DATAsheet

JUNE 2011

ENERGY EFFICIENCY in Building Regulations and the Use of Concrete in Housing

INTRODUCTION

Since the early 1980s there has been steady progress towards increasing the energy efficiency of building envelopes, with a view to reducing the consumption of operational heating and cooling energy, and reducing greenhouse gas emissions.

In 2003, the Australian Building Codes Board (ABCB) published amendments to the Building Code of Australia (BCA) Volume 2 with the objective of reducing energy use and hence greenhouse gas emissions. Since then the BCA has been progressively amended, providing increased stringency.

The BCA provides a national model for building regulations. Some states have adopted the BCA model for energy efficiency measures in full; others have adopted modifications, while another (New South Wales) has opted for alternative regulations.

In 2011, the National Construction Code (NCC) was published for the first time. The NCC is published in three volumes:

- Volume One pertains primarily to Class 2 to 9 buildings
- Volume Two pertains primarily to Class 1 and 10 buildings
- Volume Three pertains primarily to plumbing and drainage associated with all classes of buildings.

The term Building Code of Australia (BCA) has been retained in the NCC in the context of Volumes One and Two. In this document, which deals only with Class 1 buildings, the references are shown as the particular part number of BCA 2011 Volume 2 (or BCA 2010 Volume 2 or BCA 2009 Volume 2 as applicable).

This document outlines:

- Energy Efficiency provisions of BCA 2011 Volume 2, as it applies to Class 1 and 10a buildings;
- each state and territory's building regulations for Class 1 and 10a buildings; and
- applications for use of concrete in the context of these provisions.

THE BUILDING CODE OF AUSTRALIA provides a national model for building regulations

CEMENT CONCRETE & AGGREGATES AUSTRALIA

DEFINITIONS

Class 1 buildings are:

Class 1a is a single dwelling being –

(i) a detached house; or

(ii) one of a group of two or more attached dwellings, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit.

Class 1b is a boarding house, guest house, hostel or the like with a total area of all floors not exceeding 300 m^2 measured over the enclosing walls of the Class 1b building; and in which not more than 12 persons would ordinarily be resident, which is not located above or below another dwelling or another Class of building other than a private garage. (BCA 2011 Volume 2 Part 1.3.2.)

Class 10a buildings are non-habitable buildings being a private garage, carport, shed, or the like.

Conditioned space is a space within a building that is heated or cooled by the building's domestic services, excluding a non-habitable room in which a heater with a capacity of not more than 1.2 kW or 4.3 MJ/hour is installed. (BCA 2011 Volume 2 Part 3.12.)

R-Value is the thermal resistance (m^2.K/W) of a component calculated by dividing its thickness by its thermal conductivity.

Total R-Value is the sum of the R-Values of the individual component layers in a composite element including any building material, insulation material, airspace and associated surface resistances. (BCA 2011 Volume 2 Part 3.12.)

Reflective insulation is a building membrane with a reflective surface such as a reflective foil laminate, reflective barrier, foil batt or the like capable of reducing radiant heat flow. (BCA 2011 Volume 2 Part 3.12.)

Climate zones are specific locations having energy provisions based on a range of similar climatic characteristics. Climate zones are defined in Figure 1.1.4 and Table 1.1.2 of the BCA Volume 2. The relevant climate zones are reported in this Data Sheet for all states for completeness.

THE BENEFITS OF CONCRETE CONSTRUCTION

Passive Solar Design

Passive solar design is a universally accepted method of reducing the energy demands of heating and cooling buildings. Passive solar design concepts can be applied in the relatively temperate climates experienced in Australia as follows.

In southern Australia, shaded north-facing windows with large eaves overhangs permit the entry of winter sun and restrict the entry of summer sun. Properly sealed doors and windows allow cross-ventilation in summer and restrict leakage of warm air in winter.

Conversely, in northern Australia, large eaves, verandas, sun-shades and heavy curtains prevent sunshine from entering and overheating a building. Good ventilation and light-coloured roofs will assist in keeping the building cool, and will reduce the energy needed for artificial cooling.

In addition, using materials that lower operational energy through fabric energy storage or thermal mass, significant energy savings can be made. Concrete possesses a natural advantage in heat storage capacity of thermal mass. By harnessing this natural advantage, together with the heat of the sun or solar energy, comfortable living conditions can be achieved with reduced reliance on space heating or cooling with consequential reduced energy demands.

Thus the essential elements of passive solar design are orientation and solar access, and thermal mass, augmented by sealing, ventilation and insulation.

Heat Transfer

Heat transfers through roofs, walls and floors by a combination of conduction, convection and radiation.

Conduction Heat is transferred through opaque relatively airtight barriers by conduction. The thermal resistance of a material, R, measures the attenuation of steady-state conduction. Thermal bridging occurs when heat bypasses insulating materials and passes through conductive materials such as metal window and door frames, structural steelwork or other such items.

Convection Heat is transferred by convection through air. Air adjacent to a hot element (eg an outside wall of a house) is heated in summer and flows into the interior of the house where it deposits its heat. The reverse process, also classified as convection, occurs in winter. Convection may become a particular problem if poor detailing or construction leaves significant openings that permit transfer of heat by air leakage.

Radiation Heat is transferred by radiation through transparent or translucent media (such as glass) exposed to direct sunlight. Large windows exposed to direct sunlight are an advantage during the daytime in winter, but a disadvantage

in summer or during the night in winter. The conduction of heat through walls may be reduced by incorporating materials with a high thermal resistance, such as insulation. However, much of this benefit could be lost if thermal bridging, radiation and convection are not controlled. There is little point in installing insulation in walls if the heat simply transfers elsewhere by thermal bridging through windows and door frames, by radiation through windows or by convection through leakage.

Heat Storage and Thermal Mass

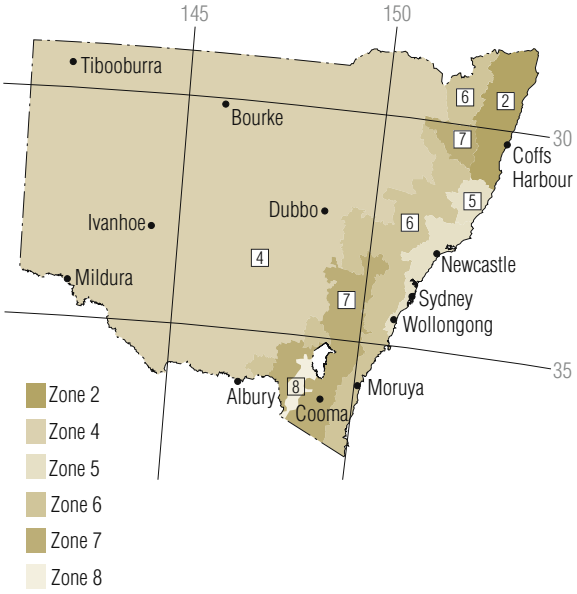
Thermal mass (also known as thermal inertia or thermal capacitance) is the ability of material to retain heat energy when subjected to a temperature differential. Concrete roofs, walls and floors have high thermal mass. If a building incorporating these elements is subject to an ambient heating and cooling cycle which crosses the comfort zone, the roof, walls and floor (as appropriate) will retain heat energy for an extended period. In summer, these elements will remain relatively cool. In winter, the same building elements will remain relatively warm.

Australia

Energy Efficiency Requirements – Roofs, walls and floors

New South Wales

Energy Efficiency Requirements – Roofs, walls and floors



NEW SOUTH WALES CLIMATE ZONES

LOCATION	ZONE
Albury	4
Armidale	7
Batemans Bay	6
Bathurst	7
Bega	6
Bellingen Shire – Dorrigo Plateau	7
Bellingen Shire – valley and seaboard	2
Bourke	4
Broken Hill	4
Byron Bay	2
Cobar	4
Coffs Harbour	2
Dubbo	4
Goulburn	7
Grafton	2
Griffith	4
Ivanhoe	4
Lismore	2
Lord Howe Island	2
Moree	4
Newcastle	5
Nowra	6
Orange	7
Perisher Smiggins	8
Port Macquarie	5
Sydney – east	5
Sydney – west	6
Tamworth	4
Thredbo	8
Wagga Wagga	4
Williamtown	5
Wollongong	5
Yass	6

GENERAL

New South Wales has not adopted the BCA Volume 2 energy provisions. The combined effect of the New South Wales amendments to the 2011, 2010 and 2009 versions of BCA Volume 2 is that the BASIX planning regulations operate in conjunction with the BCA. In order to maintain compatibility with BASIX, the 'New South Wales Additions' provides different Performance Requirements from those in the body of BCA 2011 Volume 2. These Performance Requirements relate specifically to:

- NSW P2.6.1 (a) Building Fabric (Thermal insulation and thermal breaks)
- NSW P2.6.1 (b) Building Sealing
- NSW P2.6.2 Building Services.

BASIX is a web-based planning tool, designed to assess the potential performance of new homes against a range of sustainability indices.

On 1 July 2004, BASIX was introduced, covering new single dwellings and dual occupancy dwellings; new boarding houses, guest houses, hostels, lodging-houses and backpacker accommodation under 300 m^2 in area. It initially applied only in the greater Sydney local government areas, except Blue Mountains, Hawkesbury and Wollondilly. On 1 July 2005, the scheme was extended to the whole of NSW. On 1 October 2005, the scope was extended to include new residential dwellings, including single dwellings, villas, townhouses and low-rise, mid-rise and high-rise developments. On 1 July 2006 the BASIX energy target was increased to 40% reduction in greenhouse gas emissions. Residential alterations and additions were included in two stages, 1 October 2006 for works of $100,000 or more, and 1 July 2007 for all residential developments of $50,000 or more.

BUILDING SUSTAINABILITY INDEX (BASIX)

The BASIX planning initiative ensures that houses and sole-occupancy units are designed to use less potable water and yield lower greenhouse gas emissions. BASIX is an online program, in which house designers enter data, such as location, size, building materials, etc, into the BASIX tool. The tool analyses relevant data (including rainwater tanks, water-saving fixtures, improved insulation, passive solar orientation, natural lighting and native plants for gardens) and determines scores against the Energy and Water targets. The design must pass specific targets (which vary according to location and building type) and this is recorded on the BASIX Certificate. This lists the commitments the user has agreed to, and the Certifying Authority monitors these at various construction stages. The BASIX Certificate must accompany the development application.

More information can be obtained from the NSW BASIX website www.basix.nsw.gov.au/information/about.jsp.

Australian Capital Territory

Energy Efficiency Requirements –

Roofs, walls and floors

AUSTRALIAN CAPITAL TERRITORY CLIMATE ZONES

LOCATION	ZONE
Canberra	7

GENERAL

The Australian Capital Territory government has adopted the energy efficiency measures of the BCA 2011 Volume 2 into the territory building regulations. The 'Australian Capital Territory Additions' provides additional requirements, including those for building alterations.

OBJECTIVE AND FUNCTIONAL STATEMENT

The stated objective is 'to reduce greenhouse gas emissions'. This is further developed by the Functional Statement, which states that the building and its domestic services must be capable of efficiently using energy and should, 'to the degree necessary', obtain the energy from a source of low greenhouse gas intensity, renewable on-site or reclaimed energy. (BCA 2011 Volume 2 Parts O2.6 and F2.6.)

