	3.0	2.0	Point Lonsdale	2.5	1.5			
Geelong	2.5	1.5	Portsea	2.5	1.5			
Hamilton	2.5	1.5	Queenscliff	2.5	1.5			
Heathcote	3.0	2.0	Rennick	3.0	2.0			
Horsham	2.5	1.5	Robinvale	2.5	1.0			
Jeparit	2.5	1.5	Rochester	2.5	1.5			
Kerang	2.5	1.5	Rubicon	4.0	2.0			
Kyabram	2.5	1.5	Rutherglen	3.0	2.0			
Kyneton	3.5	2.0	Sale	2.5	1.5			
Lake Eildon	3.5	2.0	Seymour	3.0	2.0			

Insulation selection

When selecting insulation, ensure that the material is:

- the recommended R value for the relevant area;
- appropriate for the intended installation;
- a material covered by Australian Standards or approved by other recognised testing authorities; and
- sufficient to meet local building authority requirements.

A list of recommended levels of ceiling and wall insulation is provided in table 7.4.

Fire safety

All insulation products should be independently tested for flammability prior to being sold. *AS1530.1 (1989)* provides a standard testing procedure to measure:

- ignitability;
- the spread of flame;
- if the material is heat evolved; and
- if the material is smoke evolved.

Ignitability is rated on a scale of zero to 20, while other factors are rated on a scale of zero to ten. The lower the number, the smaller the risk.

Cellulose fibre must be treated with a fire retardant such as a mix of borax and boracic acid during manufacture. The treatment ensures that, if the material does ignite, the flame will not spread. Expanded and extruded polystyrene are combustible, and should only be installed between fire-resistant surfaces (this includes plasterboard). Natural wool is flame resistant, provided only pure, new scoured wool is used. Wool which is oily, or has synthetic fibres mixed with it is potentially flammable.

As there is no Australian Standard, the quality of individual products may vary considerably. Ensure that the manufacturer supplies details of independent fire resistance tests. All other insulation products are essentially non-combustible.

Suggested applications for insulation products

Table 7.5 provides general information about the various insulation products currently available, together with the most common applications for each product. It is possible to adapt most products for different uses if required.

Table 7.5: Insulation products and possible applications

	INSULATING MATERIAL	MATERIAL DESCRIPTION	TYPICAL APPLICATIONS						
			FLAT CEILINGS PITCHED ROOFS	CATHEDRAL CEILINGS OR RAKED CEILINGS	TIMBER FLOORS	SUSPENDED CONCRETE SLABS	CONCRETE SLAB EDGES	FULL MASONRY WALLS	FRAMED WALLS
BATTS AND BLANKETS	Glasswool	Manufactured from melted glass spun into a mat of fine fibre. Made to an Australian Standard and commonly sold in DIY packs with R values clearly labelled. Easy to cut and install. Remains inert. Should not be compressed or moistened. Butt all ends and edges together firmly.	✔	✔	✔				✔
BATTS AND BLANKETS	Rockwool	Volcanic rock melted at high temperatures and spun into a mat of fine fibres. Denser than glasswool so R value per unit thickness is higher. Good sound absorption properties. See glasswool for other characteristics.	✔	✔	✔				✔
BATTS AND BLANKETS	Glasswool/ rockwool—foil attached	Characteristics same as above with foil providing increased insulating value (in summer) and moisture resistance. R value depends on method of installation.	✔	✔					
BATTS AND BLANKETS	Natural wool	Should only be made from new, scoured wool. Must be treated with a vermin/rot proofing agent during the scouring process. Dirt or grease can add to flammability. Some include synthetic (usually polyester) fibres to reduce settling and compression. The Wool Mark logo signifies the batt is made from pure wool only. No Australian Standard as yet.	✔	✔	✔				✔
BATTS AND BLANKETS	Polyester	Manufactured from polyester strands spun into a mat. Similar physical properties to glasswool and rockwool. Non-toxic, with no known physical or health hazards. Does not burn, but will melt if exposed to a direct flame. Butt all edges firmly. No Australian Standard as yet.	✔	✔	✔				✔
BOARDS	Extruded polystyrene (styrofoam)	Rigid boards of close cell polystyrene which retain air but exclude water. High R value per unit thickness. Suitable where space is limited. Easy to cut and install. Should only be used between non-combustible materials such as brick, aluminium and plasterboard. Can be rendered. Most commonly used material for slab-edge and cavity brick wall insulation. Greater structural strength and moisture resistance than expanded polystyrene.		✔	✔	✔	✔	✔	✔
BOARDS	Expanded polystyrene (EPS)	Semi-rigid boards of white polystyrene beads. High water absorbency. Combustible and should only be used between fire resistant materials. Easy to cut and install. Available as preclad panels.		✔	✔	✔	✔	✔	✔
BOARDS	Expanded polystyrene—foil attached	Expanded polystyrene boards sandwiched between reflective foil. Characteristics same as above, however, higher R values achieved due to the addition of two reflective surfaces and higher water resistance.		✔					✔

