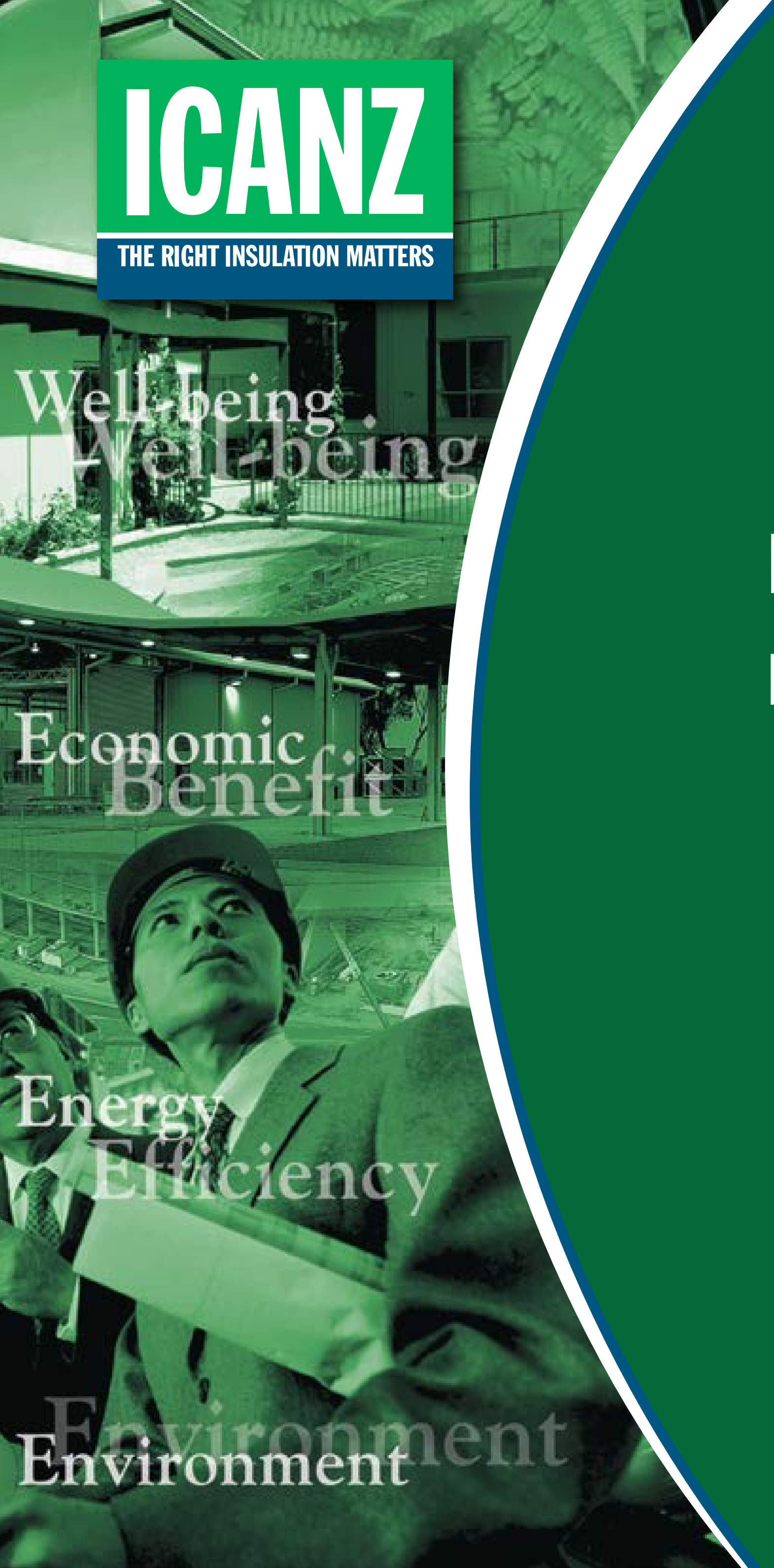
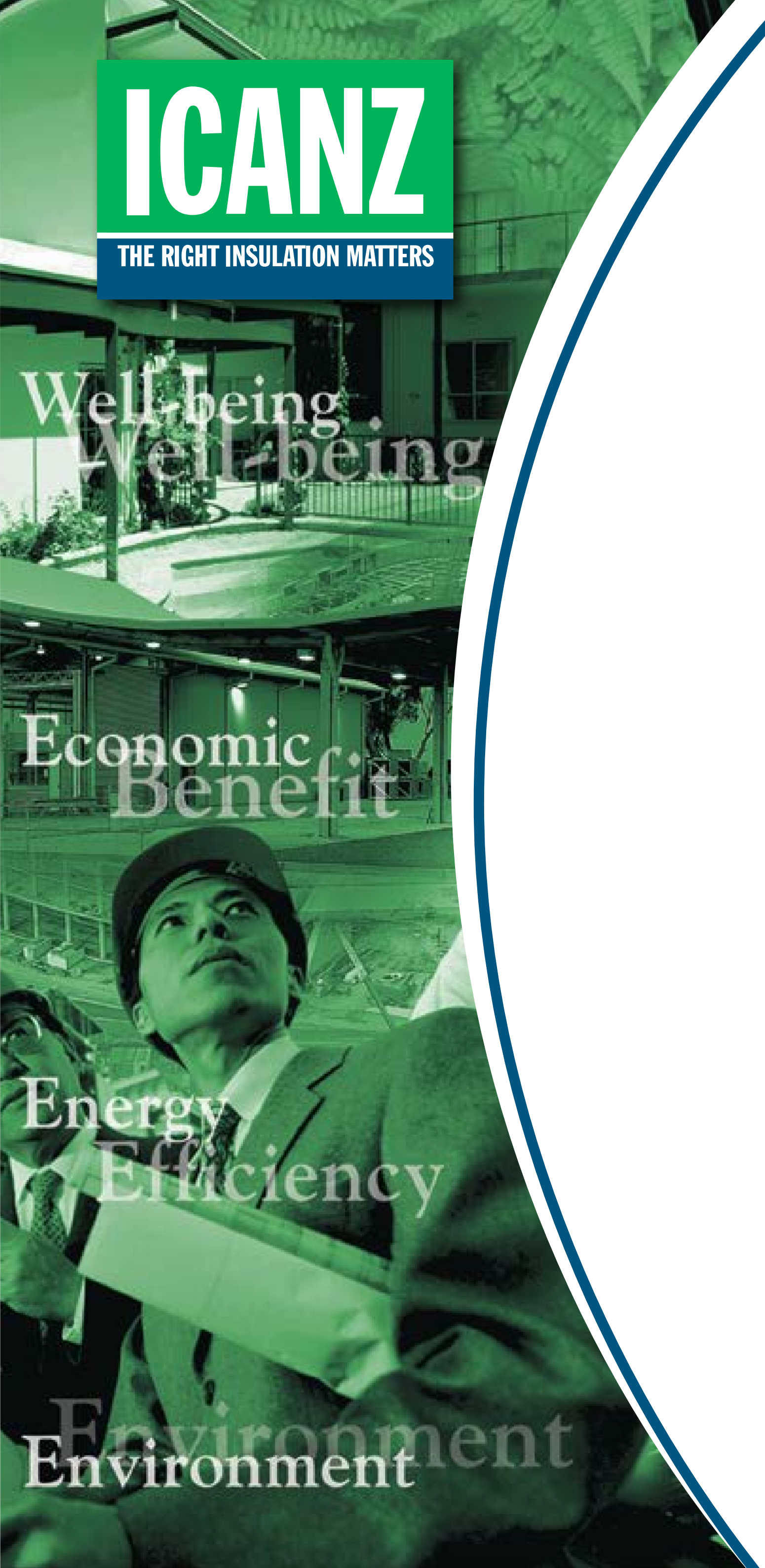


INSULATION HANDBOOK

Part 1: Thermal Performance - Version 3

Total R-value calculations for typical building applications

An independent publication of the
Insulation Council of Australia and New Zealand



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Acknowledgements

Version	Date	Description
1	Nov 2010	Initial release
2	Jan 2015	Revised Edition
3	May 2016	Revised Edition

NOTE: This document will be updated periodically. Check ICANZ website to confirm this is the latest edition.
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BEFORE READING THIS GUIDE PLEASE NOTE

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ICANZ
THE RIGHT INSULATION MATTERS

CONTENTS

ICANZ
THE RIGHT INSULATION MATTERS

THE RIGHT INSULATION MATTERS

The Right Insulation…..increases building energy efficiency, improves health and well-being and reduces greenhouse gas emissions

About this Handbook

This handbook has been developed to assist designers, specifiers and builders to:

- determine the Total R-value of common construction systems
- increase energy efficiency and reduce environmental impact of building projects
- assist in complying with the requirements of the Building Code of Australia, AS/NZS 4859.1 and energy rating software
- demonstrate accepted industry installation practices
- clarify and standardise the value of reflective foil insulation in typical building applications

While some applications can be used to achieve "Deem to Satisfy" solutions for the BCA Energy Efficiency Provisions, not all solutions will achieve compliance for all applications.

Total R-value

R-value means the thermal resistance (m^2K/W) of a material calculated by dividing the thickness by its thermal conductivity.
Total R-values are based on the sum of all components of the building system including indoor and outdoor air-films, building materials used in the system and air-spaces.