Both the Objective and Functional Statement provide guidance only. It is the Performance Requirement (below) that sets out the specific requirements for compliance with the BCA.

PERFORMANCE REQUIREMENT

(BCA 2011 Volume 2 Part P2.6.1)

A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

- *(a) the function and use of the building; and*
- *(b) the internal environment; and*
- *(c) the geographic location of the building; and*
- *(d) the effects of nearby permanent features such as topography, structures and buildings; and*
- *(e) solar radiation being (i) utilised for heating; and (ii) controlled to minimise energy for cooling; and*
- *(f) the sealing of the building envelope against air leakage; and*
- *(g) the utilisation of air movement to assist cooling.*

DEMONSTRATING COMPLIANCE BY COMPARISON TO A REFERENCE BUILDING

The BCA provides a method of verification based on comparison of a proposed building to a reference building with the same dimensions, orientation and the like, and construction specified in this part of the BCA.

Compliance is demonstrated in Climate Zone 7 when the calculated heating load of the proposed building is equal to or less than that of the reference building.

DEMONSTRATING COMPLIANCE BY ACCEPTABLE CONSTRUCTION PRACTICE

Compliance with the performance requirements of energy efficiency and reduced greenhouse gas emissions is achieved through one of the two following 'Deemed-to-Satisfy' (DTS) provisions, as specified in BCA 2011 Volume 2 Part 3.12.

Compliance may be demonstrated by:

- achieving a specified efficiency of the Nationwide House Energy Rating Scheme using complying simulation software; or
- adopting forms of construction which are 'deemed-to-satisfy' the BCA requirements.

Simulation Calculations

BCA 2011 Volume 2 Part 3.12.0.1 requires that the calculated energy efficiency of a proposed building be not less than '6 stars', as defined in the Nationwide Energy Rating Scheme.

The simulation calculations must be performed using software that complies with the ABCB Protocol for House Energy Rating Software. AccuRATE is one software tool meeting this requirement.

Deemed-to-Satisfy Construction

In this method, various building fabric components (eg roofs, walls and floors) must achieve specified

levels of thermal resistance (R), depending on the climate zone and, in some cases, the thermal mass of the walls and concrete slab-on-ground.

In addition to the building fabric measures, there are specified requirements for external glazing, building sealing, air movement and services. (BCA 2011 Parts 3.12.2 to 3.12.5.)

The 'Deemed-to-Satisfy' provisions that are considered to be acceptable forms of construction for roofs, walls and floors are described below.

ROOFS

A roof must achieve the total R-Value shown in the table below for the direction of heat flow, extracted from BCA 2011 Volume 2 Table 3.12.1.1a.

ROOFS – Minimum Total R-Value

Climate zone	7
Altitude	Any
Direction of heat flow	Up
Minimum total R-Value for a roof with an upper surface solar absorptance value of not more than 0.4	4.1
Minimum total R-Value for a roof with an upper surface solar absorptance value of more than 0.4 but not more than 0.6	4.6
Minimum total R-Value for a roof with an upper surface solar absorptance value of more than 0.6	5.1

EXTERNAL WALLS

In Climate Zone 7, external walls must achieve a Total R-Value of 2.8. (BCA 2011 Volume 2 Table 3.12.1.3(a).)

Walls with a high thermal mass, such as concrete or masonry walls, are granted a concession in the BCA. External walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 1.5. Alternatively, external walls with a surface density of 220 kg/m^2 or more may be constructed with added insulation with R-Value of not less than 1.0 or 0.5 provided there is enhanced external glazing complying with Part 3.12.2.1. The applicable value of C_u (conductance constant) can then be reduced by 15% or 20% respectively. (BCA 2011 Volume 2 Table 3.12.1.3b.)

Surface density of concrete walls

Reinforced concrete has a density of approximately 2400 kg/m^3. Therefore, a solid concrete wall with a thickness of 100 mm will have a surface density of 240 kg/m^3. However, the BCA lists '140 mm thick or greater concrete panels' with the examples of typical wall constructions that achieve a surface density of 220 kg/m^3. 140 mm thick, not 100 mm thick, is nominated in order to achieve the appropriate combination of thermal resistance and thermal mass. It should be clearly understood that the 140-mm requirement should override the 220-kg/m^3 limit if Deemed-to-Satisfy (DTS) provisions are used. When verification by calculation is adopted, any wall thickness may be used provided the performance criteria are met.

FLOORS

Suspended concrete floors must achieve the minimum total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.4.

SUSPENDED FLOORS – Minimum Total R-Value

Climate zone	7
Direction of heat flow	Down
Minimum total R-Value (including the underfloor airspace and enclosure if the perimeter is enclosed)	2.75

Suspended concrete slab construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges and R2.0 on the underside.

Concrete slab-on-ground construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges. (BCA 2011 Volume 2 Part 3.12.1.5.)

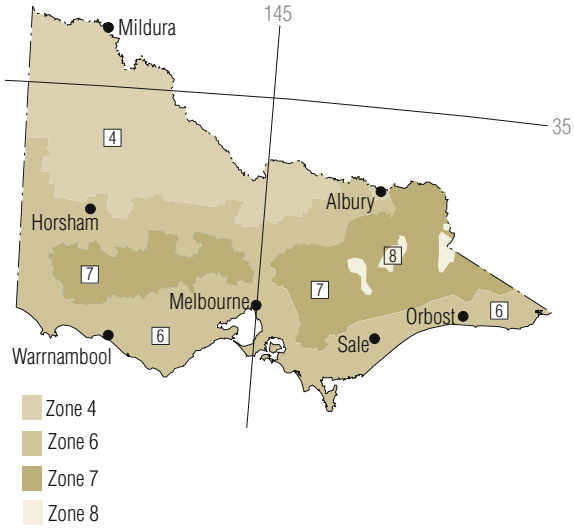
Australian Capital Territory Summary

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 7 Canberra
ROOF	
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil
EXTERNAL WALLS	
Thermal resistance Surface density Shading and glazing	**Total R-Value 2.8** Any Any
Thermal resistance Surface density Glazing	**Added insulation with R-Value 0.5** > 220 kg/m^2 Enhanced glazing (C_u reduced by 20%)
Thermal resistance Surface density Glazing	**Added insulation with R-Value 1.0** > 220 kg/m^2 Enhanced glazing (C_u reduced by 15%)
Thermal resistance Surface density Glazing	**Added insulation with R-Value 1.5** > 220 kg/m^2 Any
SUSPENDED CONCRETE FLOORS	
Thermal resistance In-slab heating or cooling	**Total R-Value 2.75** (down) Nil
Thermal resistance In-slab heating or cooling	**Total R-Value 2.75** (down) and **1.0** around the vertical edges Present
CONCRETE SLAB-ON-GROUND	
Thermal resistance In-slab heating or cooling	**No requirements** Nil
Thermal resistance In-slab heating or cooling	**R1.0** around the vertical edges Present

Victoria

Energy Efficiency Requirements – Roofs, walls and floors



VICTORIA CLIMATE ZONES

LOCATION	ZONE
Anglesea	6
Ararat	7
Bairnsdale	6
Ballarat	7
Benalla	6
Bendigo	6
Bright	7
Colac	6
Dandenong	6
Echuca	4
Geelong	6
Hamilton	7
Horsham	6
Melbourne	6
Mildura	4
Portland	6
Sale	6
Shepparton	4
Swan hill	4
Traralgon	6
Wangaratta	7
Warrnambool	6
Wodonga	6

GENERAL

The Victorian government has adopted the energy efficiency measures of the BCA 2011 Volume 2 into the state building regulations, although it has amended the Objective, Functional Statement and Performance Requirements (see below).

Victoria has no pertinent Additions to the Energy Efficiency Housing Provisions of BCA Volume 2, but has got modified Performance Requirements.

OBJECTIVE AND FUNCTIONAL STATEMENT

The stated Objective of the Victorian variation is 'to reduce greenhouse gas emissions and conserve water by efficiently using energy and water'. This is further developed by the Functional Statement, which states that the building and its domestic services must be capable of efficiently using energy and water and should, 'to the degree necessary', obtain the energy from a source of low greenhouse gas intensity, renewable on site or reclaimed energy. (BCA 2011 Volume 2 Parts O2.6 and F2.6.)

Both the Objective and Functional Statement provide guidance only. It is the Performance Requirement (below) that sets out the specific requirements for compliance with the BCA.

PERFORMANCE REQUIREMENT

In respect of Performance Requirements for energy efficiency, the Victorian variation of BCA 2011 Volume 2 Part 2.6.1 states:

A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling and a level of water use performance to facilitate the efficient use of water, appropriate to –

- *(a) the function and use of the building; and*
- *(b) the internal environment; and*
- *(c) the geographic location of the building; and*
- *(d) the effects of nearby permanent features such as topography, structures and buildings; and*
- *(e) solar radiation being (i) utilised for heating; and (ii) controlled to minimise energy for cooling; and*
- *(f) the sealing of the building envelope against air leakage; and*
- *(g) the utilisation of air movement to assist cooling; and*
- *(h) water resources available; and*
- *(i) pertinent water management measures of the responsible water authority.*

DEMONSTRATING COMPLIANCE BY COMPARISON TO A REFERENCE BUILDING

The BCA provides a method of verification, based on comparison of a proposed building to a reference building, which has the same dimensions, orientation and the like, and construction specified in this part of the BCA.

Compliance is demonstrated:

- in Climate Zones 4 and 6 when the calculated heating and cooling loads of the proposed building are equal to or less than those of the reference building; and
- in Climate Zone 7 when the calculated heating load of the proposed building is equal to or less than that of the reference building.

DEMONSTRATING COMPLIANCE BY ACCEPTABLE CONSTRUCTION PRACTICE

Compliance with the performance requirements of energy efficiency and reduced greenhouse gas emissions is achieved through one of the two following 'Deemed-to-Satisfy' (DTS) provisions, as specified in BCA 2011 Volume 2 Part 3.12.

Compliance may be demonstrated by:

- achieving a specified efficiency of the Nationwide House Energy Rating Scheme using complying simulation software; or
- adopting forms of construction which are 'deemed-to-satisfy' the BCA requirements.

Simulation Calculations

BCA 2011 Volume 2 Part 3.12.0.1 requires that the calculated energy efficiency of a proposed building be not less than '6 stars', as defined in the Nationwide House Energy Rating Scheme.

The simulation calculations must be performed using software that complies with the ABCB Protocol for House Energy Rating Software. AccuRATE is one software tool meeting this requirement.

Deemed-to-Satisfy Construction

In this method, various building fabric components (eg roofs, walls and floors) must achieve specified levels of thermal resistance (R), depending on the climate zone and, in some cases, the thermal mass of the walls and concrete slab-on-ground.

In addition to the building fabric measures, there are specified requirements for external glazing, building sealing, air movement and services. (BCA 2011 Parts 3.12.2 to 3.12.5.)

The 'Deemed-to-Satisfy' provisions that are considered to be acceptable forms of construction for roofs, walls and floors are described below.