Table 7.5 continued

	INSULATING MATERIAL	MATERIAL DESCRIPTION	TYPICAL APPLICATIONS						
			FLAT CEILINGS PITCHED ROOFS	CATHEDRAL CEILINGS OR RAKED CEILINGS	TIMBER FLOORS	SUSPENDED CONCRETE SLABS	CONCRETE SLAB EDGES	FULL MASONRY WALLS	FRAMED WALLS
LOOSE FILL	Cellulose fibre	Manufactured from waste paper pulverised into a fine fluff. Fire retardant added. Generally pumped into roof by contractor. Difficult for the purchaser to ensure uniform thickness and density if installing by hand. Product should be manufactured to AS2462 and installed in a consistent, even layer. Must be kept dry. Must not be compressed. Settling of up to 20 mm per 100 mm thickness may occur, decreasing performance.	✔	✔					
LOOSE FILL	Granulated rockwool	Properties as per rockwool batts. However, material is loose, not a prefabricated mass. Treated with a water repellent. Should be installed in an even, consistent manner.	✔	✔				✔	✔
LOOSE FILL	Natural wool	Made from off-cuts of natural sheep's wool. Quality and density can vary considerably, affecting the R value. Other characteristics same as for natural wool batts.	✔	✔					
REFLECTIVE	Reflective foil	Aluminium foil laminated with glass fibre reinforcement. Supplied in rolls, one side often painted with an anti-glare paint. Does not have a significant R value itself, and requires a sealed air space of at least 25 mm between foil and solid surface to achieve full insulation qualities. Gaps in foil reduce performance. Valuable in combination with bulk insulation for enhancing performance. Useful barrier against transfer of moisture. Reflective surface needs to remain clean and dust-free. Dust build-up reduces R value.	✔	✔	✔				✔
REFLECTIVE	Concertina foil batts	Expandable concertina folded foil-paper laminate. Can be adjusted to suit varying gaps. Other characteristics identical to laminate bought as rolls.			✔				✔
REFLECTIVE	Multi-cell foil batts	Prefabricated batts made from layers of laminated foil with partition reflective strips to produce a cell construction with enclosed air cavities. Gaps will significantly reduce performance. Double or triple-cell batts (two and three layers of cells, respectively) may be necessary to achieve adequate winter insulation levels. Dust build-up reduces R value.		✔	✔				✔

Table 7.5 continued

	INSULATING MATERIAL	MATERIAL DESCRIPTION	TYPICAL APPLICATIONS						
			FLAT CEILINGS PITCHED ROOFS	CATHEDRAL CEILINGS OR RAKED CEILINGS	TIMBER FLOORS	SUSPENDED CONCRETE SLABS	CONCRETE SLAB EDGES	FULL MASONRY WALLS	FRAMED WALLS
BUILDING MATERIALS	Aerated concrete	Lightweight concrete blocks or panels aerated to trap insulating pockets of air. Blocks provide solid masonry wall and insulation in the one product. Good thermal and acoustic properties. Non-combustible. Easy to handle.						✔	✔
	Expanded polystyrene	Hollow forms filled with concrete. Hollow EPS blocks and panels create a solid formwork which is then filled with concrete, or sprayed with an external concrete render.						✔	
	Insulated panelling	A range of building products incorporating inner and/or outer vinyl, cement or metallic materials rendered onto extruded or expanded polystyrene. Designed to be used as pre-insulated external or internal panelling on roofs or walls or as a replacement for conventional tilt concrete construction. Some manufacturers use polyurethane foam or mineral wool in place of polystyrene. Characteristics vary depending on product.	✔	✔				✔	✔
	Weatherproof housewrap	Sheeting made of polyethylene fibres bonded together by heat and pressure. Added to buildings during construction to weatherproof and draught proof walls. Can add up to R0.8 to walls by trapping a layer of still air.	✔	✔	✔				✔

Installing insulation

INSTALLATION GUIDELINES

It is vital that insulation is installed with careful attention to detail, as incorrect or inappropriate installation will significantly decrease performance. For instance, failure to butt all ends and edges of batts to give a snug fit could result in 5% of the ceiling area not being covered, losing up to 50% of the potential insulation benefits.

RELEVANT STANDARDS FOR INSTALLATION

Various Australian Standards and national codes of practice cover the installation of insulation products with key standards set out below.

Bulk insulation must be installed in compliance with *AS3999: Thermal insulation of dwellings—Bulk insulation—Installation requirements*.

Reflective foil insulation must be installed in compliance with *AS1904: Code of practice for installation of reflective foil laminate in buildings*.

All electrical wiring encased in insulation must conform to *AS3000: Electrical installations—buildings, structures and premises*. In existing dwellings, which may not conform to this standard, spacers must be installed to ensure that wiring is not in contact with the insulation (refer *AS3999*).

It is best to keep wiring clear of insulation, e.g. run wiring on top of ceiling joists.

Installation safety when installing mineral wool (glasswool and rockwool), insulation should comply with Work Safe Australia's *National code of practice for safe use of synthetic mineral fibres (1990)*.

PRINCIPLES OF INSTALLATION

The following installation principles will ensure the best possible performance from insulation.

- Avoid gaps in insulation
- Do not compress bulk insulation
- Eliminate thermal bridges
- Allow clearance around appliances and fittings
- Protect insulation from contact with moisture
- Provide a sealed air space with reflective insulation
- Provide vapour and moisture barriers to prevent condensation
- Eliminate thermal bridges

Table 7.6: Some installation techniques to improve thermal performance

SITUATION	TECHNIQUE
Gaps where insulation not installed	Fit batts snugly leaving no gaps around ducts and pipes
Gaps between pieces of insulation	Make sure corners, junctions of wall, floor and ceiling are fully covered
Compression of bulk insulation	Retain maximum thickness, allow to fully expand
Structural framing—metal, timber	Isolate metal framing from contact with cladding, or increase level of added insulation. Isolate timber framing from contact with cladding in alpine areas
Metal window frames	Insulate window frames or install windows with thermal breaks

CLEARANCE AROUND APPLIANCES AND FITTINGS

Some appliances and fittings, such as recessed downlights and heater flues, require free space around them for the dissipation of heat, to reduce fire hazard. Insulation should not be placed against these fixtures. Regulations and manufacturers' recommendations should always be checked before installing insulation. Table 7.7 sets out some common installation clearances.