- Bulk insulation thermal resistance is expressed by Material R-value
- Reflective insulation thermal resistance is expressed in terms of Total R-value

Calculations in this handbook have been made using practical assumptions for typical situations, and using conservative assumptions expected in actual systems (rather than ideal theoretical systems that are unrealistic to achieve in practice). In particular the effect of anti-glare coatings or dust on the top surface of foil has been used in accordance with the 2006 amendment to AS/NZS 4859.1.
In addition, the Total R-value of the un-insulated structures are also provided to demonstrate the thermal resistance without insulation: these are shown for both summer and winter conditions.
Total R-values "With" or "Including" insulation and/or air spaces indicate the total thermal resistance achieved when insulation products are correctly installed.
In the case of reflective insulation, these details may be used in combination with other complimentary insulation products to satisfy BCA requirements for minimum total R-values.
Note that the correct choice of insulation is dependent on a range of factors, other than thermal performance. Other factors may include condensation control, moisture absorption, non-combustibility and acoustic performance.
All calculations have been determined on the path of the insulation. Thermal bridging has not been taken into account. Consistent with the approach of the Building Code of Australia Vol 2 Part 3.12, and standard industry practice.

How does reflective insulation work

Reflective insulation may perform differently in "Summer" and "Winter"; therefore you must -

- First identify in which climate zone the particular building project is located (Refer to BCA Climate Map).
- Next, refer to the Minimum Total R-value table displayed in BCA Part J or Part 3.12.1 to determine whether the 'Summer' or 'Winter' design condition is applicable.

These steps are explained on the following pages.

Note:

Recommendations made in this handbook are based on Australian climate conditions

- Building design
- Structural systems
- Building materials

The performances of reflective foil insulation and bulk insulation are based on generic 'products' NOT proprietary brands. For information on specific reflective insulation or bulk insulation brands, please direct requests to the appropriate manufacturers. Select a product that has an equivalent or better specification of that nominated in this handbook.

I recommend this publication to all Building Designers as an invaluable source of information essential for the design of Energy Efficient Buildings.

DENNIS D'ARCY

ICANZ CEO

… AND PROVIDES MORE THAN JUST EFFICIENCY FOR BUILDINGS

Environmental benefits:

- Buildings account for over 20% of Australia's GHG emissions.
- Energy consumption in buildings is growing faster than most other areas of use.
- Insulation is the most cost effective way of reducing energy consumption and greenhouse gases emissions in the built environment.
- Insulating buildings (new and existing) is the most financially attractive of all energy efficiency and renewable energy measures to reduce greenhouse gas emissions.
- Current insulation production technology is proven and available now. Installing insulation has an immediate impact on energy demand and GHG emissions.
- A response to climate change demands well-insulated new and existing buildings.

Economic benefits:

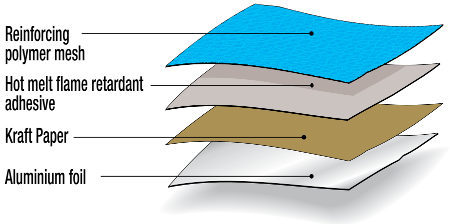
- Insulation reduces average home heating and cooling costs by around 30%.
- Insulation reduces the burden of increasing energy prices.
- The cost of installing insulation already pays for itself in around 3-5 years through reduced energy bills, and payback time will improve as energy costs rise.
- The right insulation is a once-only cost that lasts for the life of the building (typically 50 – 70 years) and requires no further maintenance.
- Saved energy is the most sustainable energy. Insulated buildings reduce the need for additional power generation capacity by "smoothing out" the peaks in energy demand.
- Well insulated buildings have reduced need for air-conditioning.
- Insulation improves property values and has been shown to increase the return on rented and leased properties.
- Insulation is not expensive. To insulate the ceilings, walls and floors of a typical house costs less than 1% of the construction cost.

Social benefits:

- People spend a great proportion of their lives in buildings. Insulation provides more than energy efficiency. Thermal and acoustic insulation play important roles in improving the quality of life by providing environments that are more comfortable – this leads to greater productivity at work.
- Studies show that well insulated buildings provide a healthier environment by controlling temperature and noise levels.
- By reducing household and business running costs, energy saving from insulation can provide a buffer to other cost of living increases.
- Insulation protects and improves the quality of life of the elderly and socially disadvantaged.

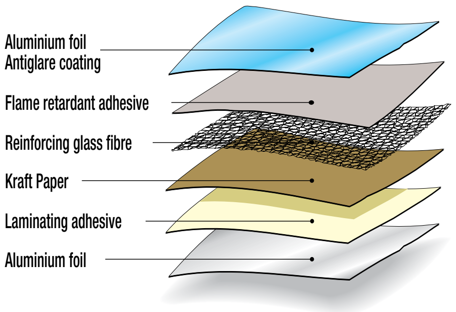
TYPES OF INSULATION

Ten types of insulation products are used throughout this Handbook.



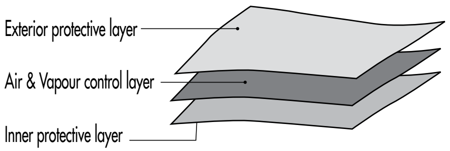
1. Single Sided Foils

Usually a woven polymer mesh material with a reflective aluminium foil adhered to one side; polymer mesh products can also have a paper inner core layer, the other side typically being opaque. Sometimes these membranes are referred to as radiant barrier insulation, reflective insulation or reflective foil laminates. The emissivity of the bright foil face is assumed to be 0.04 and the dull side 0.9 as determined by the procedure outlined in Appendix C. Examples of the visual appearance of single side foil membrane surfaces are outlined in appendix E.



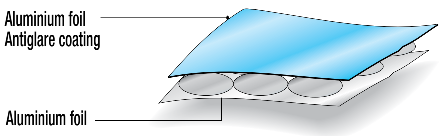
2. Double Sided Antiglare Foils

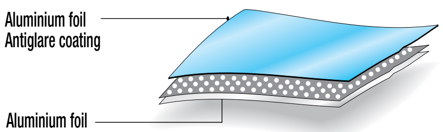
Antiglare foils with reflective foil on each side of an inner paper based lining, one face being coated with an antiglare ink to reduce glare. The emissivity of the bright foil face is assumed to be 0.04 and the antiglare side 0.08 as outlined in Appendix C. Examples of the visual appearance of double sided antiglare foil membrane surfaces are outlined in appendix E.



3. Vapour Permeable Membranes

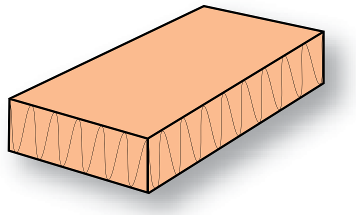
Vapour permeable membranes are specially designed to allow water vapour to pass thorugh the membrane.
A vapour and air control layer is typically bonded between protective inner and outer layers to form a vapour permebale membrane which also maintains barrier properties for liquid water and air. When used correctly this can allow for drying of construction systems.These membranes do not contain aluminium foil layers and do not have low emissivity surfaces.





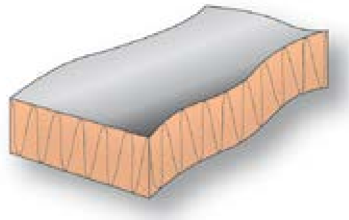
4 & 5. Bubble/Foam Foils

Double sided reflective foils with an inner core material thickness. One side coated with antiglare to reduce glare. Centre core material, typically 7mm thick enclosing a single layer of individual air bubbles or closed cell foam. The emissivity of the bright foil face is assumed to be 0.06 and the antiglare side 0.1 as outlined in Appendix C. Examples of the visual appearance of bubble and foam foil surfaces are outlined in appendix E.



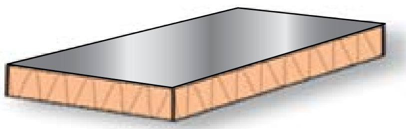
6. Ceiling and Wall Batts

Lightweight, flexible and resilient bulk glasswool Insulation batt, specially designed for thermal insulation of ceilings and cavity walls in both domestic and commercial buildings. They have the added benefit of being an effective sound absorber and so contribute to both the thermal and acoustic comfort of building occupants.



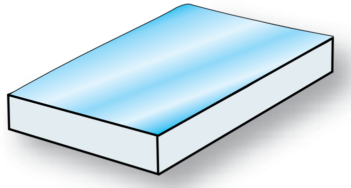
7. Foil Faced Blanket

Roofing blanket consists of a lightweight flexible bulk mineral insulation blanket faced on one side with reflective foil laminate. The blanket material is available in various R-values and thicknesses. The bright foil face is typically a single sided foil and the emissivity assumed to be 0.04. Blankets may also be faced with non-foil decorative facings which are typically white or black and are assumed to have an emissivity of 0.9.



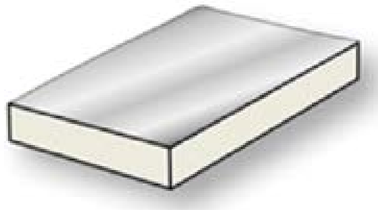
8. Foil Faced Board

Mineral wool boards consist of high density mineral wool. The higher densities give the insulation some stiffness to allow boards to be formed and these are available in various R-values and thicknesses. The bright foil face is typically a single sided foil and the emissivity assumed to be 0.04.



9. Antiglare Reflective EPS Board

Foil-faced polystyrene foam boards consist of expanded polystyrene rigid sheets (EPS) faced on both sides with a reflective foil laminate, one face additionally coated with an antiglare ink to reduce glare. The emissivity of the bright foil face is assumed to be 0.03 and the antiglare side 0.04 as outlined in Appendix C.



10. Reflective PIR Board

Foil-faced PIR foam boards consist of rigid Polyisocyanurate (PIR) sheets typically faced on both sides with a reflective aluminium foil. Polyisocyanurate foam achieves relatively high R-values for any given thicknesses. The emissivity of foil facings are assumed to be less than or equal to 0.05.