ROOFS

Roofs must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.1a.

ROOFS – Minimum Total R-Values

Climate zone	4	6	7
Altitude	Any	Any	Any
Direction of heat flow	Up	Up	Up
Minimum Total R-Value for a roof with an upper surface solar absorptance value of not more than 0.4	4.1	4.1	4.1
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.4 but not more than 0.6	4.6	4.6	4.6
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.6	5.1	5.1	5.1

In Climate Zone 4, the required Total R-Value specified above may be reduced by 0.5, provided the required insulation is laid on the ceiling, and the roof space is ventilated as specified in BCA 2011 Volume 2 Part 3.12.1.2(b).

Where exhaust fans, flues, downlights and the like reduce the area of roof and ceiling insulation, the BCA provides rules for increasing the required Total R-Value over the values given above. (BCA 2011 Volume 2 Part 3.12.1.2(e) and Table 3.12.1.1b.)

EXTERNAL WALLS

In Climate Zones 4 and 6 external walls must achieve a Total R-Value of 2.8.

In Climate Zone 4, the Total R-Value is reduced to 2.4 when the wall is shaded. Shading is considered to be effective when a veranda, balcony, eaves, carport or the like (including any attached guttering) projects horizontally from the external face of the building to the outer edge of the projection not less than 15° (1/3.7 of the wall height). The wall height is measured from the internal floor level to the underside of the projection. This may result in a need for eaves that are wider than normal. For example, if the height from the internal floor to the underside of a 125-mm-wide gutter is 2.4 m, the required eaves width (from wall to fascia) is 475 mm.

Walls with a high thermal mass, such as concrete or masonry walls, are granted a concession in the BCA.

External walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 0.5, provided:

- there is enhanced external glazing complying with Part 3.12.2.1 with the applicable value of C_u reduced by 15%; and

- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls

Alternatively, external walls with a surface density of 220 kg/m^2 or more, may be constructed without added insulation, provided there is enhanced external glazing complying with Part 3.12.2.1 with the applicable value of C_u reduced by 20%.

Alternatively, external walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 1.0, provided the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

In Climate Zone 7, external walls must achieve Total R-Value of 2.8. (BCA 2011 Volume 2 Table 3.12.1.3(a).)

Walls with a high thermal mass, such as concrete or masonry walls, are granted a concession in the BCA.

External walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 1.5. Alternatively, external walls with a surface density of 220 kg/m^2 or more may be constructed with added insulation with R-Value of not less than 1.0 or 0.5 provided there is enhanced external glazing complying with Part 3.12.2.1 with the applicable value of C_u reduced by 15% or 20% respectively. (BCA 2011 Volume 2 Table 3.12.1.3(b).)

Surface density of concrete walls

Reinforced concrete has a density of approximately 2400 kg/m^3. Therefore, a solid concrete wall with a thickness of 100 mm will have a surface density of 240 kg/m^3. However, the BCA lists '140 mm thick or greater concrete panels' with the examples of typical wall constructions that achieve a surface density of 220 kg/m^3. 140 mm thick, not 100 mm thick, is nominated in order to achieve the appropriate combination of thermal resistance and thermal mass. It should be clearly understood that the 140-mm requirement should override the 220 kg/m^3 limit if Deemed-to-Satisfy (DTS) provisions are used. When verification by calculation is adopted, any wall thickness may be used provided the performance criteria are met.

FLOORS

Suspended concrete floors must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.4.

SUSPENDED FLOORS – Minimum Total R-Values

Climate zone	4	6	7
Direction of heat flow	Down	Down	Down
Minimum Total R-Value (including the underfloor airspace and enclosure if the perimeter is enclosed)	2.25	2.25	2.75

Suspended concrete slab construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges and R2.0 on the underside.

Concrete slab-on-ground construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges. (BCA 2011 Volume 2 Part 3.12.1.5.)

Victoria Summary

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 4 Echuca, Mildura, Shepparton, Swan Hill	**ZONE 6** Anglesea, Bairnsdale, Benalla, Bendigo, Colac, Dandenong, Geelong, Horsham, Melbourne, Portland, Sale, Traralgon, Warrnambool, Wodonga	**ZONE 7** Ararat, Ballarat, Bright, Hamilton, Wangaratta
ROOF			
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 3.6** (up) Upper surface solar absorptance not more than 0.4 Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area.		
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.1** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 As above		
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.6 As above		
EXTERNAL WALLS			
Thermal resistance Surface density Shading and glazing	**Total R-Value 2.8** Any Any	**Total R-Value 2.8** Any Any	**Total R-Value 2.8** Any Any

continues page 12

Victoria Summary *continued*

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 4 Echuca, Mildura, Shepparton, Swan Hill	**ZONE 6** Anglesea, Bairnsdale, Benalla, Bendigo, Colac, Dandenong, Geelong, Horsham, Melbourne, Portland, Sale, Traralgon, Warrnambool, Wodonga	**ZONE 7** Ararat, Ballarat, Bright, Hamilton, Wangaratta
EXTERNAL WALLS *continued*			
Thermal resistance	**Total R-Value 2.4**	**Added insulation with R-Value 0.5**	**Added insulation with R-Value 0.5**
Surface density	Any	> 220 kg/m^2	> 220 kg/m^2
Shading and glazing	Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 15%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	Enhanced glazing (C_{SHGC} reduced by 20%)
Thermal resistance	**Added insulation with R-Value 0.5**	**Added insulation with R-Value 1.0**	**Added insulation with R-Value 1.0**
Surface density	> 220 kg/m^2	> 220 kg/m^2	> 220 kg/m^2
Shading and glazing	Enhanced external glazing (C_u reduced by 15%) **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	The lowest storey has concrete slab-on-ground floor or masonry internal walls	Enhanced glazing (C_{SHGC} reduced by 15%)
Thermal resistance	**No added insulation required**		**Added insulation with R-Value 1.5**
Surface density	> 220 kg/m^2		> 220 kg/m^2
Shading and glazing	Enhanced external glazing (C_u reduced by 20%)		Any
Thermal resistance	**Added insulation with R-Value 1.0**		
Surface density	> 220 kg/m^2		
Shading and glazing	The lowest storey has concrete slab-on-ground floor or masonry internal walls		
SUSPENDED CONCRETE FLOORS			
Thermal resistance	**Total R-Value 2.25** (down)	**Total R-Value 2.25** (down)	**Total R-Value 2.75** (down)
In-slab heating or cooling	Nil	Nil	Nil
Thermal resistance	**Total R-Value 2.25** (down) and **1.0** around the vertical edges	**Total R-Value 2.25** (down) and **1.0** around the vertical edges	**Total R-Value 2.75** (down) and **1.0** around the vertical edges
In-slab heating or cooling	Present	Present	Present
CONCRETE SLAB-ON-GROUND			
Thermal resistance	**No requirements**	**No requirements**	**No requirements**
In-slab heating or cooling	Nil	Nil	Nil
Thermal resistance	**R1.0** around the vertical edges	**R1.0** around the vertical edges	**R1.0** around the vertical edges
In-slab heating or cooling	Present	Present	Present

Queensland

Energy Efficiency Requirements – Roofs, walls and floors

QUEENSLAND CLIMATE ZONES

LOCATION	ZONE
Birdsville	3
Brisbane	2
Bundaberg	2
Cairns	1
Cooktown	1
Cunnamulla	3
Longreach	3
Gladstone	2
Labrador	2
Mackay	2
Maryborough	2
Mount Isa	3
Normanton	1
Rockhampton	2
Roma	3
Toowoomba	5
Torrens Creek	3
Townsville	1
Warwick	5
Weipa	1

GENERAL

The Queensland government has adopted the energy efficiency measures of the BCA 2011 Volume 2 into the state building regulations.

OBJECTIVE AND FUNCTIONAL STATEMENT

The stated Objective is 'to reduce greenhouse gas emissions'. This is further developed by the Functional Statement, which states that the building and its domestic services must be capable of efficiently using energy and should, 'to the degree necessary', obtain the energy from a source of low greenhouse gas intensity, renewable on site or reclaimed energy. (BCA 2011 Volume 2 Parts O2.6 and F2.6.)

Both the Objective and Functional Statement provide guidance only. It is the Performance Requirement (below) that sets out the specific requirements for compliance with the BCA.

PERFORMANCE REQUIREMENT

(BCA 2011 Volume 2 Part P2.6.1)

A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

(a) the function and use of the building; and
(b) the internal environment; and
(c) the geographic location of the building; and
(d) the effects of nearby permanent features such as topography, structures and buildings; and
(e) solar radiation being (i) utilised for heating; and (ii) controlled to minimise energy for cooling; and
(f) the sealing of the building envelope against air leakage; and
(g) the utilisation of air movement to assist cooling.

DEMONSTRATING COMPLIANCE BY COMPARISON TO A REFERENCE BUILDING

The BCA provides a method of verification, based on comparison of a proposed building to a reference building, which has the same dimensions, orientation and the like, and construction specified in this part of the BCA.

Compliance is demonstrated when:

- in Climate Zones 1 and 2, the calculated cooling load of the proposed building is equal to or less than that of the reference building; and
- in Climate Zones 3 and 5, the calculated heating and cooling loads of the proposed building are equal to or less than those of the reference building.

ROOFS – Minimum Total R-Values

Climate zone	1	2		3	5
Altitude	Any	Less than 300 m	300 m or more	Any	Any
Direction of heat flow	Down	Down	Down and up	Down and up	Up
Minimum Total R-Value for a roof with an upper surface solar absorptance value of not more than 0.4	4.1	4.1	4.1	4.1	4.1
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.4 but not more than 0.6	4.6	4.6	4.6	4.6	4.6
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.6	5.1	5.1	5.1	5.1	5.1

DEMONSTRATING COMPLIANCE BY ACCEPTABLE CONSTRUCTION PRACTICE

Compliance with the performance requirements of energy efficiency and reduced greenhouse gas emissions is achieved through one of the two following 'Deemed-to-Satisfy' (DTS) provisions, as specified in BCA 2011 Volume 2 Part 3.12.

Compliance may be demonstrated by:

- achieving a specified efficiency of the Nationwide House Energy Rating Scheme using complying simulation software; or
- adopting forms of construction which are 'deemed-to-satisfy' the BCA requirements.

Simulation Calculations

BCA 2011 Volume 2 Part 3.12.0.1 requires that the calculated energy efficiency of a proposed building be not less than '6 stars', as defined in the Nationwide House Energy Rating Scheme.

In Climate Zones 1 and 2, this may be reduced to '5.5 stars' if the building has *either* a complying outdoor living area (BCA 2011 Volume 2 Part 3.12.0.1(b)) which is fully covered with an impervious roof of total thermal resistance of at least R1.5 for downward heat flow; *or* has at least one permanent ceiling fan.

This may be further reduced in Climate Zones 1 and 2 to '5 stars' if the building has *both* a complying outdoor living area (described above) with a fully covered impervious roof of total thermal resistance at least R1.5 for downward heat flow; *and* at least one permanent ceiling fan.

The simulation calculations must be performed using software that complies with the ABCB Protocol for House Energy Rating Software. AccuRATE is one software tool meeting this requirement.