Table 7.7: Insulation clearance requirements

ITEM TO BE CLEARED	TECHNIQUE
Recessed downlights	Minimum clearance of 25 mm
Flues and exhaust fans	Minimum clearance of 90 mm
Loose fill insulation material	Use barriers to restrain and ensure adequate clearance
Electrical wiring (existing home)	Check by electrician before installing insulation. Keep wiring clear of insulation. Restrain loose fill material by spacers

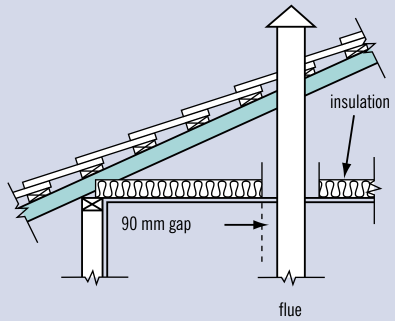


Figure 7.10: Insulation clearance around flues

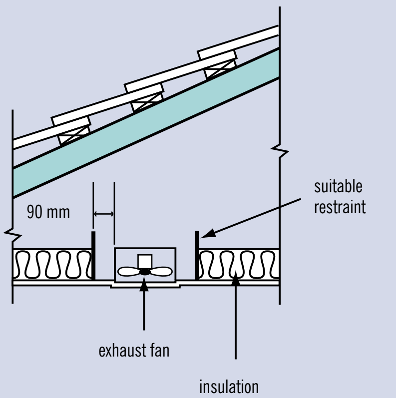


Figure 7.11: Insulation clearance around exhaust fans

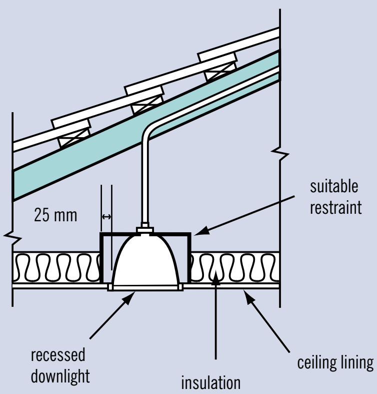


Figure 7.12: Insulation clearance around recessed downlights

Condensation

Air always contains a certain amount of water vapour. This vapour can originate from many sources around the home—respiration, cooking, bathrooms and laundries, indoor plants, LPG gas heaters and so on. When moist air is cooled below its dewpoint (i.e. cooled to a temperature at which it cannot contain all the water originally present), and if the cooling is caused by contact with a colder surface, the vapour changes to liquid droplets on that surface. This phenomenon is called condensation.

Condensation is more likely to occur:

- where there is a low ventilation rate within the walls or roof space, insufficient to remove water vapour (e.g. cathedral and flat roof ceilings);
- where daytime temperatures do not exceed 5°C (e.g. in alpine areas in winter); and
- where high amounts of water vapour are generated internally but not mechanically exhausted.

CONDENSATION ON INTERIOR SURFACES

Insulation, correctly installed, can keep the interior surface temperature of ceilings and external walls above the dewpoint, preventing condensation on these surfaces. Condensation control involves preventing moist air from coming into contact with cold surfaces below the dewpoint of the air by one or more of the following means:

- removing moisture-laden air by controllable ventilation or exhaust fans;
- insulating to keep ceiling and wall temperatures above dewpoint, and to reduce the difference between room temperature and surface temperatures; and
- background heating to prevent interior surfaces from cooling below the dewpoint.

INTERSTITIAL CONDENSATION

In cold conditions, condensation may occur within the roof space (especially where metal deck roofs are used) or walls and within the insulation itself. Exhausting moist air into the roof space or wall cavity may also cause condensation. Such condensation is known as interstitial condensation. It can cause mould, mildew and rotting of building components. In addition, the effectiveness of insulation is significantly reduced when it contains water.

Condensation is a particular hazard in cathedral and flat roof systems where the low ventilation rate within the roof space may be insufficient to remove water vapour contained in the air, or condensed upon or within building components.

These problems can be avoided by either providing sufficient ventilation within the wall or roof space to remove water vapour, or by installing vapour barriers such as reflective foil on the warm side of insulation. This prevents water vapour from contacting cool surfaces within the walls or roof structure.

Exhaust fans in buildings with metal deck or tiled roofs with sarking (reflective foil installed under roofing material for weatherproofing) must be ducted to the atmosphere.

PROTECT INSULATION FROM CONTACT WITH MOISTURE

Masonry walls are not waterproof. In both brick veneer and double-brick wall construction a cavity between the external masonry wall and the internal lining keeps the internal lining dry. Moisture on the internal face of the external masonry wall can drain away through weepholes or evaporate into the cavity. Table 7.8 sets out techniques to prevent the insulation from absorbing moisture from the external leaf and losing effectiveness.

Table 7.8: Keeping insulation dry in wall cavities

SITUATION	TECHNIQUE
Brick veneer construction	Restrain bulk insulation within the frame. Reflective foil laminate, polypropylene lashing, nylon cord, galvanised wire or building paper can be used to keep bulk insulation in place
Cavity masonry walls	Restrain bulk insulation to maintain at least 30 mm cavity
Existing wall cavities	Use 'cavity fill' water-repellent loose-fill granular rockwool insulation. Contains water-repelling agent to prevent absorption of moisture. Not allowed by some building authorities because of concern over moisture penetration

PROVIDE A SEALED AIR SPACE WITH REFLECTIVE INSULATION

Reflective insulation adjacent to a solid surface without an airspace, has no insulative value and acts only as a vapour barrier. To add thermal resistance, reflective insulation must face a sealed air space (see figure 7.13).