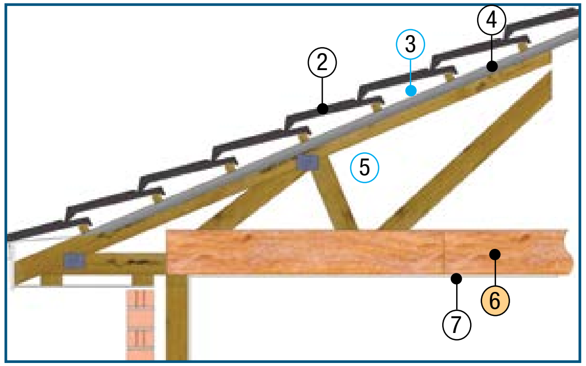
Added R-value	Thermal resistance added to a construction element by insulation.
Bulk insulation	Insulation depending for its performance upon thickness and thermal conductivity to achieve Material R-value.
Climate Zone	An area defined in the BCA Climate Zone Map of Australia having energy efficiency provisions based on a range of similar climate characteristics.
Conduction	Heat flow transfer by exciting molecules of a solid material.
Convection	Heat flow transferred by movement of a fluid (eg. air movement).
Double Sided	Reflective foil on both faces of reflective insulation.
Double Sided Antiglare	Reflective foil on both faces of reflective insulation with additional ink coating on external face (for OH&S antiglare requirements).
Emittance	Ratio of radiant energy emitted by a surface compared to that of a blackbody (a blackbody emits radiant energy at the maximum rate possible).
EPS Antiglared Reflective	Expanded polystyrene board, based on 'SL' grade with both sides foil faced, one side with antiglare coating.
FBS-1™ Glass Wool	Insulation composed of bio-soluble glass fibres.
FBS-1™ Mineral Wool	Insulation composed of fibres manufactured from glass or rock.
FBS-1™ Rock Wool	Insulation composed of bio-soluble rock fibres.
Heat Transfer	Heat flow from a hot to a cold body (see convection, conduction and radiation)
Indoor air film	A layer of air adjacent to the internal surface of the building element.
Material R-value	Thermal resistance determined by dividing thickness by thermal conductivity, excluding surface air film resistances. NOTE: Material R-values shown in the applications may be higher or lower than that stated on packaging. Labelled Material R-values are determined in accordance with AS/NZS 4859.1 - Amdt. 1-2006. The contribution of any insulation product may vary due to the composition of the application. It is for this reason that the Material R-values may vary from their normal values.
Nat. Ventilation	An air space bounded by one or more permeable surfaces allowing a degree of air movement (eg. an attic space below an unsarked tiled roof), 'Natural Ventilation'.
Non-Ventilated	Air space enclosed by non permeable building materials.
Outdoor air film	A layer of air adjacent to the external surface of the building element.
Radiation	Heat flow transfer by electromagnetic radiation (infra red waves).
Reflective Attic Space	Air space between flat ceiling and pitched roof bounded by reflective insulation under roofing material.
Reflective Insulation	Insulation depending for its performance upon reduction of radiant heat transfer across air spaces by use of one or more surfaces of high reflectance and low emittance.
Single Sided	Reflective foil on only one face of reflective insulation.
Summer	Denotes BCA design heat flow direction INTO the structure.
System R-value	Thermal resistance of a system, or construction of different materials, excluding surface air film resistances. The system may or may not be insulated.
Thermal bridging	Structural connections that allows heat loss or heat gain through the path of the structural member via conduction.
Thermal conductivity	A measure of the ability of a material to conduct heat.
Total R-value	Thermal resistance associated with a material or system, including surface air film resistances may also be refered to as "Total Insulated System R-value" or "Total Uninsulated System R-value" depending on whether the primary insulation layer is included or not included.
Ventilated	Air space ventilation provided by an opening designed to allow air movement, or by mechanical means.
Winter	Denotes BCA design heat flow direction OUT of the structure.
Vapour Permeable	Products which allow water vapour to pass through them. This commonly refers to purpose made building membranes which do not have foil surfaces.

STEP 1 - SELECT YOUR SYSTEM

Select the system which best represents your system. The generic descriptions describe the type of construction but may not exactly represent your system. For detailed calculations of your system contact your ICANZ representative.

STEP 2 - IDENTIFY MATERIAL LAYERS

Familiarise yourself with the system components as per the diagrams for each system. Solid circle, blue or orange coloured components indicate a layer which you can select a value.

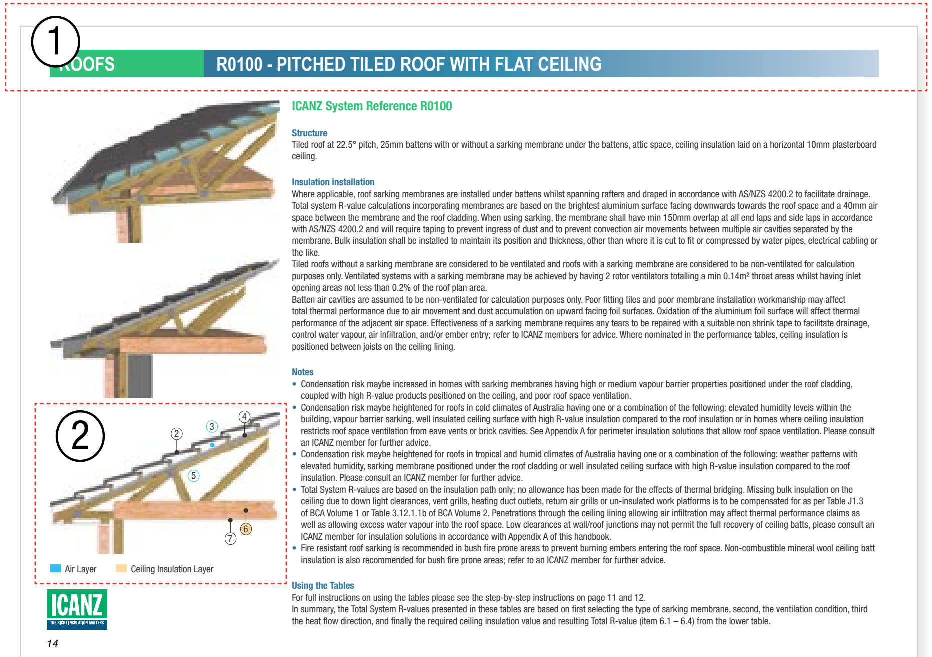


Solid Materials

Air Layer

Insualtion Layer - R-value to be selected

Air Layer - Thickness to be selected



R0100 - PITCHED TILED ROOF WITH FLAT CEILING

ICANZ System Reference R0100

Structure

Tiled roof at 22.5° pitch, 25mm battens with or without a sarking membrane under the battens, attic space, ceiling insulation laid on a horizontal 10mm plasterboard ceiling.

Insulation installation

Where applicable, roof sarking membranes are installed under battens whilst spanning rafters and draped in accordance with AS/NZS 4200.2 to facilitate drainage. Total system R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards towards the roof space and a 40mm air space between the membrane and the roof cladding. When using sarking, the membrane shall have min 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust and to prevent convection air movements between multiple air cavities separated by the membrane. Bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like.

Tiled roofs without a sarking membrane are considered to be ventilated and roofs with a sarking membrane are considered to be non-ventilated for calculation purposes only. Ventilated systems with a sarking membrane may be achieved by having 2 rotor ventilators totalling a min $0.14m^2$ throat areas whilst having inlet opening areas not less than 0.2% of the roof plan area.

Batten air cavities are assumed to be non-ventilated for calculation purposes only. Poor fitting tiles and poor membrane installation workmanship may affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces. Oxidation of the aluminium foil surface will affect thermal performance of the adjacent air space. Effectiveness of a sarking membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage, control water vapour, air infiltration, and/or ember entry; refer to ICANZ members for advice. Where nominated in the performance tables, ceiling insulation is positioned between joists on the ceiling lining.

Notes

- Condensation risk maybe increased in homes with sarking membranes having high or medium vapour barrier properties positioned under the roof cladding, coupled with high R-value products positioned on the ceiling, and poor roof space ventilation.
- Condensation risk maybe heightened for roofs in cold climates of Australia having one or a combination of the following: elevated humidity levels within the building, vapour barrier sarking, well insulated ceiling surface with high R-value insulation compared to the roof insulation or in homes where ceiling insulation restricts roof space ventilation from eave vents or brick cavities. See Appendix A for perimeter insulation solutions that allow roof space ventilation. Please consult an ICANZ member for further advice.
- Condensation risk maybe heightened for roofs in tropical and humid climates of Australia having one or a combination of the following: weather patterns with elevated humidity, sarking membrane positioned under the roof cladding or well insulated ceiling surface with high R-value insulation compared to the roof insulation. Please consult an ICANZ member for further advice.
- Total System R-values are based on the insulation path only; no allowance has been made for the effects of thermal bridging. Missing bulk insulation on the ceiling due to down light clearances, vent grills, heating duct outlets, return air grills or un-insulated work platforms is to be compensated for as per Table J1.3 of BCA Volume 1 or Table 3.12.1.1b of BCA Volume 2. Penetrations through the ceiling lining allowing air infiltration may affect thermal performance claims as well as allowing excess water vapour into the roof space. Low clearances at wall/roof junctions may not permit the full recovery of ceiling batts, please consult an ICANZ member for insulation solutions in accordance with Appendix A of this handbook.
- Fire resistant roof sarking is recommended in bush fire prone areas to prevent burning embers entering the roof space. Non-combustible mineral wool ceiling batt insulation is also recommended for bush fire prone areas; refer to an ICANZ member for further advice.

Using the Tables

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Total System R-values presented in these tables are based on first selecting the type of sarking membrane, second, the ventilation condition, third the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.4) from the lower table.

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STEP 3 - IDENTIFY VARIABLE LAYER

Identify the blue and orange components you can select a value for.