Deemed-to-Satisfy Construction

In this method, various building fabric components (eg roofs, walls and floors) must achieve specified levels of thermal resistance (R), depending on the climate zone and, in some cases, the thermal mass of the walls and concrete slab-on-ground.

In addition to the building fabric measures, there are specified requirements for external glazing, building sealing, air movement and services. (BCA 2011 Parts 3.12.2 to 3.12.5.)

The 'Deemed-to-Satisfy' provisions that are considered to be acceptable forms of construction for roofs, walls and floors are described below.

ROOFS

Roofs must achieve the minimum Total R-Value shown in the table above, extracted from BCA 2011 Volume 2 Table 3.12.1.1. Where a pitched roof has a flat ceiling, at least 50% of the added insulation must be laid on the ceiling.

In Climate Zones 1, 2, 3 and 5, the required Total R-Value specified above may be reduced by 0.5, provided the required insulation is laid on the ceiling; and the roof space is ventilated as specified in BCA 2011 Volume 2 Part 3.12.1.2 (b).

Where exhaust fans, flues, downlights and the like reduce the area of roof and ceiling insulation, the BCA provides rules for increasing the required Total R-Value over the values given above (BCA 2011 Volume 2 Part 3.12.1.2(e)).

EXTERNAL WALLS

In Climate Zones 1, 2, 3 and 5, external walls must achieve Total R-Value of 2.8, **OR** external walls must achieve Total R-Value of 2.4 when the wall is shaded (see *Shading* below).

Walls with a high thermal mass, such as concrete or masonry wall, are granted a concession in the BCA. External walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 0.5, provided:

- the top storey is shaded, as described below; and
- storeys below the top storey, although not shaded, have enhanced external glazing (complying with Part 3.12.2.1 with the applicable value of C_{SHGC} reduced by 20% for Climate Zones 1, 2 and 3 and 15% for Climate Zone 5); and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

In Climate Zone 5, external walls with a surface density of 220 kg/m^2 or more, may be constructed without added insulation, provided:

- the external walls (of all storeys) are shaded, as described below; and
- there is enhanced external glazing (complying with Part 3.12.2.1 with the applicable value of C_{SHGC} reduced by 15%); and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

Shading

Shading is considered to be effective when a veranda, balcony, eaves, carport or the like (including any attached guttering) projects horizontally from the external face of the building to the outer edge of the projection not less than 15° (1/3.7 of the wall height). The wall height is measured from the internal floor level to the underside of the projection. This may result in a need for eaves that are wider than normal. For example, if the height from the internal floor to the underside of a 125 mm wide gutter is 2.4 m, the required eaves width (from wall to fascia) is 475 mm.

Surface density of concrete walls

Reinforced concrete has a density of approximately 2400 kg/m^3. Therefore, a solid concrete wall with a thickness of 100 mm will have a surface density of 240 kg/m^3. However, the BCA lists '140 mm thick or greater concrete panels' with the examples of typical wall constructions that achieve a surface density of 220 kg/m^3. 140 mm thick, not 100 mm thick, is nominated in order to achieve the appropriate combination of thermal resistance and thermal mass. It should be clearly understood that the 140-mm requirement should override the 220 kg/m^3 limit if Deemed-to-Satisfy (DTS) provisions are used. When verification by calculation is adopted, any wall thickness may be used provided the performance criteria are met.

FLOORS

Suspended concrete floors must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.4.

SUSPENDED FLOORS – Minimum Total R-Values

Climate zone	1	2	3	5
Direction of heat flow	Up	Up	Up	Down
Minimum Total R-Value (including the underfloor airspace and enclosure if the perimeter is enclosed)	1.5	1.0	1.5	1.0

Suspended concrete slab construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges and R2.0 on the underside.

Concrete slab-on-ground construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges. (BCA 2011 Volume 2 Part 3.12.1.5.)

Queensland Summary

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 1 Cairns, Cooktown, Normanton, Townsville, Weipa	**ZONE 2** Brisbane, Bundaberg, Gladstone, Labrador, Mackay, Maryborough, Rockhampton
ROOF		
Thermal resistance	**Total R-Value 4.1** (down)	**Total R-Value 4.1** ('down' if at altitude under 300 m, 'down and up' if higher than 300 m)
Solar absorptance	Upper surface solar absorptance not more than 0.4	Upper surface solar absorptance not more than 0.4
Ventilation	Nil	Nil
Thermal resistance	**Total R-Value 4.6** (down)	**Total R-Value 4.6** ('down' if at altitude under 300 m, 'down and up' if higher than 300 m)
Solar absorptance	Upper surface solar absorptance more than 0.4 but not more than 0.6	Upper surface solar absorptance more than 0.4 but not more than 0.6
Ventilation	Nil	Nil
Thermal resistance	**Total R-Value 5.1** (down)	**Total R-Value 5.1** ('down' if at altitude under 300 m, 'down and up' if higher than 300 m)
Solar absorptance	Upper surface solar absorptance more than 0.6	Upper surface solar absorptance more than 0.6
Ventilation	Nil	Nil
Thermal resistance	**Total R-Value 3.6** (down)	**Total R-Value 3.6** ('down' if at altitude under 300 m, 'down and up' if higher than 300 m)
Solar absorptance	Upper surface solar absorptance not more than 0.4	Upper surface solar absorptance not more than 0.4
Ventilation	Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area	Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area
Thermal resistance	**Total R-Value 4.1** (down)	**Total R-Value 4.1** ('down' if at altitude under 300 m, 'down and up' if higher than 300 m)
Solar absorptance	Upper surface solar absorptance more than 0.4 but not more than 0.6	Upper surface solar absorptance more than 0.4 but not more than 0.6
Ventilation	As above	As above
Thermal resistance	**Total R-Value 4.6** (down)	**Total R-Value 4.6** ('down' if at altitude under 300 m, 'down and up' if higher than 300 m)
Solar absorptance	Upper surface solar absorptance more than 0.6	Upper surface solar absorptance more than 0.6
Ventilation	As above	As above
EXTERNAL WALLS		
Thermal resistance	**Total R-Value 2.8**	**Total R-Value 2.8**
Surface density	Any	Any
Shading and glazing	Any	Any
Thermal resistance	**Total R-Value 2.4**	**Total R-Value 2.4**
Surface density	Any	Any
Shading and glazing	Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°
Thermal resistance	**Added insulation with R-Value 0.5**	**Added insulation with R-Value 0.5**
Surface density	> 220 kg/m^2	> 220 kg/m^2
Shading and glazing	Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 20%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 20%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls

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	ZONE 3 Birdsville, Cunnamulla, Longreach, Mount Isa, Roma, Torrens Creek	ZONE 5 Toowoomba, Warwick
ROOF		
Thermal resistance	**Total R-Value 4.1** (down and up)	**Total R-Value 4.1** (up)
Solar absorptance	Upper surface solar absorptance not more than 0.4	Upper surface solar absorptance not more than 0.4
Ventilation	Nil	Nil
Thermal resistance	**Total R-Value 4.6** (down and up)	**Total R-Value 4.6** (up)
Solar absorptance	Upper surface solar absorptance more than 0.4 but not more than 0.6	Upper surface solar absorptance more than 0.4 but not more than 0.6
Ventilation	Nil	Nil
Thermal resistance	**Total R-Value 5.1** (down and up)	**Total R-Value 5.1** (up)
Solar absorptance	Upper surface solar absorptance more than 0.6	Upper surface solar absorptance more than 0.6
Ventilation	Nil	Nil
Thermal resistance	**Total R-Value 3.6** (down and up)	**Total R-Value 3.6** (up)
Solar absorptance	Upper surface solar absorptance not more than 0.4	Upper surface solar absorptance not more than 0.4
Ventilation	Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area	Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area
Thermal resistance	**Total R-Value 4.1** (down and up)	**Total R-Value 4.1** (up)
Solar absorptance	Upper surface solar absorptance more than 0.4 but not more than 0.6	Upper surface solar absorptance more than 0.4 but not more than 0.6
Ventilation	As above	As above
Thermal resistance	**Total R-Value 4.6** (down and up)	**Total R-Value 4.6** (up)
Solar absorptance	Upper surface solar absorptance more than 0.6	Upper surface solar absorptance more than 0.6
Ventilation	As above	As above
EXTERNAL WALLS		
Thermal resistance	**Total R-Value 2.8**	**Total R-Value 2.8**
Surface density	Any	Any
Shading and glazing	Any	Any
Thermal resistance	**Total R-Value 2.4**	**Total R-Value 2.4**
Surface density	Any	Any
Shading and glazing	Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°
Thermal resistance	**Added insulation with R-Value 0.5**	**Added insulation with R-Value 0.5**
Surface density	> 220 kg/m^2	> 220 kg/m^2
Shading and glazing	Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 20%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 20%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls

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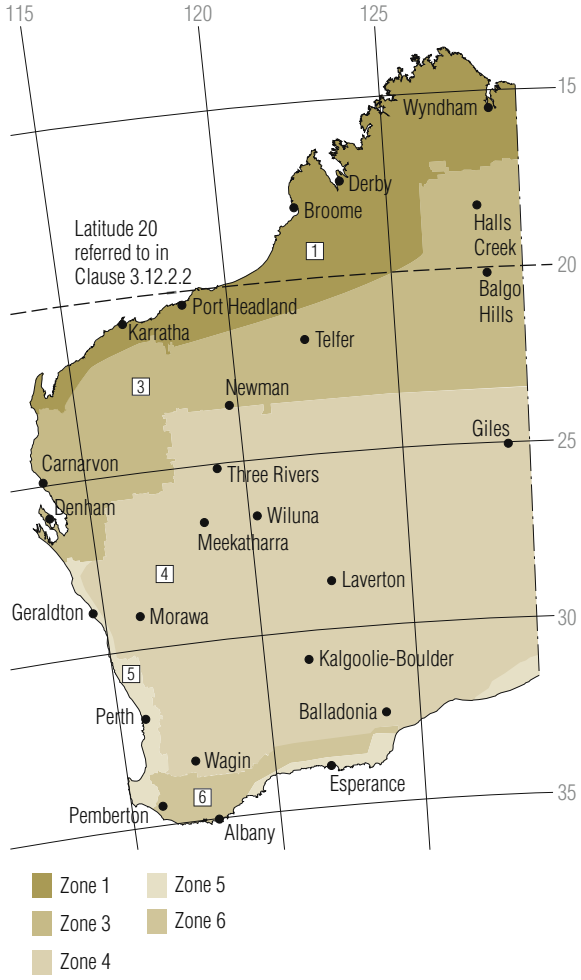
Queensland Summary *continued*

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 1 Cairns, Cooktown, Normanton, Townsville, Weipa	**ZONE 2** Brisbane, Bundaberg, Gladstone, Labrador, Mackay, Maryborough, Rockhampton	**ZONE 3** Birdsville, Cunnamulla, Longreach, Mount Isa, Roma, Torrens Creek	**ZONE 5** Toowoomba, Warwick
SUSPENDED CONCRETE FLOORS				
Thermal resistance	**Total R-Value 1.5** (up)	**Total R-Value 1.0** (up)	**Total R-Value 1.5** (up)	**Total R-Value 1.0** (down)
In-slab heating or cooling	Nil	Nil	Nil	Nil
Thermal resistance	**Total R-Value 2.0** (up) and **1.0** around the vertical edges	**Total R-Value 2.0** (up) and **1.0** around the vertical edges	**Total R-Value 2.0** (up) and **1.0** around the vertical edges	**Total R-Value 2.0** (up) and **1.0** around the vertical edges
In-slab heating or cooling	Present	Present	Present	Present
CONCRETE SLAB-ON-GROUND				
Thermal resistance	**No requirements**	**No requirements**	**No requirements**	**No requirements**
In-slab heating or cooling	Nil	Nil	Nil	Nil
Thermal resistance	**R1.0** around the vertical edges	**R1.0** around the vertical edges	**R1.0** around the vertical edges	**R1.0** around the vertical edges
In-slab heating or cooling	Present	Present	Present	Present

Western Australia

Energy Efficiency Requirements – Roofs, walls and floors



WESTERN AUSTRALIA CLIMATE ZONES

LOCATION	ZONE
Albany	6
Balladonia	4
Broome	1
Bunbury	5
Carnarvon	3
Christmas Island	1
Cocos Island	1
Derby	1
Esperance	5
Exmouth	1
Geraldton	5
Halls Creek	3
Kalgoorlie-Boulder	4
Karratha	1
Meekatharra	4
Northam	4
Pemberton	6
Perth	5
Port Hedland	1
Wagin	4
Wyndham	1

GENERAL

The Western Australian government has adopted the energy efficiency measures of the BCA 2011 Volume 2 into the state building regulations.