To maximise the effectiveness of reflective foil:

- maintain a sealed air space of at least 25 mm;
- eliminate air movement between air spaces on either side of the foil;
- overlap sheets by 150 mm and tape over joins;
- seal any gaps;
- use face-of-wall brick ties instead of ties which penetrate the foil; and
- reflective surfaces should be kept clean and dust free, vertical installation is best for this.

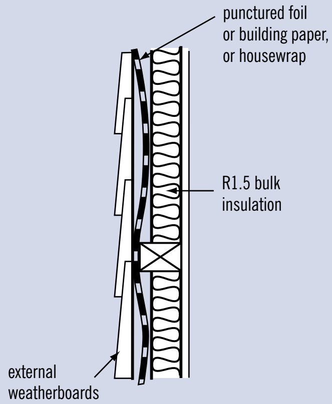


Figure 7.13: Reflective insulation with sealed air space (weatherboard wall)

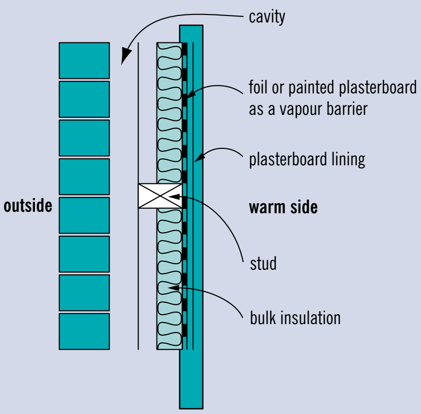


Figure 7.14: Place vapour barrier on the warm side of insulation (brick veneer wall)

PROVIDE BARRIERS TO PREVENT CONDENSATION

Condensation in bulk insulation reduces its insulating properties significantly. Vapour barriers stop the transmission of water vapour generated inside the home, through the building elements and into the building structure.

A vapour barrier installed on the warm side of insulation will prevent moist air from contacting a cold surface (see figure 7.14). The vapour barrier should be continuous, with no breaks. Vapour barriers include well-maintained painted surfaces, polythene sheeting and aluminium foil. If aluminium foil is required to act as both thermal insulation and a vapour barrier, ensure that a still airspace is provided.

Painted surfaces generally provide adequate protection from condensation in Victorian climates.

Moisture barriers stop the transmission of water from outside the home entering through the building elements. Sarking may be installed directly under roofing material to act primarily as a moisture barrier. It is usually made of reflective foil laminate (which adds to the insulation effect), or other waterproof material.

HEALTH AND SAFETY

Glasswool, rockwool and cellulose fibre

Claims have been made regarding exposure to glasswool and rockwool as an apparent ongoing health risk, particularly in reference to cancer. However, continuing medical research has failed to find any evidence to support these claims. In 1994, The Institute of Respiratory Medicine Royal Prince Alfred Hospital, NSW, investigated the Respiratory Health of Australian Glasswool and Rockwool Manufacturing Industry, for the Insulation Wools Research Advisory Board. They found no evidence of occupational asthma, pulmonary fibrosis or lung cancer.

The main risk associated with glasswool and rockwool is short-term irritation to skin, eyes, nose and throat. This reaction is a physical reaction, not an allergic reaction. Cellulose fibre may cause minor eye and respiratory irritation when handled. For most people, the irritation quickly disappears. Once installed, the insulation should present no further problems. However additional weatherstripping should be installed around access holes and ceiling cracks.

The irritation caused by these fibres can generally be avoided by:

- minimising dust release when opening insulation wrapping;
- wearing long-sleeved, loose-fitting clothing and gloves during installation;
- wearing goggles and head covering, especially when installing insulation overhead;
- wearing a half-face (Class L or M) disposable respirator during work in enclosed or poorly-ventilated spaces;
- washing skin with warm, soapy water following installation; and
- washing protective clothing separately.

Reflective foil

Reflective foil can cause dangerous glare and even sunburn if installed outdoors. Anti-glare products should be selected if installed in sunlight and adequate eye protection should be worn.

Installation options

CEILING INSTALLATION

The following details illustrate ways of achieving an overall minimum insulation level of at least R2.2 for a variety of ceiling and roof types for Victoria.

FLAT CEILINGS WITH PITCHED ROOFS

This is the most common form of ceiling and the easiest to insulate.

Bulk insulation between ceiling joists

The use of only bulk insulation between joists is shown in figure 7.15. With added R2.5 bulk insulation, the overall R value is 2.2. This can be increased to 2.7 by using R3.0 or higher.

Bulk insulation and reflective foil between ceiling joists

The use of bulk insulation between ceiling joists as well as reflective foil directly under the roof is shown in figure 7.16. The use of double-sided reflective foil placed directly under the roof improves summer and winter performance and provides a moisture barrier (sarking). Foil alone has an overall R value of approximately 0.5 and must be supplemented by other insulation to satisfy the minimum insulation level. With added R2.0 bulk insulation, the overall value is R2.3. This can be increased to R2.7 by using R2.5 or greater.

Ceilings with exposed rafters

These roofs include sloping ceilings, cathedral ceilings, vaulted ceilings, flat and skillion roofs. Ceilings with exposed rafters require insulation to be installed during construction, as it cannot be accessed later.