For Example:

- Ceiling Insulation Layer (orange)
- Air Layer (blue)

Element No.	Element Description:
1	Outdoor Air Film
2	Tiled Roof
3	40mm Air gap
4	Sarking material R-value
5	Attic Space
6.0	Ceiling Insulation (see table below)
7	10mm Plasterboard
8	Indoor Air-Film
	Total R-value

STEP 4 – CHOOSE INSULATION, VENTIALTION & HEAT FLOW DIRECTION

Select the following parameters which best represent your system:

The sarking or insulation treatment behind cladding
The ventilation scenario (if applicable)
Winter or summer heat flow direction

For example bubble foam with a ventilated roof for summer heat flow direction.

DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2			
No ceiling insulation			
Non Ventilated		Ventilated	
R0130NVW	R0130NVS	R0130VW	R0130VS
WINTER	SUMMER	WINTER	SUMMER

STEP 5 - TOTAL UNINSULATED SYSTEM R-VALUE

The total uninsulated system R-value is given as the sum of all the material layers identified in each row.

The highlighted row has not included any value for the insulation layer and the value represents the un-insulated system value.

For example a tile roof with bubble foam, ventilated roof space for heat flow down in summer would achieve R2.2 without considering any ceiling insulation added.

To determine the Total R-value, go to step 6

DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2			
No ceiling insulation			
Non Ventilated		Ventilated	
R0130NVW	R0130NVS	R0130VW	R0130VS
WINTER	SUMMER	WINTER	SUMMER
0.04	0.04	0.04	0.04
0.02	0.02	0.02	0.02
0.32	0.34	0.32	0.34
0.20	0.20	0.20	0.20
0.56	1.09	0.34	1.36
0.06	0.06	0.06	0.06
0.11	0.16	0.11	0.16
1.3	1.9	1.1	2.2

STEP 6 - TOTAL INSULATED SYSTEM R-VALUE

Determine the total insulated system R-value by:

1) Selecting your desired insulation value for the ceiling layer (defined in step 3) from the lower table. For example "Ceiling Insulation R6.0"

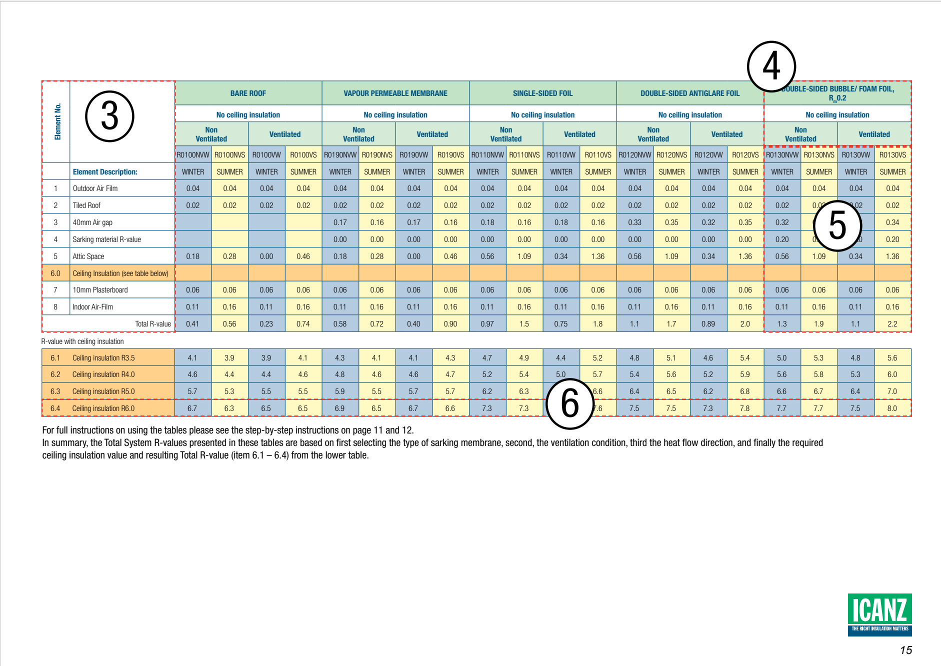
6.4	Ceiling insulation R6.0

2) Moving across to the appropriate column which represents your cladding treatment, ventilation scenario and heat flow direction (defined in step 4).

3) The number in either the blue or yellow cell will be your total insulated system R-value for winter and summer heat flow directions respectively.

For example bubble foam with a ventilated roof for summer heat flow direction and R6.0 Ceiling insulation will achieve R8.0

7.7	7.7	7.5	8.0



Element No.	Element Description:	BARE ROOF – No ceiling insulation – Non Ventilated R0100NVW WINTER	R0100NVS SUMMER	Ventilated R0100VW WINTER	R0100VS SUMMER	VAPOUR PERMEABLE MEMBRANE – No ceiling insulation – Non Ventilated R0190NVW WINTER	R0190NVS SUMMER	Ventilated R0190VW WINTER	R0190VS SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Tiled Roof	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	40mm Air gap					0.17	0.16	0.17	0.16
4	Sarking material R-value					0.00	0.00	0.00	0.00
5	Attic Space	0.18	0.28	0.00	0.46	0.18	0.28	0.00	0.46
6.0	Ceiling Insulation (see table below)								
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16
	Total R-value	0.41	0.56	0.23	0.74	0.58	0.72	0.40	0.90
R-value with ceiling insulation									
6.1	Ceiling insulation R3.5	4.1	3.9	3.9	4.1	4.3	4.1	4.1	4.3
6.2	Ceiling insulation R4.0	4.6	4.4	4.4	4.6	4.8	4.6	4.6	4.7
6.3	Ceiling insulation R5.0	5.7	5.3	5.5	5.5	5.9	5.5	5.7	5.7
6.4	Ceiling insulation R6.0	6.7	6.3	6.5	6.5	6.9	6.5	6.7	6.6

Element No.	Element Description:	SINGLE-SIDED FOIL – No ceiling insulation – Non Ventilated R0110NVW WINTER	R0110NVS SUMMER	Ventilated R0110VW WINTER	R0110VS SUMMER	DOUBLE-SIDED ANTIGLARE FOIL – No ceiling insulation – Non Ventilated R0120NVW WINTER	R0120NVS SUMMER	Ventilated R0120VW WINTER	R0120VS SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Tiled Roof	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	40mm Air gap	0.18	0.16	0.18	0.16	0.33	0.35	0.32	0.35
4	Sarking material R-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Attic Space	0.56	1.09	0.34	1.36	0.56	1.09	0.34	1.36
6.0	Ceiling Insulation (see table below)								
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16
	Total R-value	0.97	1.5	0.75	1.8	1.1	1.7	0.89	2.0
R-value with ceiling insulation									
6.1	Ceiling insulation R3.5	4.7	4.9	4.4	5.2	4.8	5.1	4.6	5.4
6.2	Ceiling insulation R4.0	5.2	5.4	5.0	5.7	5.4	5.6	5.2	5.9
6.3	Ceiling insulation R5.0	6.2	6.3	[illegible]	6.6	6.4	6.5	6.2	6.8
6.4	Ceiling insulation R6.0	7.3	7.3	[illegible]	7.6	7.5	7.5	7.3	7.8

Element No.	Element Description:	DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2 – No ceiling insulation – Non Ventilated R0130NVW WINTER	R0130NVS SUMMER	Ventilated R0130VW WINTER	R0130VS SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04
2	Tiled Roof	0.02	[illegible]	[illegible]	0.02
3	40mm Air gap	0.32	[illegible]	[illegible]	0.34
4	Sarking material R-value	0.20	[illegible]	[illegible]	0.20
5	Attic Space	0.56	1.09	0.34	1.36
6.0	Ceiling Insulation (see table below)				
7	10mm Plasterboard	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.16	0.11	0.16
	Total R-value	1.3	1.9	1.1	2.2
R-value with ceiling insulation					
6.1	Ceiling insulation R3.5	5.0	5.3	4.8	5.6
6.2	Ceiling insulation R4.0	5.6	5.8	5.3	6.0
6.3	Ceiling insulation R5.0	6.6	6.7	6.4	7.0
6.4	Ceiling insulation R6.0	7.7	7.7	7.5	8.0

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total System R-values presented in these tables are based on first selecting the type of sarking membrane, second, the ventilation condition, third the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.4) from the lower table.

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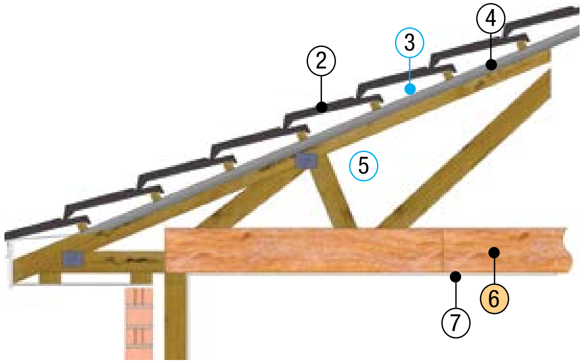
R0100 - PITCHED TILED ROOF WITH FLAT CEILING



Air Layer
Ceiling Insulation Layer

ICANZ System Reference R0100

Structure

Tiled roof at 22.5° pitch, 25mm battens with or without a sarking membrane under the battens, attic space, ceiling insulation laid on a horizontal 10mm plasterboard ceiling.

Insulation installation

Where applicable, roof sarking membranes are installed under battens whilst spanning rafters and draped in accordance with AS/NZS 4200.2 to facilitate drainage. Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards towards the roof space and a 40mm air space between the membrane and the roof cladding. When using sarking, the membrane shall have min 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust and to prevent convection air movements between multiple air cavities separated by the membrane. Bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like. Tiled roofs without a sarking membrane are considered to be ventilated and roofs with a sarking membrane are considered to be non-ventilated for calculation purposes only. Ventilated systems with a sarking membrane may be achieved by having 2 rotor ventilators totalling a min 0.14m² throat areas whilst having inlet opening areas not less than 0.2% of the roof plan area.