OBJECTIVE AND FUNCTIONAL STATEMENT

The stated Objective is 'to reduce greenhouse gas emissions'. This is further developed by the Functional Statement, which states that the building and its domestic services must be capable of efficiently using energy and should, 'to the degree necessary', obtain the energy from a source of low greenhouse gas intensity, renewable on site or reclaimed energy. (BCA 2011 Volume 2 Parts O2.6 and F2.6.)

Both the Objective and Functional Statement provide guidance only. It is the Performance Requirement (below) that sets out the specific requirements for compliance with the BCA.

PERFORMANCE REQUIREMENT

(BCA 2011 Volume 2 Part P2.6.1)

A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

(a) the function and use of the building; and
(b) the internal environment; and
(c) the geographic location of the building; and
(d) the effects of nearby permanent features such as topography, structures and buildings; and
(e) solar radiation being (i) utilised for heating; and (ii) controlled to minimise energy for cooling; and
(f) the sealing of the building envelope against air leakage; and
(g) the utilisation of air movement to assist cooling.

DEMONSTRATING COMPLIANCE BY ACCEPTABLE CONSTRUCTION PRACTICE

Compliance with the performance requirements of energy efficiency and reduced greenhouse gas emissions is achieved through one of the two following 'Deemed-to-Satisfy' (DTS) provisions, as specified in BCA 2011 Volume 2 Part 3.12.

Compliance may be demonstrated by:

- achieving a specified efficiency of the Nationwide House Energy Rating Scheme using complying simulation software; or
- adopting forms of construction which are 'deemed-to-satisfy' the BCA requirements.

Simulation Calculations

BCA 2011 Volume 2 Part 3.12.0.1 requires that the calculated energy efficiency of a proposed building be not less than '6 stars', as defined in the Nationwide House Energy Rating Scheme.

In Climate Zone 1, this may be reduced to '5.5 stars' if the building has *either* a complying outdoor living area (BCA 2011 Volume 2 part 3.12.0.1(b)) which is fully covered with an impervious roof of total thermal resistance of at least R1.5 for downward heat flow; *or* has at least one permanent ceiling fan.

This may be further reduced in Climate Zone 1 to '5 stars' if the building has *both* a complying outdoor living area (described above) with a fully covered impervious roof of total thermal resistance at least R1.5 for downward heat flow; *and* at least one permanent ceiling fan.

The simulation calculations must be performed using software that complies with the ABCB Protocol for House Energy Rating Software. AccuRATE is one software tool meeting this requirement.

Deemed-to-Satisfy Construction

In this method, various building fabric components (eg roofs, walls and floors) must achieve specified levels of thermal resistance (R), depending on the climate zone and, in some cases, the thermal mass of the walls and concrete slab-on-ground.

In addition to the building fabric measures, there are specified requirements for external glazing, building sealing, air movement and services. (BCA 2011 Parts 3.12.2 to 3.12.5.)

The 'Deemed-to-Satisfy' provisions that are considered to be acceptable forms of construction for roofs, walls and floors are described below.

ROOFS

Roofs must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.1. Where a pitched roof has a flat ceiling, at least 50% of the added insulation must be laid on the ceiling. (BCA 2011 Volume 2 Part 3.12.1.2 (a)).

In Climate Zones 1, 3, 4 and 5, the required Total R-Value specified above may be reduced by 0.5, provided the required insulation is laid on the ceiling; and the roof space is ventilated as specified in BCA 2011 Volume 2 Part 3.12.1.2(b).

Where exhaust fans, flues, downlights and the like reduce the area of roof and ceiling insulation, the BCA provides rules for increasing the required Total R-Value over the values given above (BCA 2011 Volume 2 Part 3.12.1.2(e)).

EXTERNAL WALLS

In Climate Zones 1, 3, 4 and 5 external walls must achieve Total R-Value of 2.8, **OR** external walls must achieve Total R-Value of 2.4 when the wall is shaded (see *Shading* below).

Walls with a high thermal mass, such concrete or masonry wall, are granted a concession in the BCA.

In Climate Zones 1, 3 and 5, external walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 0.5, provided:

- the top storey is shaded, as described below; and
- storeys below the top storey, although not shaded, have enhanced external glazing (complying with Part 3.12.2.1 with the applicable value of C_{SHGC} reduced by 20% for Climate Zones 1 and 3 and 15% for Climate Zone 5); and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

Alternatively, in Climate Zone 5, external walls with a surface density of 220 kg/m^2 or more, may be constructed without added insulation, provided:

- the external walls (of all storeys) are shaded, as described below; and
- there is enhanced external glazing (complying with Part 3.12.2.1 with the applicable value of C_{SHGC} reduced by 15%); and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

ROOFS – Minimum Total R-Values

Climate zone	1	3	4	5	6
Altitude	Any	Any	Any	Any	Any
Direction of heat flow	Down	Down and up	Up	Up	Up
Minimum Total R-Value for a roof with an upper surface solar absorptance value of not more than 0.4	4.1	4.1	4.1	4.1	4.1
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.4 but not more than 0.6	4.6	4.6	4.6	4.6	4.6
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.6	5.1	5.1	5.1	5.1	5.1

In Climate Zones 4 and 6, external walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 0.5, provided:

- there is enhanced external glazing (complying with Part 3.12.2.1 with the applicable value of C_u reduced by 15%; and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls;

  OR

External walls with a surface density of 220 kg/m^2 or more, may be constructed without added insulation, provided:

- there is enhanced external glazing (complying with Part 3.12.2.1 with the applicable value of C_u reduced by 20%);

  OR

External walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 1.0, provided:

- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

Shading

Shading is considered to be effective when a veranda, balcony, eaves, carport or the like (including any attached guttering) projects horizontally from the external face of the building to the outer edge of the projection not less than 15°(1/3.7 of the wall height). The wall height is measured from the internal floor level to the underside of the projection. This may result in a need for eaves that are wider than normal. For example, if the height from the internal floor to the underside of a 125 mm wide gutter is 2.4 m, the required eaves width (from wall to fascia) is 475 mm.

Surface density of concrete walls

Reinforced concrete has a density of approximately 2400 kg/m^3. Therefore, a solid concrete wall with a thickness of 100 mm will have a surface density of 240 kg/m^3. However, the BCA lists '140 mm thick or greater concrete panels' with the examples of typical wall constructions that achieve a surface density of 220 kg/m^3. 140 mm thick, not 100 mm thick, is nominated in order to achieve the appropriate combination of thermal resistance and thermal mass. It should be clearly understood that the 140-mm requirement should override the 220 kg/m^3 limit if Deemed-to-Satisfy (DTS) provisions are used. When verification by calculation is adopted, any wall thickness may be used provided the performance criteria are met.

FLOORS

Suspended concrete floors must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.4.

SUSPENDED FLOORS – Minimum Total R-Values

Climate zone	1	3	4	5	6
Direction of heat flow	Up	Up	Down	Down	Down
Minimum Total R-Value (including the underfloor airspace and enclosure if the perimeter is enclosed)	1.5	1.5	2.25	1.0	2.25

Suspended concrete slab construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges and R2.0 on the underside.

Concrete slab-on-ground construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges. (BCA 2011 Volume 2 Part 3.12.1.5.)

Western Australia Summary

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 1 Broome, Christmas Island, Cocos Island, Derby, Exmouth, Karratha, Port Hedland, Wyndham	**ZONE 3** Carnarvon, Halls Creek
ROOF		
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.1** (down) Upper surface solar absorptance not more than 0.4 Nil	**Total R-Value 4.1** (down and up) Upper surface solar absorptance not more than 0.4 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.6** (down) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil	**Total R-Value 4.6** (down and up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 5.1** (down) Upper surface solar absorptance more than 0.6 Nil	**Total R-Value 5.1** (down and up) Upper surface solar absorptance more than 0.6 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 3.6** (down) Upper surface solar absorptance not more than 0.4 Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area	**Total R-Value 3.6** (down and up) Upper surface solar absorptance not more than 0.4 Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.1** (down) Upper surface solar absorptance more than 0.4 but not more than 0.6 As above	**Total R-Value 4.1** (down and up) Upper surface solar absorptance more than 0.4 but not more than 0.6 As above
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.6** (down) Upper surface solar absorptance more than 0.6 As above	**Total R-Value 4.6** (down and up) Upper surface solar absorptance more than 0.6 As above
EXTERNAL WALLS		
Thermal resistance Surface density Shading and glazing	**Total R-Value 2.8** Any Any	**Total R-Value 2.8** Any Any
Thermal resistance Surface density Shading and glazing	**Total R-Value 2.4** Any Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	**Total R-Value 2.4** Any Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°
Thermal resistance Surface density Shading and glazing	**Added insulation with R-Value 0.5** > 220 kg/m^2 Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 20%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	**Added insulation with R-Value 0.5** > 220 kg/m^2 Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 20%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls

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ZONE 4 Balladonia, Kalgoorlie-Boulder, Meekatharra, Northam, Wagin	ZONE 5 Bunbury, Esperance, Geraldton, Perth	ZONE 6 Albany, Pemberton
ROOF		
Total R-Value 4.1 (up) Upper surface solar absorptance not more than 0.4 Nil	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil
Total R-Value 4.6 (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil
Total R-Value 5.1 (up) Upper surface solar absorptance more than 0.6 Nil	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil
Total R-Value 3.6 (up) Upper surface solar absorptance not more than 0.4 Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area	**Total R-Value 3.6** (up) Upper surface solar absorptance not more than 0.4 Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area	
Total R-Value 4.1 (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 As above	**Total R-Value 4.1** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 As above	
Total R-Value 4.6 (up) Upper surface solar absorptance more than 0.6 As above	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.6 As above	
EXTERNAL WALLS		
Total R-Value 2.8 Any Any	**Total R-Value 2.8** Any Any	**Total R-Value 2.8** Any Any
Total R-Value 2.4 Any Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	**Total R-Value 2.4** Any Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	**Added insulation with R-Value 0.5** > 220 kg/m^2 Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 15%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls
Added insulation with R-Value 0.5 > 220 kg/m^2 Enhanced external glazing (C_u reduced by 15%) **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	**Added insulation with R-Value 0.5** > 220 kg/m^2 Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 15%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	**Added insulation with R-Value 1.0** > 220 kg/m^2 The lowest storey has concrete slab-on-ground floor or masonry internal walls

continues page 24

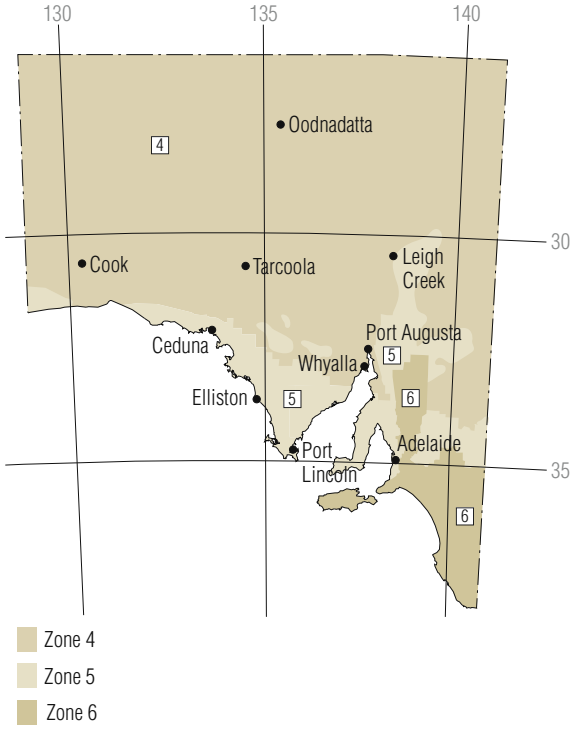
Western Australia Summary *continued*

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 1 Broome, Christmas Island, Cocos Island, Derby, Exmouth, Karratha, Port Hedland, Wyndham	**ZONE 3** Carnarvon, Halls Creek	**ZONE 4** Balladonia, Kalgoorlie-Boulder, Meekatharra, Northam, Wagin	**ZONE 5** Bunbury, Esperance, Geraldton, Perth	**ZONE 6** Albany, Pemberton
EXTERNAL WALLS *continued*					
Thermal resistance			**No added insulation required**	**No added thermal insulation required**	
Surface density			> 220 kg/m^2	> 220 kg/m^2	
Shading and glazing			Enhanced external glazing (C_u reduced by 20%)	Shade all walls; **AND** Enhanced glazing (C_{SHGC} reduced by 15%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	
Thermal resistance			**Added insulation with R-Value 1.0**		
Surface density			> 220 kg/m^2		
Shading and glazing			The lowest storey has concrete slab-on-ground floor or masonry internal walls		
SUSPENDED CONCRETE FLOORS					
Thermal resistance	**Total R-Value 1.5** (up)	**Total R-Value 1.5** (up)	**Total R-Value 2.25** (down)	**Total R-Value 1.0** (down)	**Total R-Value 2.25** (down)
In-slab heating or cooling	Nil	Nil	Nil	Nil	Nil
Thermal resistance	**Total R-Value 2.0** (up) and **1.0** around the vertical edges	**Total R-Value 2.0** (up) and **1.0** around the vertical edges	**Total R-Value 2.25** (down) and **1.0** around the vertical edges	**Total R-Value 2.0** (up) and **1.0** around the vertical edges	**Total R-Value 2.25** (down) and **1.0** around the vertical edges
In-slab heating or cooling	Present	Present	Present	Present	Present
CONCRETE SLAB-ON-GROUND					
Thermal resistance	**No requirements**	**No requirements**	**No requirements**	**No requirements**	**No requirements**
In-slab heating or cooling	Nil	Nil	Nil	Nil	Nil
Thermal resistance	**R1.0** around the vertical edges	**R1.0** around the vertical edges	**R1.0** around the vertical edges	**R1.0** around the vertical edges	**R1.0** around the vertical edges
In-slab heating or cooling	Present	Present	Present	Present	Present

South Australia

Energy Efficiency Requirements – Roofs, walls and floors



SOUTH AUSTRALIA CLIMATE ZONES

LOCATION	ZONE
Adelaide	5
Bordertown	6
Ceduna	5
Cook	4
Elliston	5
Kingscote	6
Leigh Creek	5
Lobethal	6
Loxton	5
Marree	4
Mount Gambier	6
Murray Bridge	6
Naracoorte	6
Oodnadatta	4
Port Augusta	4
Port Lincoln	5
Renmark	5
Tarcoola	4
Victor Harbour	6
Whyalla	4

GENERAL

The South Australian government has adopted the energy efficiency measures of the BCA 2011 Volume 2 into the state building regulations.

OBJECTIVE AND FUNCTIONAL STATEMENT

The stated Objective is 'to reduce greenhouse gas emissions'. This is further developed by the Functional Statement, which states that the building and its domestic services must be capable of efficiently using energy and should, 'to the degree necessary', obtain the energy from a source of low greenhouse gas intensity, renewable on site or reclaimed energy. (BCA 2011 Volume 2 Parts O2.6 and F2.6.)

Both the Objective and Functional Statement provide guidance only. It is the Performance Requirement (below) that sets out the specific requirements for compliance with the BCA.

PERFORMANCE REQUIREMENT

(BCA 2011 Volume 2 Part P2.6.1)

A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

(a) the function and use of the building; and
(b) the internal environment; and
(c) the geographic location of the building; and
(d) the effects of nearby permanent features such as topography, structures and buildings; and
(e) solar radiation being (i) utilised for heating; and (ii) controlled to minimise energy for cooling; and
(f) the sealing of the building envelope against air leakage; and
(g) the utilisation of air movement to assist cooling.

DEMONSTRATING COMPLIANCE BY COMPARISON TO A REFERENCE BUILDING

The BCA provides a method of verification, based on comparison of a proposed building to a reference building, which has the same dimensions, orientation and the like, and construction specified in this part of the BCA.

Compliance is demonstrated in Climate Zones 4, 5 and 6 when the calculated heating and cooling loads of the proposed building are equal to or less than those of the reference building.

DEMONSTRATING COMPLIANCE BY ACCEPTABLE CONSTRUCTION PRACTICE

Compliance with the performance requirements of energy efficiency and reduced greenhouse gas emissions is achieved through one of the two following 'Deemed-to-Satisfy' (DTS) provisions, as specified in BCA 2011 Volume 2 Part 3.12.

Compliance may be demonstrated by:

- achieving a specified efficiency of the Nationwide House Energy Rating Scheme using complying simulation software; or
- adopting forms of construction which are 'deemed to satisfy' the BCA requirements.

Simulation Calculations

BCA 2011 Volume 2 Part 3.12.0.1 requires that the calculated energy efficiency of a proposed building be not less than '6 stars', as defined in the Nationwide House Energy Rating Scheme.

The simulation calculations must be performed using software that complies with the ABCB Protocol for House Energy Rating Software. AccuRATE is one software tool meeting this requirement.

Deemed-to-Satisfy Construction

In this method, various building fabric components (eg roofs, walls and floors) must achieve specified levels of thermal resistance (R), depending on the climate zone and, in some cases, the thermal mass of the walls and concrete slab-on-ground.

In addition to the building fabric measures, there are specified requirements for external glazing, building sealing, air movement and services. (BCA 2011 Parts 3.12.2 to 3.12.5.)

The 'Deemed-to-Satisfy' provisions that are considered to be acceptable forms of construction for roofs, walls and floors are described below.

ROOFS

Roofs must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.4.

ROOFS – Minimum Total R-Values

Climate zone	4	5	6
Altitude	Any	Any	Any
Direction of heat flow	Up	Up	Up
Minimum Total R-Value for a roof with an upper surface solar absorptance value of not more than 0.4	4.1	4.1	4.1
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.4 but not more than 0.6	4.6	4.6	4.6
Minimum Total R-Value for a roof with an upper surface solar absorptance value of more than 0.6	5.1	5.1	5.1

In Climate Zones 4 and 5, the required Total R-Value specified above may be reduced by 0.5, provided the required insulation is laid on the ceiling; and the roof space is ventilated as specified in BCA 2011 Volume 2 Part 3.12.1.2(b).

Where exhaust fans, flues, downlights and the like reduce the area of roof and ceiling insulation, the BCA provides rules for increasing the required Total R-Value over the values given above (BCA 2011 Volume 2 Part 3.12.1.2(e)).

EXTERNAL WALLS

In Climate Zones 4 and 5 external walls must achieve Total R-Value of 2.8, OR external walls must achieve Total R-Value of 2.4 when the wall is shaded (see *Shading* below).

Walls with a high thermal mass, such as concrete or masonry wall, are granted a concession in the BCA.

In Climate Zone 5, external walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 0.5, provided:

- the top storey is shaded, as described below; and
- storeys below the top storey, although not shaded, have enhanced external glazing (complying with Part 3.12.2.1 and a value of C_{SHGC} reduced by 15%; and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

OR

In Climate Zone 5, external walls with a surface density of 220 kg/m^2 or more, may be constructed without *added insulation*, provided:

- the external walls (of all storeys) are shaded, as described below; and
- there is enhanced external glazing (complying with Part 3.12.2.1 and a value of C_{SHGC} reduced by 15%); and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

In Climate Zone 6 external walls must achieve a minimum Total R-Value of 2.8.

In Climate Zones 4 and 6, external walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 0.5, provided:

- there is enhanced external glazing complying with Part 3.12.2.1 with the applicable value of C_u reduced by 15%; and
- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

OR

In Climate Zones 4 and 6, external walls with a surface density of 220 kg/m^2 or more, may be constructed without added insulation, provided:

- there is enhanced external glazing complying with Part 3.12.2.1 with the applicable value of C_u reduced by 20%;

OR

External walls with a surface density of 220 kg/m^2 or more, must have *added insulation* with an R-Value not less than 1.0, provided:

- the lowest storey containing habitable rooms has either a concrete slab-on-ground floor or masonry internal walls.

Shading

Shading is considered to be effective when a veranda, balcony, eaves, carport or the like (including any attached guttering) projects horizontally from the external face of the building to the outer edge of the projection not less than 15° (1/3.7 of the wall height). The wall height is measured from the internal floor level to the underside of the projection. This may result in a need for eaves that are wider than normal. For example, if the height from the internal floor to the underside of a 125 mm wide gutter is 2.4 m, the required eaves width (from wall to fascia) is 475 mm.