Roof space can be very limited in these situations. Note that 100–125 mm batten height is needed to avoid compression of R2.5 bulk insulation. For this reason consider materials that offer the same R value with less thickness, e.g. extruded or expanded polystyrene boards.

These roofs are more susceptible to problems of condensation due to the low ventilation rate in the roof space, so a vapour barrier installed directly above the ceiling lining may be a useful inclusion.

Bulk insulation and vapour barrier between battens

A metal deck roof with bulk insulation between battens with a vapour barrier is shown in figure 7.17. With added R2.5 bulk insulation, the overall value is R2.2. The overall R value can be increased to 2.7 by using R3.0 bulk insulation. An alternative solution is to use 50 mm extruded polystyrene boards laid above the ceiling lining requiring no vapour barrier and providing an overall R value of 2.3.

Bulk insulation blanket over battens

A metal deck roof with bulk and reflective insulation is shown in figure 7.18. With added R2.5 foil backed batts or blankets, the overall R value is 2.2. Compression of bulk insulation reduces its effectiveness. An alternative solution is to use 25 mm expanded polystyrene foil boards installed between the ceiling and metal deck roof, with a 25 mm air space above and below. This would provide an approximate overall R value of 2.2.

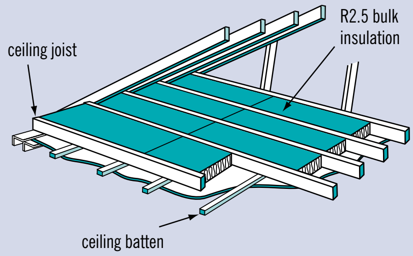


Figure 7.15: Bulk insulation between joists (overall R value 2.2)

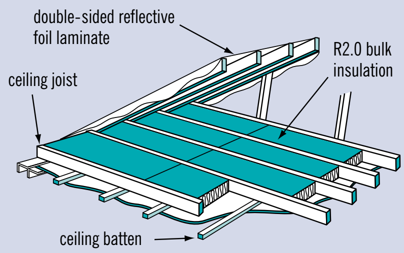


Figure 7.16: Bulk insulation between ceiling joists and reflective foil under roof (overall R value 2.3)

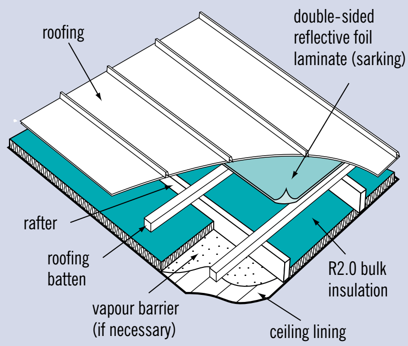


Figure 7.17: Bulk insulation between battens and vapour barrier under metal roof (overall R value 2.2)

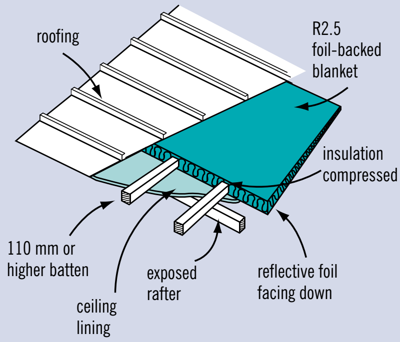


Figure 7.18: Foil backed bulk insulation over battens under metal roof (overall R value at least 2.2)

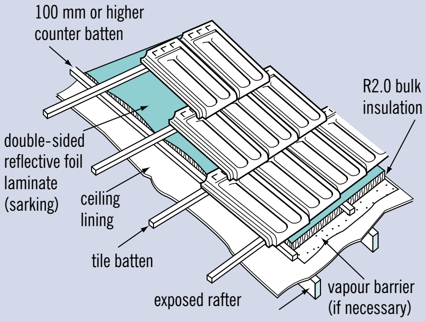


Figure 7.19: Bulk insulation and reflective foil between counter battens under tiled roof (overall R value at least 2.2)

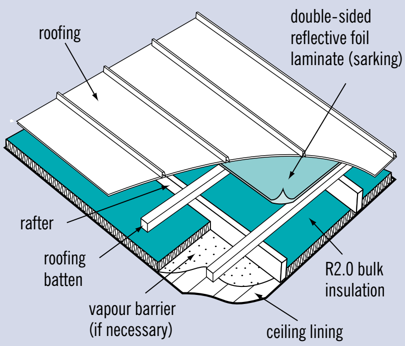


Figure 7.20: Bulk insulation between rafters and vapour barrier under metal roof (overall R value 2.2)

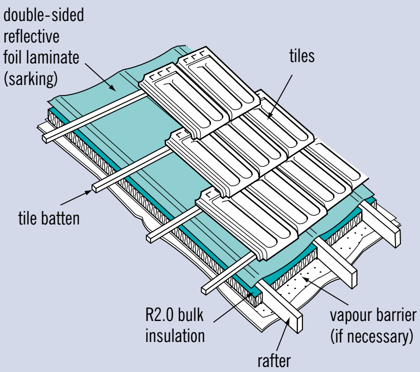


Figure 7.21: Bulk insulation between rafters and vapour barrier under tiled roof (overall R value 2.2)

Bulk insulation and reflective foil between counter battens under tiled roof

A tiled roof with bulk and reflective insulation is shown in figure 7.19. With added R2.5 bulk insulation and reflective foil, the overall R value is at least 2.2. This can be increased to 2.7 by using R3.0 batts, requiring a minimum batten depth of 125 mm.