Batten air cavities are assumed to be non-ventilated for calculation purposes only. Poor fitting tiles and poor membrane installation workmanship may affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces. Oxidation of the aluminium foil surface will affect thermal performance of the adjacent air space. Effectiveness of a sarking membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage, control water vapour, air infiltration, and/or ember entry; refer to ICANZ members for advice. Where nominated in the performance tables, ceiling insulation is positioned between joists on the ceiling lining.

Notes

- Condensation risk maybe increased in homes with sarking membranes having high or medium vapour barrier properties positioned under the roof cladding, coupled with high R-value products positioned on the ceiling, and poor roof space ventilation.
- Condensation risk maybe heightened for roofs in cold climates of Australia having one or a combination of the following: elevated humidity levels within the building, vapour barrier sarking, well insulated ceiling surface with high R-value insulation compared to the roof insulation or in homes where ceiling insulation restricts roof space ventilation from eave vents or brick cavities. See Appendix A for perimeter insulation solutions that allow roof space ventilation. Please consult an ICANZ member for further advice.
- Condensation risk maybe heightened for roofs in tropical and humid climates of Australia having one or a combination of the following: weather patterns with elevated humidity, sarking membrane positioned under the roof cladding or well insulated ceiling surface with high R-value insulation compared to the roof insulation. Please consult an ICANZ member for further advice.
- Total R-values are based on the insulation path only; no allowance has been made for the effects of thermal bridging. Missing bulk insulation on the ceiling due to down light clearances, vent grills, heating duct outlets, return air grills or un-insulated work platforms is to be compensated for as per Table J1.3 of BCA Volume 1 or Table 3.12.1.1b of BCA Volume 2. Penetrations through the ceiling lining allowing air infiltration may affect thermal performance claims aswell as allowing excess water vapour into the roof space. Low clearances at wall/roof junctions may not permit the full recovery of ceiling batts, please consult an ICANZ member for insulation solutions in accordance with Appendix A of this handbook.
- Fire resistant roof sarking is recommended in bush fire prone areas to prevent burning embers entering the roof space. Non-combustible mineral wool ceiling batt insulation is also recommended for bush fire prone areas; refer to an ICANZ member for further advice.

Using the Tables

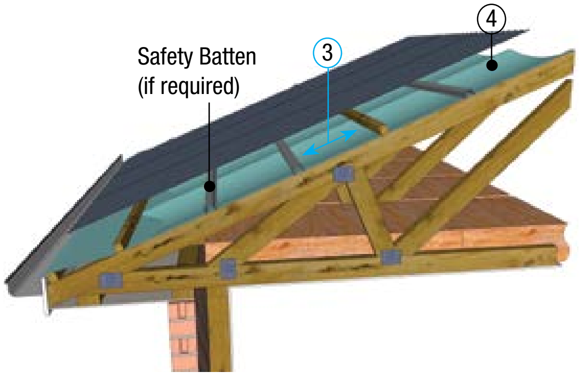
For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

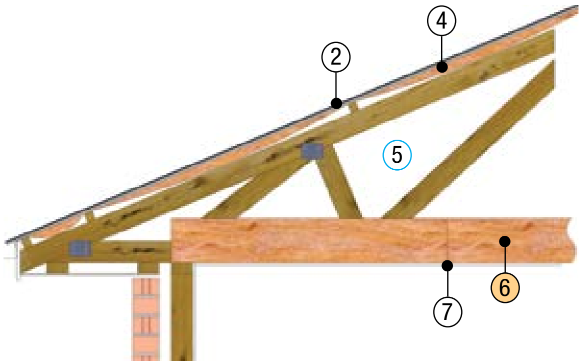
In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane, second, the ventilation condition, third the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.4) from the lower table.

Element No.		BARE ROOF				VAPOUR PERMEABLE MEMBRANE				SINGLE-SIDED FOIL				DOUBLE-SIDED ANTIGLARE FOIL				DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2			
		No ceiling insulation				No ceiling insulation				No ceiling insulation				No ceiling insulation				No ceiling insulation			
		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated	
		R0100NVW	R0100NVS	R0100VW	R0100VS	R0190NVW	R0190NVS	R0190VW	R0190VS	R0110NVW	R0110NVS	R0110VW	R0110VS	R0120NVW	R0120NVS	R0120VW	R0120VS	R0130NVW	R0130NVS	R0130VW	R0130VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Tiled Roof	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	40mm Air gap					0.17	0.16	0.17	0.16	0.18	0.16	0.18	0.16	0.33	0.35	0.32	0.35	0.32	0.34	0.32	0.34
4	Sarking material R-value					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20
5	Attic Space	0.18	0.28	0.00	0.46	0.18	0.28	0.00	0.46	0.56	1.09	0.34	1.36	0.56	1.09	0.34	1.36	0.56	1.09	0.34	1.36
6.0	Ceiling Insulation (see table below)																				
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16
	Total R-value **WITHOUT** insulation	0.41	0.56	0.23	0.74	0.58	0.72	0.40	0.90	0.97	1.5	0.75	1.8	1.1	1.7	0.89	2.0	1.3	1.9	1.1	2.2
Total R-value **WITH** ceiling insulation																					
6.1	Ceiling insulation R3.5	4.1	3.9	3.9	4.1	4.3	4.1	4.1	4.3	4.7	4.9	4.4	5.2	4.8	5.1	4.6	5.4	5.0	5.3	4.8	5.6
6.2	Ceiling insulation R4.0	4.6	4.4	4.4	4.6	4.8	4.6	4.6	4.7	5.2	5.4	5.0	5.7	5.4	5.6	5.2	5.9	5.6	5.8	5.3	6.0
6.3	Ceiling insulation R5.0	5.7	5.3	5.5	5.5	5.9	5.5	5.7	5.7	6.2	6.3	6.0	6.6	6.4	6.5	6.2	6.8	6.6	6.7	6.4	7.0
6.4	Ceiling insulation R6.0	6.7	6.3	6.5	6.5	6.9	6.5	6.7	6.6	7.3	7.3	7.1	7.6	7.5	7.5	7.3	7.8	7.7	7.7	7.5	8.0

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane, second, the ventilation condition, third the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.4) from the lower table.

R0200 - PITCHED METAL ROOF WITH FLAT CEILING





Air Layer   Ceiling Insulation Layer

ICANZ System Reference R0200

Structure

Metal sheet roof at 22.5° pitch, 40mm battens with or without a sarking membrane under the battens, attic space, ceiling insulation laid on a horizontal 10mm plasterboard ceiling.

Insulation installation

Where applicable, roof sarking membranes are installed under battens whilst spanning rafters and draped in accordance with AS/NZS 4200.2 to facilitate drainage. Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards towards the roof space and a 40mm air space between the membrane and the roof cladding. When using sarking, the membrane shall have a minimum 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust and prevent convection air movements between multiple air cavities separated by the membrane. Bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like.

Insulation nominal thickness shall be maintained other than where compressed at roof cladding and supporting members.

Metal clad roofs are considered to be non-ventilated for calculation purposes only. Ventilated cases are based on a roof having 2 rotor ventilators totalling a min 0.14m² throat areas whilst having not less than 0.2% of ceiling plan area as open inlet air passage.

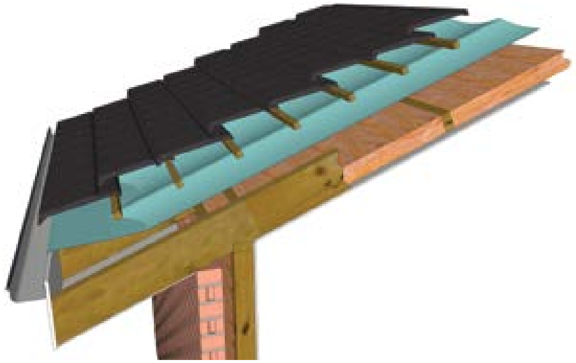
Batten air cavities assumed to be non-ventilated for calculation purposes only. **Open end cladding profiles and flashing junctions will affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces.** Oxidation of aluminium foil will affect the thermal performance of the system. Effectiveness of a sarking membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage. Effectiveness of membranes to control vapour, air infiltration, and/or ember entry require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal; refer to ICANZ member for advice. Where nominated in the performance tables, bulk insulation batts are positioned between joists on the ceiling lining.

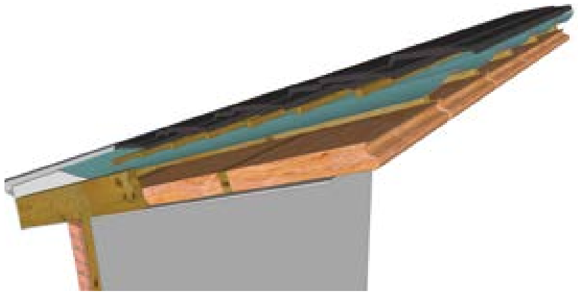
Notes

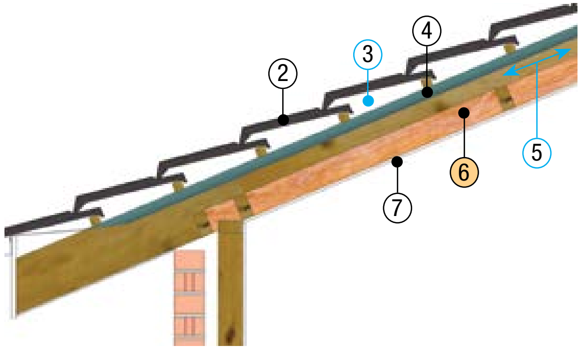
- Condensation risk may be increased for metal roofs having very little thermal resistance between a membrane and the roof sheeting. Foil membranes with small upper air cavities may not provide enough thermal resistance to prevent condensation on the underside of the membrane.
- Other reasons for an increase in frequency of condensation occurrence may relate to occupied spaces having elevated humidity levels when combined with the use of foil membranes in contact with metal structure or cladding, the use of metal framing structure, or the use of recessed down lights. Please consult an ICANZ member for further advice.
- For roofs with very low pitch the likelihood of accumulated condensation on the underside of cladding or membrane dripping onto occupants or workspaces below is increased.
- A multi-layer system may be required as an alternative roof insulation system for climate zones 7 & 8 requiring higher winter insulation values whilst maintaining high condensation risk protection and suitable drying paths. Please consult an ICANZ member for alternative thermal results for systems with increased condensation control and drying potential.
- In membrane-only applications utilising spacer systems it is recommended to lap and tape all joins as to eliminate membrane lap flapping driven by wind pressure fluctuations. A similar concern may arise when a light weight faced blanket solution has a spacer system height greater than the faced blanket nominal thickness.
- Penetration through any membrane lining allowing air infiltration may affect thermal performance claims. Penetrations may also provide ingress for humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. All penetrations through the vapour barrier must be sealed.
- Foil faced mineral wool (blanket component is non-combustible) blankets and mineral wool non-combustible ceiling batt insulation are recommended in bush fire prone areas in order to prevent burning embers entering corrugated roof profile openings when full coverage is applied; refer to ICANZ member for advice.
- Total R-values are based on the insulation path only; no allowance has been made for the effects of thermal bridging.
- Calculations are carried out in accordance with AS/NZS 4859.1 without unsupported extrapolations.