Surface density of concrete walls

Reinforced concrete has a density of approximately 2400 kg/m^3. Therefore, a solid concrete wall with a thickness of 100 mm will have a surface density of 240 kg/m^3. However, the BCA lists '140-mm thick or greater concrete panels' with the examples of typical wall constructions that achieve a surface density of 220 kg/m^3. 140 mm thick, not 100 mm thick, is nominated in order to achieve the appropriate combination of thermal resistance and thermal mass. It should be clearly understood that the 140-mm requirement should override the 220 kg/m^3 limit if Deemed-to-Satisfy (DTS) provisions are used. When verification by calculation is adopted, any wall thickness may be used provided the performance criteria are met.

FLOORS

Suspended concrete floors must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2011 Volume 2 Table 3.12.1.4.

SUSPENDED FLOORS – Minimum Total R-Values

Climate zone	4	5	6
Direction of heat flow	Down	Down	Down
Minimum Total R-Value (including the underfloor airspace and enclosure if the perimeter is enclosed)	2.25	1.0	2.25

Suspended concrete slab construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the edges and R2.0 on the underside.

Concrete slab-on-ground construction with in-slab heating or cooling system must have insulation with an R-Value of not less than 1.0 installed around the vertical edge of its perimeter. (BCA 2011 Volume 2 Part 3.12.1.5.)

South Australia Summary

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 4 Cook, Marree, Oodnadatta, Port Augusta, Tarcoola, Whyalla	**ZONE 5** Adelaide, Ceduna, Elliston, Leigh Creek, Loxton, Port Lincoln, Renmark	**ZONE 6** Bordertown, Kingscote, Lobethal, Mount Gambier, Murray Bridge, Naracoorte, Victor Harbour
ROOF			
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil	**Total R-Value 4.1** (up) Upper surface solar absorptance not more than 0.4 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil	**Total R-Value 5.1** (up) Upper surface solar absorptance more than 0.6 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 3.6** (up) Upper surface solar absorptance not more than 0.4 Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; OR Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area	**Total R-Value 3.6** (up) Upper surface solar absorptance not more than 0.4 Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; OR Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area	
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.1** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 As above	**Total R-Value 4.1** (up) Upper surface solar absorptance more than 0.4 but not more than 0.6 As above	
Thermal resistance Solar absorptance Ventilation	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.6 As above	**Total R-Value 4.6** (up) Upper surface solar absorptance more than 0.6 As above	
EXTERNAL WALLS			
Thermal resistance Surface density Shading and glazing	**Total R-Value 2.8** Any Any	**Total R-Value 2.8** Any Any	**Total R-Value 2.8** Any Any
Thermal resistance Surface density Shading and glazing *continues page 29*	**Total R-Value 2.4** Any Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	**Total R-Value 2.4** Any Shade the external wall of the storey with a verandah, balcony, eaves, carport and the like, which projects a minimum angle of 15°	**Added insulation with R-Value 0.5** > 220 kg/m^2 Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 15%); AND The lowest storey has concrete slab-on-ground floor or masonry internal walls

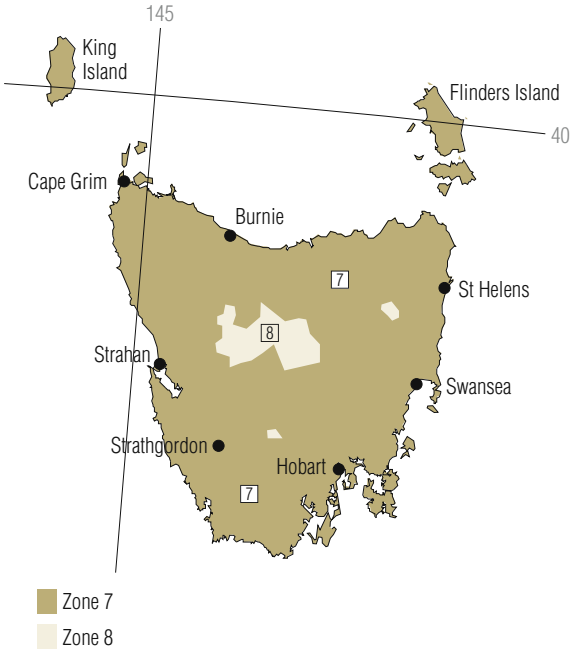
South Australia Summary *continued*

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 4 Cook, Marree, Oodnadatta, Port Augusta, Tarcoola, Whyalla	**ZONE 5** Adelaide, Ceduna, Elliston, Leigh Creek, Loxton, Port Lincoln, Renmark	**ZONE 6** Bordertown, Kingscote, Lobethal, Mount Gambier, Murray Bridge, Naracoorte, Victor Harbour
EXTERNAL WALLS *continued*			
Thermal resistance Surface density Shading and glazing	**Added insulation with R-Value 0.5** > 220 kg/m^2 Enhanced external glazing (C_u reduced by 15%) **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	**Added insulation with R-Value 0.5** > 220 kg/m^2 Top storey; **AND** Storeys below the top storey with enhanced glazing (C_{SHGC} reduced by 15%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	**Added insulation with R-Value 1.0** > 220 kg/m^2 The lowest storey has concrete slab-on-ground floor or masonry internal walls
Thermal resistance Surface density Shading and glazing	**No added insulation required** > 220 kg/m^2 Enhanced external glazing (C_u reduced by 20%)	**No added thermal insulation required** > 220 kg/m^2 Shade all walls; **AND** Enhanced glazing (C_{SHGC} reduced by 15%); **AND** The lowest storey has concrete slab-on-ground floor or masonry internal walls	
Thermal resistance Surface density Shading and glazing	**Added insulation with R-Value 1.0** > 220 kg/m^2 The lowest storey has concrete slab-on-ground floor or masonry internal walls		
SUSPENDED CONCRETE FLOORS			
Thermal resistance In-slab heating or cooling	**Total R-Value 2.25** (down) Nil	**Total R-Value 1.0** (down) Nil	**Total R-Value 2.25** (down) Nil
Thermal resistance In-slab heating or cooling	**Total R-Value 2.25** (down) and **1.0** around the vertical edges Present	**Total R-Value 2.0** (down) and **1.0** around the vertical edges Present	**Total R-Value 2.25** (down) and **1.0** around the vertical edges Present
CONCRETE SLAB-ON-GROUND			
Thermal resistance In-slab heating or cooling	**No requirements** Nil	**No requirements** Nil	**No requirements** Nil
Thermal resistance In-slab heating or cooling	**R1.0** around the vertical edges Present	**R1.0** around the vertical edges Present	**R1.0** around the vertical edges Present

Tasmania

Energy Efficiency Requirements – Roofs, walls and floors



TASMANIA CLIMATE ZONES

LOCATION	ZONE
Burnie	7
Bicheno	7
Deloraine	7
Devonport	7
Flinders Island	7
Hobart	7
Huonville	7
King Island	7
Launceston	7
New Norfolk	7
Oatlands	7
Orford	7
Rossarden	7
Smithton	7
St Marys	7
Zeehan	7

GENERAL

The Tasmanian government has continued to adopt the energy efficiency measures of the BCA 2009 Volume 2 into the state building regulations.

OBJECTIVE AND FUNCTIONAL STATEMENT

The stated Objective is 'to reduce greenhouse gas emissions by efficiently using energy'. This is further developed by the Functional Statement, which states that the building and its domestic services must be capable of efficiently using energy. (BCA 2009 Volume 2 Parts O2.6 and F2.6.)

Both the Objective and Functional Statement provide guidance only. It is the Performance Requirement (below) that sets out the specific requirements for compliance with the BCA.

PERFORMANCE REQUIREMENT

(BCA 2009 Volume 2 Part P2.6.1)

A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

- *(a) the function and use of the building; and*
- *(b) the internal environment; and*
- *(c) the geographic location of the building; and*
- *(d) the effects of nearby permanent features such as topography, structures and buildings; and*
- *(e) solar radiation being (i) utilised for heating; and (ii) controlled to minimise energy for cooling; and*
- *(f) the sealing of the building envelope against air leakage; and*
- *(g) the utilisation of air movement to assist cooling.*

DEMONSTRATING COMPLIANCE BY STATED VALUES

BCA 2009 Volume 2 Part V2.6.1 requires that the calculated energy efficiency of a proposed building be not less than '5 stars', as defined in the Nationwide Energy Rating Scheme. The simulation calculations must be performed using software that complies with the ABCB Protocol for House Energy Rating Software. AccuRATE is one software tool meeting this requirement.

DEMONSTRATING COMPLIANCE BY COMPARISON TO A REFERENCE BUILDING

BCA 2009 Volume 2 Part V2.6.2.2 provides a method of verification, based on comparison of a proposed building to a reference building, which has the same dimensions, orientation and the like, and construction specified in this part of the BCA.

DEMONSTRATING COMPLIANCE BY ACCEPTABLE CONSTRUCTION PRACTICE

Compliance with the performance requirements of energy efficiency and reduced greenhouse gas emissions is achieved through the following 'Deemed-to-Satisfy' (DTS) provisions, as specified in BCA 2009 Volume 2 Part 3.12.

Deemed-to-Satisfy Construction

In this method, various building fabric components (eg roofs, walls and floors) must achieve specified levels of thermal resistance (R), depending on the climate zone and, in some cases, the thermal mass of the walls and concrete slab-on-ground.

In addition to the building fabric measures, there are specified requirements for external glazing, building sealing, air movement and services. (BCA 2009 Parts 3.12.2 to 3.12.5)

The 'Deemed-to-Satisfy' provisions that are considered to be acceptable forms of construction for roofs, walls and floors are described below.

ROOFS

Roofs must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2009 Volume 2 Table 3.12.1.1.

ROOFS – Minimum Total R-Value

Climate zone	7
Altitude	Any
Direction of heat flow	Up
Minimum Total R-Value	4.3

EXTERNAL WALLS

In Climate Zone 7 external walls must achieve Total R-Value of 2.4 (BCA 2009 Volume 2 Table 3.12.1.3).

Walls with a high thermal mass, such as concrete or masonry walls, are granted a concession in the BCA. External walls with a surface density of 220 kg/m^2 or more must have added insulation with an R-Value of not less than 1.0.

Surface density of concrete walls

Reinforced concrete has a density of approximately 2400 kg/m^3. Therefore, a solid concrete wall with a thickness of 100 mm will have a surface density of 240 kg/m^3. However, the BCA lists '140 mm thick or greater concrete panels' with the examples of typical wall constructions that achieve a surface density of 220 kg/m^3. 140 mm thick, not 100 mm thick, is nominated in order to achieve the appropriate combination of thermal resistance and thermal mass. It should be clearly understood that the 140-mm requirement should override the 220 kg/m^3 limit if Deemed-to-Satisfy (DTS) provisions are used. When verification by calculation is adopted, any wall thickness may be used provided the performance criteria are met.

FLOORS

The only requirement for concrete slab-on-ground is that, if there is an in-slab heating or cooling system, insulation with an R-value of not less than 1.0 must be installed around the vertical edge of its perimeter.

Suspended floors must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2009 Volume 2 Table 3.12.1.4.