Ceilings with concealed rafters

Such roofs include sloping ceilings, cathedral ceilings, vaulted ceilings, flat and skillion roofs. Bulk insulation may be placed between rafters, and moisture problems avoided by placing a vapour barrier directly above the ceiling lining. Extruded polystyrene products do not require a vapour barrier.

Bulk insulation between rafters and vapour barrier

A metal deck roof with air space, bulk insulation and a vapour barrier beneath is shown in figure 7.20. With added R2.5 bulk insulation, the overall R value is 2.2. This can be increased to 2.7 by using R3.0 or higher batts, requiring a minimum rafter depth of 125 mm.

Bulk insulation between rafters and vapour barrier

A tiled roof with bulk insulation and a vapour barrier beneath is shown in figure 7.21. Note that sarking is used below the tiles as a moisture barrier. With added R2.5 bulk insulation, the overall R value is at least 2.2. This can be increased to 2.7 by using R3.0 or higher batts, requiring a minimum rafter depth of 125 mm.

EXTERNAL WALL INSTALLATION

The following notes provide information on correctly installing wall insulation and illustrate ways of achieving at least an overall minimum insulation level of R1.3 for a variety of external wall construction types (refer to page 52 for minimum insulation level for Victoria).

Existing walls

For existing housing, wall insulation can be installed by removing internal or external linings to access the cavity, and then replacing the linings. Alternatively wall cavities can be filled with granulated rockwool, if permitted by local building regulations. It is costly to insulate existing walls and often difficult to access the cavity. In these circumstances the insulation installation cost may be better invested in extra ceiling or floor insulation, or other energy saving measures.

Wall sections with a roof space

It is essential to insulate vertical wall sections within the roof space above ceilings of different heights, as these can be a major source of heat loss. These sections should be insulated to the same level as the ceiling (see figure 7.22).

Vapour barriers

Where there is a risk of condensation, install reflective foil or polythene sheets on the warm side of wall insulation to act as a vapour barrier. Well-maintained painted or foil-backed plasterboard also act as vapour barriers (see figure 7.15).

Framed walls: Brick veneer and weatherboard

Reflective foil should be installed on the outside of wall studs, creating a still air layer on either side of the foil. The material must be continuous, and any holes, tears or joins in the foil must be taped over.

For weatherboard or cladding construction (where the outer skin is in contact with the timber framing), the foil should be dished between the studs to create still air pockets on both sides. Perforated or 'breather' foil should be used with weatherboard walls, as it allows the timber to breathe and prevents warping.

Framed walls with reflective foil laminate

By installing double-sided reflective foil on the outside of the framed walls (studs), achieves an overall R value of 1.3. This can be increased to R1.8 if combined with concertina-style reflective foil stapled between the studs as well (leaving at least 25 mm air space between them).
The use of reflective foil over framing is shown in figure 7.23. Suitable materials are double-sided reflective foil laminate and reflective building paper.

Framed walls with reflective foil batts

The use of reflective foil batts between framing is shown in figure 7.24. Suitable materials are concertina-style reflective foil laminate or single-cell foil batts, both stapled between the studs.

The overall R value is 1.4, and can be increased to 1.8 by using two layers of concertina batts stapled between the studs (leaving at least 25 mm air space between them), or by using double-cell foil batts stapled between the studs.

Weatherboard walls with bulk insulation and reflective foil

The use of weatherboard walls with bulk insulation is shown in figure 7.25. Weatherboards should be lined with a fire retardant building paper or perforated reflective foil attached to the outside of the frame, with R1.5 bulk insulation between the studs. The overall R value is at least 1.7 and can be increased to at least 2.2 by using batts with an R value of 2.0.

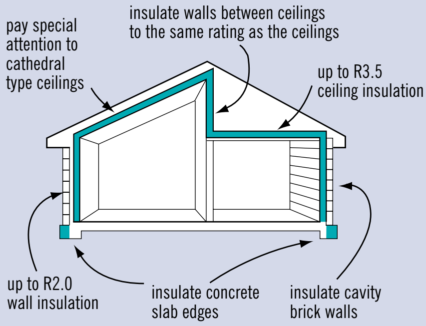


Figure 7.22: Insulate vertical wall sections between ceilings of different heights

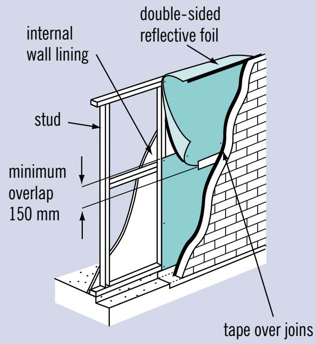


Figure 7.23: Framed walls with reflective foil (overall R value 1.3)

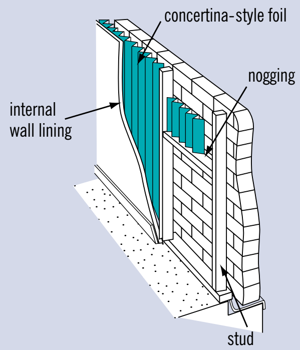


Figure 7.24: Framed walls with reflective foil batts (overall R value 1.4)

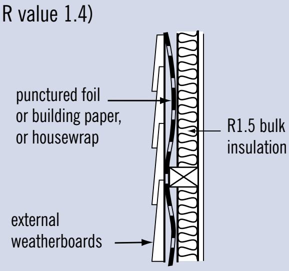


Figure 7.25: Weatherboard walls with bulk insulation and reflective foil (overall R value at least 1.7)