Element No.		BARE ROOF				VAPOUR PERMEABLE MEMBRANE				SINGLE-SIDED FOIL				DOUBLE-SIDED ANTIGLARE FOIL				DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2				FOIL FACED R1.3 BLANKET				FOIL FACED R1.8 BLANKET			
		No ceiling insulation				No ceiling insulation				No ceiling insulation				No ceiling insulation				No ceiling insulation				No ceiling insulation				No ceiling insulation			
		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated		Non Ventilated		Ventilated	
		R0200NVW	R0200NVS	R0200VW	R0200VS	R0290NVW	R0290NVS	R0290VW	R0290VS	R0210NVW	R0210NVS	R0210VW	R0210VS	R0220NVW	R0220NVS	R0220VW	R0220VS	R0230NVW	R0230NVS	R0230VW	R0230VS	R0230NVW	R0230NVS	R0230VW	R0230VS	R0230NVW	R0230NVS	R0230VW	R0230VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	40mm Air gap					0.17	0.16	0.17	0.16	0.18	0.16	0.18	0.16	0.46	0.62	0.45	0.62	0.46	0.58	0.44	0.58								
4	Sarking OR Blanket R-value					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	1.38	1.22	1.37	1.21	1.90	1.69	1.90	1.69
5	Attic Space	0.18	0.28	0.00	0.46	0.18	0.28	0.00	0.46	0.56	1.09	0.34	1.36	0.56	1.09	0.34	1.36	0.56	1.09	0.34	1.36	0.56	1.09	0.34	1.36	0.56	1.09	0.34	1.36
6.0	Ceiling Insulation (see below)																												
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16
	Total R-value **WITHOUT** insulation	0.39	0.54	0.21	0.72	0.56	0.70	0.38	0.88	0.95	1.5	0.73	1.8	1.2	2.0	1.0	2.2	1.4	2.1	1.2	2.4	2.2	2.6	1.9	2.8	2.7	3.0	2.5	3.3
Total R-value **WITH** ceiling insulation																													
6.1	Ceiling insulation R3.5	4.1	3.9	3.9	4.1	4.3	4.1	4.1	4.2	4.6	4.9	4.4	5.2	5.0	5.4	4.8	5.6	5.1	5.5	5.0	5.8	5.8	5.9	5.6	6.2	6.3	6.4	6.1	6.7
6.2	Ceiling insulation R4.0	4.6	4.4	4.4	4.5	4.8	4.5	4.6	4.7	5.2	5.4	4.9	5.6	5.6	5.8	5.3	6.1	5.7	6.0	5.5	6.3	6.3	6.4	6.1	6.7	6.9	6.9	6.7	7.2
6.3	Ceiling insulation R5.0	5.6	5.3	5.5	5.5	5.8	5.5	5.7	5.7	6.2	6.3	6.0	6.6	6.6	6.8	6.4	7.1	6.8	7.0	6.6	7.2	7.4	7.4	7.2	7.7	7.9	7.8	7.7	8.1
6.4	Ceiling insulation R6.0	6.7	6.3	6.5	6.5	6.9	6.4	6.7	6.6	7.3	7.3	7.1	7.6	7.7	7.8	7.5	8.0	7.9	7.9	7.6	8.2	8.4	8.3	8.2	8.6	9.0	8.8	8.8	9.1

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane, second, the ventilation condition, third the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.4) from the lower table.







Air Layer   Ceiling Insulation Layer

ICANZ System Reference R0300

Structure

Tiled roof at 22.5° pitch, 25mm battens over 190mm rafters with a sarking membrane, 10mm plasterboard raked ceiling fixed under the rafters. This application results in the following un-insulated system dimensions:
Bare roof: 215mm (air cavity) = 25mm (batten) and 190mm (rafter)
Vapour permeable membrane: 40mm (air gap above) and 175mm (rafter cavity below)
Single-sided foil: 40mm (air gap above) and 175mm (rafter cavity below)
Double-sided antiglare: 40mm (air gap above) and 175mm (rafter cavity below)
Double-sided antiglare bubble/foam foil R_m0.2 (7mm): 40mm (air gap above) and 168mm (rafter cavity below)

Insulation installation

All roof sarking membranes shall be installed under the battens and draped between rafters in accordance with AS/NZS 4200.2 to facilitate drainage. **This system is not recommended without the use of a sarking membrane.** Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards and a 40mm air space being created between the membrane and the roof cladding. When using sarking, membranes shall have min 150mm overlap in accordance with AS/NZS 4200.2 and may require taping to prevent ingress of dust. Bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like.
R0300 roofs with a sarking are considered to be non-ventilated. Typically a ventilated roof system cannot be constructed for this roof type. **R0300 systems without a sarking membrane are not recommended as it will not allow an effective system for water ingress protection and water vapour control.**
Batten air cavities assumed to be non-ventilated for calculation purposes only. **Poor fitting tiles and poor membrane installation workmanship may affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces.** Corrosive air gap conditions and oxidation of aluminium foil may affect the thermal performance of the surface and the adjacent air space. Effectiveness of a sarking membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage. Effectiveness of membranes to control vapour, air infiltration, and/or ember entry require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal; refer to ICANZ member for advice. Where nominated in the performance tables, bulk insulation batts are positioned between rafters on the ceiling lining.

Notes

- Risk of water damage and condensation risk maybe increased in homes having no sarking at the roof line or for homes with a vapour barrier sarking positioned at the roof line with high R-value products on the ceiling lining.
- Condensation risk maybe heightened for roofs in cold climates of Australia having one or a combination of the following: elevated humidity levels within the building, vapour barrier sarking under the roof tiles, metal framing structure, or the use of recessed down lights. Please consult an ICANZ member for further advice.
- Penetration through the ceiling lining allowing air transfer into the roof cavity may affect the thermal performance. Recessed down lights are not recommended for use in cathedral ceilings as they allow thermal bridging paths and potentially the direct transfer of humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- Total R-values are based on the insulation path only; no allowance has been made for the effects of thermal bridging. Missing bulk insulation on the ceiling due to down light clearances is to be compensated for as per Table J1.3 of BCA Volume 1 or Table 3.12.1.1b of BCA Volume 2.
- Non-combustible foil faced mineral wool blankets and non-combustible mineral wool ceiling batt insulation are recommended in bush fire prone areas in order to prevent burning embers entering corrugated roof profile openings when full coverage is applied; refer to an ICANZ member for advice.
- Calculations are carried out in accordance with AS/NZS 4859.1 with no unsupported extrapolations.

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Element No.		BARE ROOF		VAPOUR PERMEABLE MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2	
		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation	
		R0300NVW	R0300NVS	R0390NVW	R0390NVS	R0310NVW	R0310NVS	R0320NVW	R0320NVS	R0330NVW	R0330NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Tiled Roof	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	40mm Air gap			0.17	0.16	0.18	0.16	0.33	0.35	0.32	0.34
4	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20
5.0	Rafter remaining air space	0.17	0.17	0.18	0.17	0.58	1.14	0.60	1.16	0.59	1.02
6.0	Ceiling Insulation (see table below)										
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15
	Total R-value **WITHOUT** insulation	0.40	0.44	0.58	0.60	0.99	1.6	1.2	1.8	1.3	1.8

Total R-value **INCLUDING** insulation and air spaces

5.1	Rafter remaining air space	140mm		100mm		100mm		100mm		93mm	
6.1	Ceiling insulation R2.0 (75mm)	2.5	2.4	2.7	2.5	3.3	3.6	3.4	3.8	3.6	3.8
5.2	Rafter remaining air space	125mm		85mm		85mm		85mm		78mm	
6.2	Ceiling insulation R2.5 (90mm)	3.1	2.8	3.2	3.0	3.8	4.1	4.0	4.3	4.1	4.4
5.3	Rafter remaining air space	95mm		55mm		55mm		55mm		48mm	
6.3	Ceiling insulation R3.0 (120mm	3.6	3.3	3.8	3.5	4.3	4.4	4.5	4.6	4.7	4.7
5.4	Rafter remaining air space	65mm		25mm		25mm		25mm		Insufficient space	
6.4	Ceiling insulation R4.0 (150mm)	4.6	4.3	4.8	4.4	5.4	5.0	5.6	5.2		

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Tota R-values presented in these tables are based on first selecting the type of sarking membrane, second, the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.4) from the lower table which results in the remaining air space (item 5.1 - 5.4) whilst utilising a 190mm rafter. Larger support members will allow alternative combinations and results. Please consult an ICANZ member for alternative thermal results from deeper rafters