SUSPENDED FLOORS – Minimum Total R-Value

Climate zone	7
Direction of heat flow	Down
Minimum total R-Value Enclosed airspace	1.5
Minimum total R-Value Unenclosed airspace	2.5

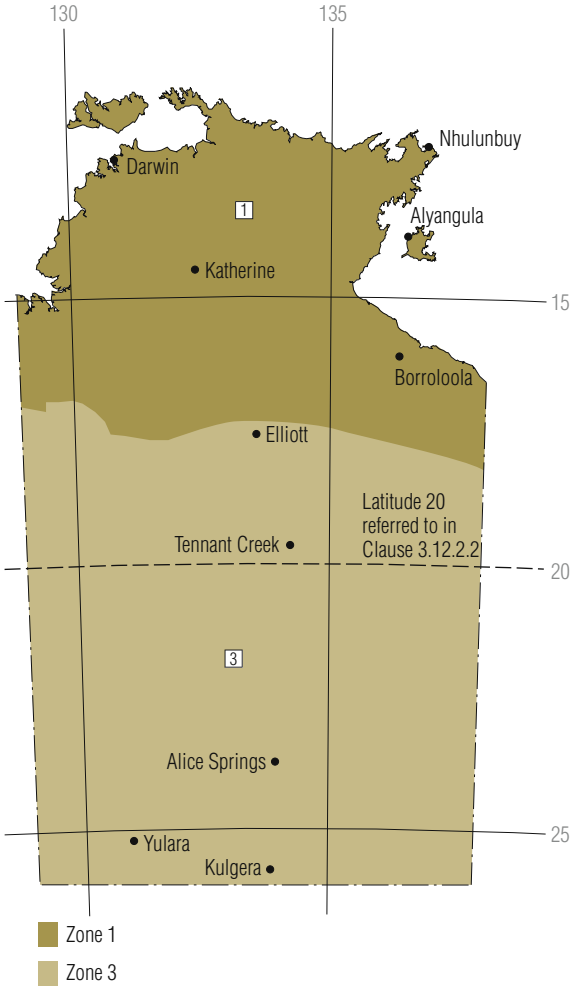
Tasmania Summary

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 7
ROOF	
Thermal resistance	**Total R-Value 4.3** (up)
Solar absorptance	Any
Ventilation	Nil
EXTERNAL WALLS	
Thermal resistance	**Total R-Value 2.4**
Surface density	Any
Other construction	Any
Thermal resistance	**Added R1.0**
Surface density	> 220 kg/m^2
Other construction	Concrete slab-on-ground
SUSPENDED CONCRETE FLOORS	
Thermal resistance	**Total R-Value 1.5**
Other construction	Enclosed floors
Thermal resistance	**Total R-Value 2.5**
Other construction	Unenclosed floors
CONCRETE SLAB-ON-GROUND	
Thermal resistance	**No requirements**, **except when there is in-slab heating or cooling**

Northern Territory

Energy Efficiency Requirements – Roofs, walls and floors



NORTHERN TERRITORY CLIMATE ZONES

LOCATION	ZONE
Alice Springs	3
Darwin	1
Elliot	3
Katherine	1
Renner Springs	3
Tennant Creek	3

GENERAL

The Northern Territory government has adopted the energy efficiency measures of the BCA 2009 Volume 2 into the territory building regulations.

OBJECTIVE AND FUNCTIONAL STATEMENT

The stated Objective is 'to reduce greenhouse gas emissions by efficiently using energy'. This is further developed by the Functional Statement which states that the building and its domestic services must be capable of efficiently using energy. (BCA 2009 Volume 2 Parts O2.6 and F2.6.)

Both the Objective and Functional Statement provide guidance only. It is the Performance Requirement (below) that sets out the specific requirements for compliance with the BCA.

PERFORMANCE REQUIREMENT

(BCA 2009 Volume 2 Part P2.6.1)

A building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling appropriate to –

- *(a) the function and use of the building; and*
- *(b) the internal environment; and*
- *(c) the geographic location of the building; and*
- *(d) the effects of nearby permanent features such as topography, structures and buildings; and*
- *(e) solar radiation being (i) utilised for heating; and (ii) controlled to minimise energy for cooling; and*
- *(f) the sealing of the building envelope against air leakage; and*
- *(g) the utilisation of air movement to assist cooling.*

DEMONSTRATING COMPLIANCE BY STATED VALUES

BCA 2009 Volume 2 Part V2.6.1 requires that the calculated energy efficiency of a proposed building be not less than '5 stars', as defined in the Nationwide Energy Rating Scheme. The simulation calculations must be performed using software that complies with the ABCB Protocol for House Energy Rating Software. AccuRATE is one software tool meeting this requirement.

DEMONSTRATING COMPLIANCE BY COMPARISON TO A REFERENCE BUILDING

BCA 2009 Volume 2 Part V2.6.2.2 provides a method of verification, based on comparison of a proposed building to a reference building, which has the same dimensions, orientation and the like, and construction specified in this part of the BCA.

DEMONSTRATING COMPLIANCE BY ACCEPTABLE CONSTRUCTION PRACTICE

Compliance with the performance requirements of energy efficiency and reduced greenhouse emissions is achieved though the following 'Deemed-to-Satisfy' (DTS) provisions, as specified in BCA 2009 Volume 2 Part 3.12.

Deemed-to-Satisfy Construction

In this method, various building fabric components (eg roofs, walls and floors) must achieve specified levels of thermal resistance (R), depending on the climate zone and, in some cases, the thermal mass of the walls and concrete slab-on-ground.

In addition to the building fabric measures, there are specified requirements for external

glazing, building sealing, air movement and services. (BCA 2009 Parts 3.12.2 to 3.12.5.)

The 'Deemed-to-Satisfy' provisions that are considered to be acceptable forms of construction for roofs, walls and floors are described below.

ROOFS

Roofs must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2009 Volume 2 Table 3.12.1.1.

ROOFS – Minimum Total R-Value

Climate zone	1	3
Altitude	Any	Any
Direction of heat flow	Down	Down and up
Minimum Total R-Value	2.7	2.7

In Climate Zones 1 and 3 the required Total R-Value specified above may be reduced by 0.5 if the roof upper surface has a solar absorptance of not more than 0.55; or the roof space is ventilated as specified in BCA 2009 Volume 2 Part 3.12.1.2(b) or the roof is tiled and without sarking.

EXTERNAL WALLS

Walls and floors with a high thermal mass are granted concessions in the BCA. This includes concrete-slab-on ground, concrete or masonry external walls and masonry internal walls. Shading is also granted a concession.

In Climate Zone 1 the requirements shown below do not apply to any building storey that has a surface density ≥ 220 kg/m^2, the external surfaces have a solar absorptance not more than 0.45, and the external glazing has enhanced performance (C_{SHGC} in accordance with Table 3.12.1.1 is reduced by 15% where the external walls are shaded and 25% when the external walls are not shaded), and the habitable rooms contain ceiling fans.

Shading

Shading is considered to be effective when a veranda, balcony, eaves, carport or the like (including any attached guttering) projects horizontally from the external face of the building to the outer edge of the projection not less than 15°(1/3.7 of the wall height). The wall height is measured from the internal floor level to the underside of the projection. This may result in a need for eaves that are wider than normal. For example, if the height from the internal floor to the underside of a 125 mm wide gutter is 2.4 m, the required eaves width (from wall to fascia) is 475 mm.

In Climate Zone 1, a shaded external wall facing north-east, east, south-east, south-west, west and north-west require a shading projection of 45°.

Surface density of concrete walls

Reinforced concrete has a density of approximately 2400 kg/m^3. Therefore, a solid concrete wall with a thickness of 100 mm will have a surface density of 240 kg/m^3. However, the BCA lists '140 mm thick or greater concrete panels' with the examples of typical wall constructions that achieve a surface density of 220 kg/m^3. 140 mm thick, not 100 mm thick, is nominated in order to achieve the appropriate combination of thermal resistance and thermal mass. It should be clearly understood that the 140-mm requirement should override the 220 kg/m^3 limit if Deemed-to-Satisfy (DTS) provisions are used. When verification by calculation is adopted, any wall thickness may be used provided the performance criteria are met.

FLOORS

The only requirement for concrete slab-on-ground is that, if there is an in-slab heating or cooling system, insulation with an R-value of not less than 1.0 must be installed around the edges.

Suspended floors must achieve the minimum Total R-Value shown in the table below, extracted from BCA 2009 Volume 2 Table 3.12.1.4.

SUSPENDED FLOORS – Minimum Total R-Value

Climate zone	1	3
Minimum total R-Value Enclosed airspace	Nil	Nil
Minimum total R-Value Unenclosed airspace	Nil	Nil

EXTERNAL WALLS BCA 2009 Volume 2 Table 3.12.1.3

Wall type or surface density kg/m^2	Is there a concrete slab-on-ground	Is there effective shading?	Insulation required in particular climate zones
Any	–	–	Zone 1 – Total R-Value 1.9 Zone 3 – Total R-Value 1.9
Any	Yes	–	Zone 1 – Total R-Value 1.4 Zone 3 – Total R-Value 1.4
> 220 kg/m^2	–	Yes	Zone 1 – Nil
External weatherboard, sheet clad or masonry veneer walls	–	Yes	Zone 1 – Reflective insulation (emittance not more than 0.05) inwards

Northern Territory Summary

ENERGY EFFICIENT ACCEPTABLE CONSTRUCTION PRACTICE

	ZONE 1 Darwin, Katherine	**ZONE 3** Alice Springs, Elliot, Renner Springs, Tennant Creek
ROOF		
Thermal resistance Solar absorptance Ventilation	**Total R-Value 2.7** (down) Any Nil	**Total R-Value 2.7** (down and up) Any Nil
Thermal resistancet Solar absorptance Ventilation	**Total R-Value 2.2** (down) Upper surface solar absorptance more than 0.55 Nil	**Total R-Value 2.2** (down and up) Upper surface solar absorptance more than 0.55 Nil
Thermal resistance Solar absorptance Ventilation	**Total R-Value 2.2** (down) Any Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area; **OR** The roof is tiled without sarking	**Total R-Value 2.2** (down and up) Any Fixed ventilation with aggregate fixed open area at least 1.0% of ceiling area; **OR** Two wind-driven roof ventilators with aggregate opening area at least 0.14 m^2, and fixed ventilation with aggregate fixed open area at least 0.2% of ceiling area; **OR** The roof is tiled without sarking
EXTERNAL WALLS		
Thermal resistance Surface density Other construction	**Total R-Value 1.9** Any Any	**Total R-Value 1.9** Any Any
Thermal resistance Surface density Other construction	**Total R-Value 1.4** Any Concrete slab-on-ground	**Total R-Value 1.4** Any Concrete slab-on-ground
Thermal resistance Surface density Other construction	**Nil** Any Shaded	
Thermal resistance Surface density Other construction	**Reflective insulation (emittance not more than 0.05) inwards** Any External weatherboard, sheet clad or masonry veneer walls, shaded	
SUSPENDED CONCRETE FLOORS		
Thermal resistance Other construction	**Nil** Enclosed floors	**Nil** Enclosed floors
Thermal resistance Other construction	**Nil** Unenclosed floors	**Nil** Unenclosed floors
CONCRETE SLAB-ON-GROUND		
Thermal resistance	**No requirements, except when there is in-slab heating or cooling**	**No requirements, except when there is in-slab heating or cooling**

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