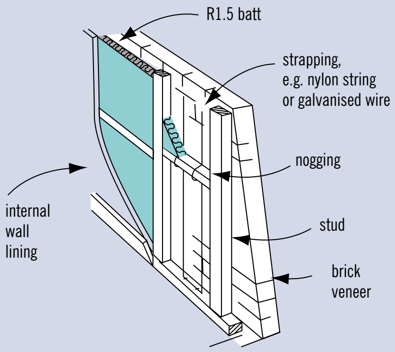


Figure 7.26: Framed walls with bulk insulation between studs (overall R value 1.7)

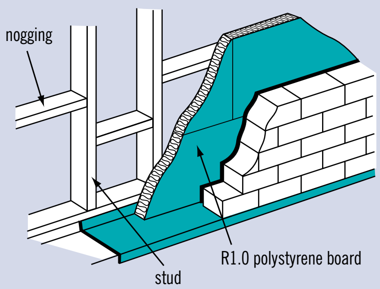


Figure 7.27: Brick veneer walls with bulk insulation across the studs (overall R value 1.7). Particularly suitable where metal framing is used

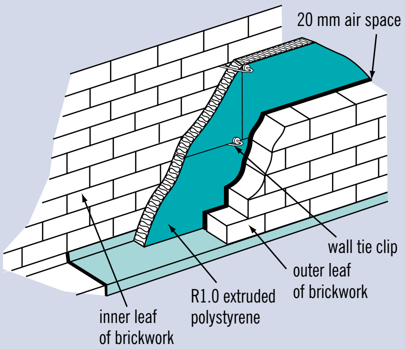


Figure 7.28: New cavity brick wall with bulk insulation within the cavity (overall R value 1.7)

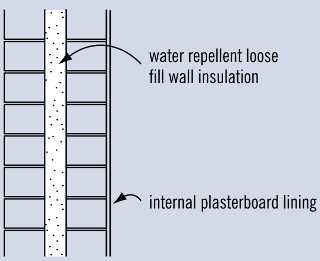


Figure 7.29: Existing cavity brick wall with cavity fill insulation (overall R value 1.5)

Brick veneer walls with bulk insulation between studs

The use of bulk insulation between studs is shown in figure 7.26. Strapping, reflective foil or building paper should be used to prevent R1.5 batts falling against the cladding or bricks and absorbing moisture from them. The overall R value is 1.7 and can be increased to 2.2 by using batts with an R value of 2.0.

Brick veneer walls with insulation boards across studs

The use of bulk insulation across the outside face of studs is shown in figure 7.27. Insulating across the outside of the frame reduces thermal bridging through the frame and achieves a better overall insulation value when comparing the addition of products with equivalent R values.
This method is particularly suitable for metal framing. Although other products can be used, ten millimetres of foil-faced expanded polystyrene or R1.0 extruded polystyrene boards are the most practical for this type of insulation, as they maintain a 25 mm cavity between the external cladding and the insulation.
The overall R value is 1.7 and can be increased to over 2.0 by using thicker boards.

Double brick cavity walls

Insulating a double brick wall is relatively simple if insulation is installed during it's construction. For established homes, existing walls can be insulated using either loose-fill cavity insulation or internal or external insulation, however it is difficult and more costly to install. Internal insulation is less effective than external insulation as it isolates the thermal mass benefits of the wall from the inside of the dwelling and reduces the internal size of the room.

New cavity brick wall with insulation boards within the cavity

The use of insulation boards in the cavity of new walls is shown in figure 7.28. The boards are pushed over the brick ties of the internal brick wall. Foil-faced expanded polystyrene (ten millimetres) or R 1.0 extruded polystyrene boards are typically used. They are self-supporting and need only small clips to keep them in place. The overall R value is at least 1.7.

Existing cavity brick wall with cavity fill insulation

The use of cavity fill insulation in an existing wall is shown in figure 7.29. Subject to local building regulations, the cavity can be filled with water-repellent loose-fill rockwool insulation.
R 1.0 hydrophobic loose-fill rockwool is also suitable. The overall R value is 1.5.

Solid walls: brick, mud brick and concrete
Solid masonry walls, including concrete block, concrete panel, mud brick, pise and solid brick forms of construction without cavity and less than 180 mm thick, should have internal or external insulation applied to meet Victorian Insulation Regulations. The insulation must be protected from contact with moisture by using a moisture barrier for external insulation and a vapour barrier for internal insulation. External insulation provides the advantage of containing the thermal mass within the building envelope, and protects the wall from moisture absorption. Construction techniques and total R values depend on the product used.

Solid walls may be constructed using materials such as 200 mm thick aerated concrete that have an inherent R value and do not require additional insulation to satisfy the insulation regulations. Other products available include cement-rendered straw bales, Thermomass (two concrete panels joined together with polystyrene insulation between them), and Thermocell (polystyrene foam cell filled with concrete).

Solid masonry wall with internal insulation
The use of internal insulation is shown in figure 7.30. Suitable materials, together with a wall lining, are R1.0 batts or polystyrene boards. If extruded polystyrene or foil-faced expanded polystyrene is used, no vapour barrier is necessary. The overall R value is at least 1.3 (dependent on wall thickness, material and insulation).

Solid masonry wall with external insulation
The use of external insulation is shown in figure 7.31. Suitable materials are R1.0 extruded polystyrene boards together with an external impact and weather resistant finish. The overall R value is at least 1.3 (dependent on wall thickness, material and insulation).

FLOOR INSULATION

The following notes illustrate ways of insulating a variety of floor construction types.

Concrete slab-on-ground floors generally do not require added insulation, unless the home is constructed in an area with a high water table or where in-slab heating is installed.