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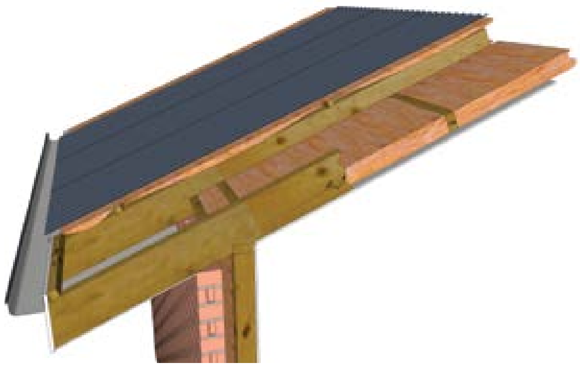
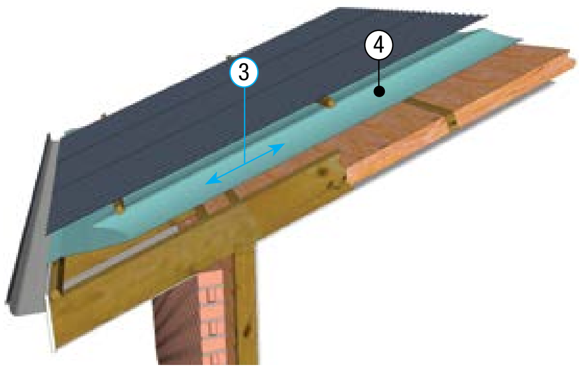
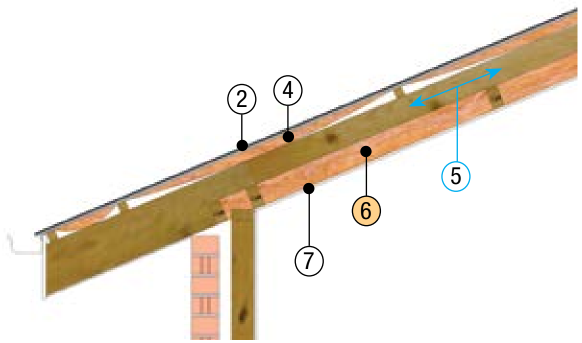
R0400 - PITCHED METAL ROOF WITH CATHEDRAL CEILING BELOW RAFTERS (concealed rafters)







Air Layer   Ceiling Insulation Layer

ICANZ System Reference R0400

Structure

Metal roof cladding at 22.5° pitch, 40mm battens over 190mm rafters with a sarking membrane between, min. 75mm high noggins between rafter, 10mm plasterboard raked ceiling fixed under the rafters. Note: where blanket insulation is installed, this is assumed to be over battens. The following dimensions apply to the base roof construction in order to calculate their respective air cavities:

Bare roof: 230mm (air cavity) = 40mm (batten) and 190mm (rafter)
Vapour permeable membrane: 40mm (batten space above) and 190mm (rafter space below)
Single sided foil: 40mm (batten space above) and 190mm (rafter space below)
Double-sided antiglare: 40mm (batten space above) and 190mm (rafter space below)
Double-sided antiglare bubble/foam foil R_m0.2: 40mm (batten space above) and 183mm (rafter space below)
Foil faced R1.3 blanket: 170mm (rafter cavity) = 40mm (batten) + 190mm (rafter) - 60mm (blanket thickness)
Foil faced R1.8 blanket: 150mm (rafter cavity) = 40mm (batten) + 190mm (rafter) - 80mm (blanket thickness)
Foil faced R2.5 blanket: 130mm (rafter cavity) = 40mm (batten) + 190mm (rafter) - 100mm (blanket thickness)

Insulation installation

Where applicable, all roof sarking membranes shall be installed under battens and draped between rafters in accordance with AS/NZS 4200.2 to facilitate drainage. Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards and a 40mm air space being created between the membrane and the roof cladding. When using sarking, the membrane shall have minimum 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust. Metal clad cathedral roofs are considered to be non-ventilated. Typically, a ventilated roof system cannot be constructed for this roof type. For foil faced blanket applications, 40mm high batten are used whilst allowing blanket to sag between to regain nominal thickness.

Batten air cavities assumed to be non-ventilated for calculation purposes only. **Open end cladding profiles, flashing junctions and poor membrane installation workmanship may affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces.** Oxidation of aluminium foil may affect the thermal performance of the surface and the adjacent air space. Effectiveness of a sarking membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage. Effectiveness of membranes to control water vapour, air infiltration, and/or ember entry require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal; refer to ICANZ member for advice. Where nominated in the performance tables, bulk insulation batts are positioned between rafters on the ceiling lining.

Notes

- Condensation risk may result for metal roofs with no insulation at the roof line when combined with high R-value ceiling batts. Further condensation risk maybe heightened in homes having vapour barrier sarking material positioned directly under the metal roof cladding.
- Other reasons for an increase in frequency of condensation occurrence may relate to homes having elevated humidity levels within the building when combined with the use of foil membrane in contact with metal cladding, the use of metal framing structure, or the use of recessed down lights. Please consult an ICANZ member for further advice.
- Penetration through the ceiling lining allowing air infiltration may affect the thermal performance. Recessed down lights are not recommended for use in cathedral ceilings as they allow thermal bridging paths and potentially the direct transfer of humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- Thermal calculations are based on insulation path only. Gaps in the bulk insulation layer on the ceiling due to down light clearances, vent grills, heating duct outlets, return air grills or un-insulated work platforms are to be compensated for by using adjustment table J1.3 of BCA volume 1 or table 3.12.1.1b of BCA volume 2.
- Foil faced blankets greater than R_m1.3 require a greater recovery depth and a roof spacer system may be required.
- For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. All penetrations through the vapour barrier must be sealed.
- Bulk insulation blankets made from non-combustible mineral wool when faced onto foil are recommended in bush fire prone areas in order to prevent burning embers entering corrugated roof profile openings. Non-combustible mineral wool ceiling batt insulation is also recommended for bush fire prone areas; refer to ICANZ member for advice.
- Calculations are carried out in accordance with AS/NZS 4859.1 with no unsupported extrapolations

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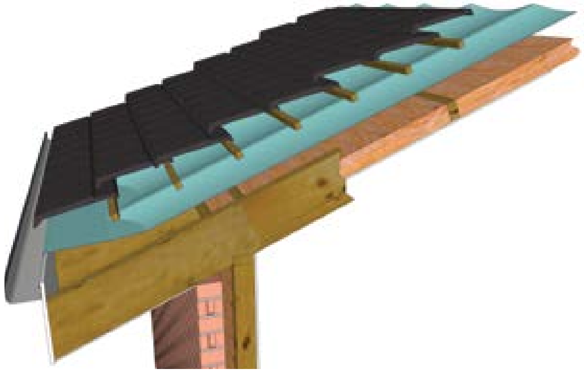
Element No.		BARE ROOF		VAPOUR PERMEABLE MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2		FOIL FACED R1.3 BLANKET		FOIL FACED R1.8 BLANKET		FOIL FACED R2.5 BLANKET	
		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation	
		R0400NVW	R0400NVS	R0490NVW	R0490NVS	R0410NVW	R0410NVS	R0420NVW	R0420NVS	R0430NVW	R0430NVS	R0440NVW	R0440NVS	R0450NVW	R0450NVS	R0460NVW	R0460NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	40mm Air gap			0.17	0.16	0.18	0.16	0.47	0.62	0.46	0.58						
4	Sarking OR Blanket R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	1.38	1.21	1.90	1.69	2.64	2.35
5.0	Rafter remaining air space	0.17	0.17	0.17	0.17	0.58	1.13	0.61	1.18	0.60	1.03	0.68	1.22	0.71	1.25	0.75	1.28
6.0	Ceiling Insulation (see table below)																
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15
	Total R-value **WITHOUT** insulation	0.38	0.42	0.55	0.58	0.97	1.5	1.3	2.1	1.5	2.1	2.3	2.7	2.8	3.2	3.6	3.9

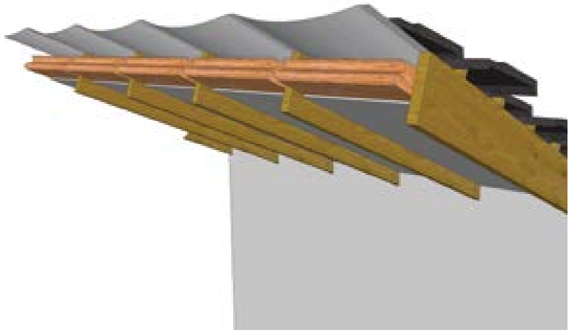
Total R-value **INCLUDING** insulation and air spaces

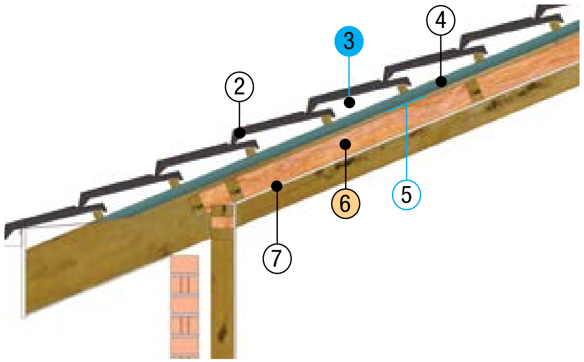
5.1	Rafter remaining air space	155mm		115mm		115mm		115mm		108mm		95mm		75mm		55mm	
6.1	Ceiling insulation R2.0 (75mm)	2.5	2.3	2.7	2.5	3.2	3.6	3.6	4.1	3.7	4.1	4.4	4.7	4.9	5.1	5.7	5.7
5.2	Rafter remaining air space	140mm		100mm		100mm		100mm		93mm		80mm		60mm		40mm	
6.2	Ceiling insulation R2.5 (90mm)	3.0	2.8	3.2	3.0	3.8	4.1	4.2	4.6	4.3	4.6	4.9	5.2	5.5	5.6	6.3	6.1
5.3	Rafter remaining air space	110mm		70mm		70mm		70mm		63mm		50mm		30mm		10mm	
6.3	Ceiling insulation R3.0 (120mm)	3.6	3.3	3.8	3.5	4.3	4.5	4.7	5.0	4.8	5.1	5.5	5.5	6.0	5.7	6.4	5.9
5.4	Rafter remaining air space	80mm		40mm		40mm		40mm		33mm		20mm		Insufficient space		Insufficient space	
6.4	Ceiling insulation R4.0 (150mm)	4.6	4.2	4.8	4.4	5.4	5.3	5.8	5.8	5.9	5.8	6.4	5.9				

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane or insulation blanket, second, the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.4) from the lower table which results in the remaining air space (item 5.1 - 5.4) whilst utilising a 190mm rafter. Larger support members will allow alternative combinations and results.
Please consult an ICANZ member for alternative thermal results from deeper rafters.