The first step in reducing heat loss through a timber floor is to enclose the under-floor space, maintaining sufficient ventilation to satisfy local building requirements to prevent rotting. Next, where appropriate, provide a good underlay and carpet. If this is not possible, under-floor insulation may be necessary. Overall R values depend on the type of sub-floor (i.e. open or enclosed).

In some situations, insulation of timber or suspended slab floors may increase discomfort in summer. This can occur in regions where there is a significant hot summer season, as the opportunity for heat loss to the cool air or ground below the floor has been reduced with insulation. Therefore, it is wise to limit insulation of these floors.

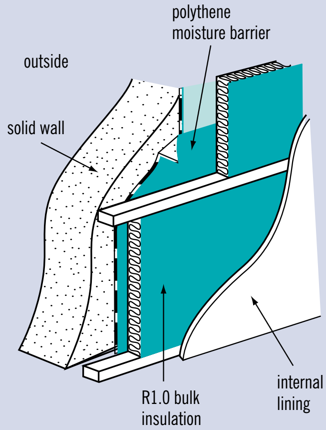


Figure 7.30: Solid masonry wall with internal insulation (overall R value 1.4)

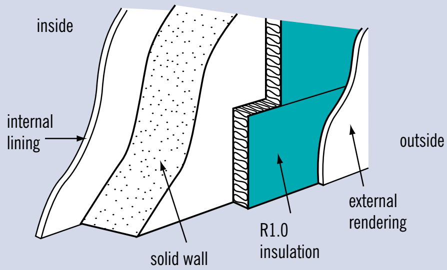


Figure 7.31: Solid masonry or concrete panel wall with external insulation (overall R value 1.4)

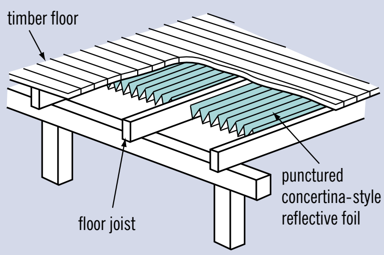


Figure 7.32: Suspended timber floor with perforated concertina-style reflective foil batts (overall R value 1.0)

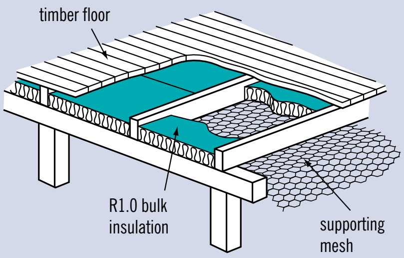


Figure 7.33: Suspended timber floor with bulk insulation between the joists and supporting mesh (overall R value at least 1.3)

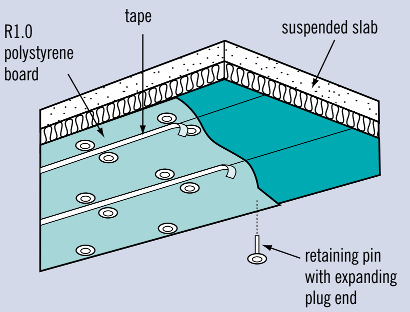


Figure 7.34: Suspended concrete slab with polystyrene board insulation (overall R value 1.2)

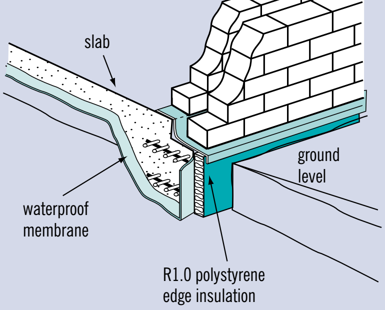


Figure 7.35: Heated concrete slab, insulated around the edge with extruded polystyrene (overall R value 2.2).

Suspended floors

Suspended timber floor with reflective foil

The use of perforated concertina-style reflective foil batts with a suspended timber floor is shown in figure 7.32. Perforated foil maintains a still layer of air under the floorboards, whilst allowing moisture to escape, preventing warping and deterioration of the flooring. The foil can be stapled between the floor joists (where concertina-style foil is used), or reflective foil laminate placed over the joists and dished between them, to provide a still air space, before the flooring is laid. The overall R value is at least 1.0.

Suspended timber floor with bulk insulation between joists

The use of bulk insulation between the joists of a suspended timber floor is shown in figure 7.33. Supporting mesh (non-degradable material, e.g. nylon, galvanised wire) should be laid under the floor joists. Suitable materials for insulation are R1.0 batts or polystyrene boards. Boards can be attached to the underside of the joists using fixing spikes or long staples. The overall R value is at least 1.3.

Suspended concrete slab with polystyrene board insulation

The use of polystyrene boards below a suspended concrete slab is shown in figure 7.34. R1.0 expanded or extruded polystyrene boards are attached to the underside of the slab using retaining pins. Insulation is essential for heated suspended slabs. The overall R value is 1.2.

Slab-on-ground floors

Edge insulation is recommended for a heated slab, or a slab-on-ground where the water table is high, as approximately 80% of heat loss from the slab occurs through the edge. For structural reasons it is not recommended that insulation be installed under concrete edge beams.

Heated concrete slab with edge insulation

The use of edge insulation with a heated slab-on-ground floor is shown in figure 7.35. Insulation should be installed before the concrete is poured. Ensure that insulation forms a continuous barrier around the slab edge, with no gaps. In termite-prone areas, the slab edge needs to be visible for inspections. Contact manufacturers for specific installation details, especially with regard to placement of insulation in relation to the waterproof membrane. The only suitable materials, due to their waterproof qualities, are extruded and expanded polystyrene boards of R1.0 or higher. The overall R value is 2.2 in the insulated section only.