R0500 - PITCHED TILED ROOF WITH RAKED CEILING (exposed rafters)







Air Layer Ceiling Insulation Layer

ICANZ System Reference R0500

Structure

Tiled roof at 22.5° pitch, 25mm battens over 190mm rafters with a sarking membrane and 10mm plasterboard raked ceiling with exposed rafters. Minimum 75mm noggins between rafters positioned to allow 20mm clearance below sagged sarking membrane, and a 10mm plasterboard ceiling lining pushed up between the rafters and fixed to the noggings. This application results in the following dimensions:

Bare roof: 25mm batten, 75mm (noggin) and 10mm (plasterboard). Minimum 85mm concealed depth of rafter.

Vapour permeable membrane: 25mm batten, 40mm (air gap above membrane), 20mm (air gap under membrane), 75mm (noggin) and 10mm (plasterboard). Minimum 120mm concealed depth of rafter.

Single-sided foil: 25mm batten, 40mm (air gap above membrane), 20mm (air gap under membrane), 75mm (noggin) and 10mm (plasterboard). Minimum 120mm concealed depth of rafter.

Double-sided antiglare: 25mm batten, 40mm (air gap above membrane), 20mm (air gap under membrane), 75mm (noggin) and 10mm (plasterboard). Minimum 120mm concealed depth of rafter.

Double sided bubble/foam foil R_m0.2 (7mm): 25mm batten, 40mm (air gap above membrane), 20mm (air gap under membrane) and 75mm (noggin) and 10mm (plasterboard). Minimum 120mm concealed depth of rafter.

Insulation installation

All roof sarking membranes shall be installed under the battens and draped between rafters in accordance with AS/NZS 4200.2 to facilitate drainage. **This system is not recommended without the use of a sarking membrane.** Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards and a 40mm air space being created between the membrane and the roof cladding. **When using sarking, membranes shall have min 150mm overlap in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust.** Bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like.

R0500 roofs with a roof sarking membrane are considered to be non-ventilated. Typically a ventilated roof system cannot be constructed for this roof type. **R0500 systems without a sarking membrane are not recommended as it will not allow an effective system for water ingress protection and water vapour control.**

Batten air cavities assumed to be non-ventilated for calculation purposes only. **Poor fitting tiles and poor membrane installation workmanship will affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces.** Oxidation of aluminium foil will affect the thermal performance of the system. Effectiveness of a sarking membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage. Effectiveness of membranes to control vapour, air infiltration, and/or ember entry require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal; refer to an ICANZ member for advice. Where nominated in the performance tables, bulk insulation batts are positioned between rafters on the ceiling lining.

Notes

- Condensation risk may result for metal roofs with no insulation at the roof line when combined with high R-value ceiling batts. Further condensation risk maybe heightened in homes having vapour barrier sarking material positioned directly under the metal roof cladding.
- Other reasons for an increase in frequency of condensation occurrence may relate to homes having elevated humidity levels within the building when combined with the use of foil membranes in contact with metal cladding, the use of metal framing structure, or the use of recessed down lights. Please consult an ICANZ member for further advice.
- Penetration through the ceiling lining allowing air infiltration may affect the thermal performance. Recessed down lights are not recommended for use in cathedral ceilings as they allow thermal bridging paths and potentially the direct transfer of humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- Thermal calculations are based on insulation path only. Gaps in the bulk insulation layer on the ceiling due to down light clearances, vent grills, heating duct outlets, return air grills or un-insulated work platforms are to be compensated for by using adjustment table J1.3 of BCA volume 1 or table 3.12.1.1b of BCA volume 2.
- Foil faced blankets greater than R_m1.3 require a greater recovery depth and a roof spacer system may be required.
- **For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. All penetrations through the vapour barrier must be sealed.**

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- Bulk insulation blankets made from non-combustible mineral wool when faced onto foil are recommended in bush fire prone areas in order to prevent burning embers entering corrugated roof profile openings. Non-combustible mineral wool ceiling batt insulation is also recommended for bush fire prone areas; refer to ICANZ member for advice.
- Calculations are carried out in accordance with AS/NZS 4859.1 without unsupported extrapolations.

Element No.		BARE ROOF		VAPOUR PERMEABLE MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2	
		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation	
		R0500NVW	R0500NVS	R0590NVW	R0590NVS	R0510NVW	R0510NVS	R0520NVW	R0520NVS	R0530NV	R0530NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Tiled Roof	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	4 0mm Air gap (when sarked)			0.17	0.16	0.18	0.16	0.33	0.35	0.32	0.34
4	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20
5	Nogging air space (~95mm)	0.17	0.17	0.18	0.17	0.58	1.14	0.60	1.16	0.59	1.02
6.0	Ceiling Insulation (see table below)										
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15
	Total R-value **WITHOUT** insulation	0.40	0.44	0.58	0.60	0.99	1.6	1.2	1.8	1.3	1.8

Total R-value **INCLUDING** insulation and air spaces

a	Concealed depth of rafter	85mm		120mm		120mm		120mm		127mm	
6.1	Ceiling insulation R2.0 (75mm)	2.5	2.3	2.7	2.5	3.2	3.0	3.3	3.2	3.5	3.3
b	Concealed depth of rafter	100mm		135mm		135mm		135mm		142mm	
6.2	Ceiling insulation R2.5 (90mm)	3.0	2.8	3.2	3.0	3.7	3.5	3.9	3.7	4.0	3.8
c	Concealed depth of rafter	130mm		165mm		165mm		165mm		172mm	
6.3	Ceiling insulation R3.0 (120mm)	3.6	3.3	3.8	3.5	4.2	3.9	4.4	4.1	4.6	4.3
d	Concealed depth of rafter	160mm		195mm		195mm		195mm		202mm	
6.4	Ceiling insulation R4.0 (150mm)	4.6	4.2	4.8	4.4	5.3	4.9	5.5	5.1	5.7	5.3
e	Concealed depth of rafter	190mm		225mm		225mm		225mm		232mm	
6.5	Ceiling insulation R5.0 (180mm)	5.7	5.2	5.9	5.4	6.4	5.8	6.6	6.0	6.7	6.2
f	Concealed depth of rafter	190mm		225mm		225mm		225mm		232mm	
6.6	Ceiling insulation R5.4 (180mm)	6.1	5.6	6.3	5.7	6.8	6.2	7.0	6.4	7.1	6.6

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane, second, the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.6) from the lower table which results in a concealed depth of rafter (items a - f). To allow for some exposed rafter the total rafter depth specified will need to be greater than the concealed depth of rafter dimension for the corresponding ceiling insulation thickness. The concealed depth of rafter is the amount of rafter that will be hidden and includes an allowance for 20mm air gap clearance from the underside of roof sarking membrane to the ceiling insulation as per AS 3999. The insulation should be positioned as high as possible between the rafters (while maintaining 20mm clearance) to maximise the exposed rafter dimension. The rafters will need to be increased in size to accommodate higher R-values and still maintain a portion of exposed rafter according to the desired architectural look. Altering the air gap and/or insulation R-value outside the examples given may result in a different Total R-value. Please consult an ICANZ member for thermal performance for different configurations.

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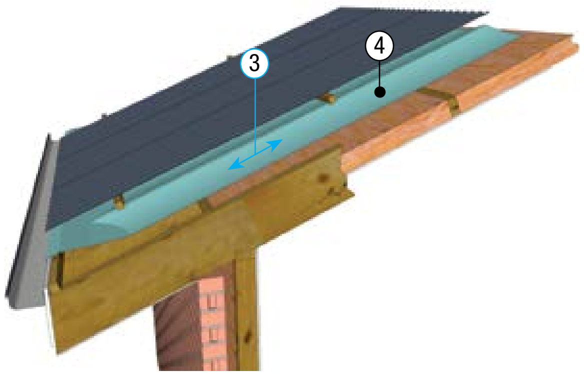
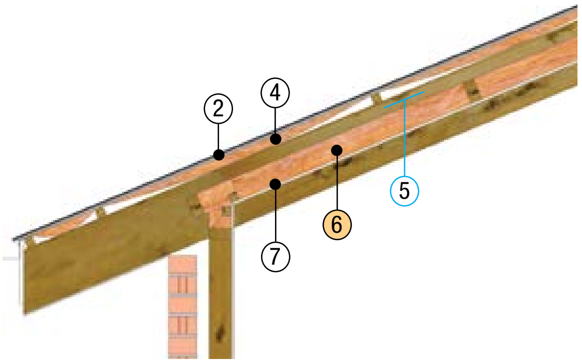
R0600 - PITCHED METAL ROOF WITH CATHEDRAL CEILING ABOVE RAFTERS (exposed rafters)





Air Layer
Ceiling Insulation Layer

ICANZ
THE RIGHT INSULATION MATTERS

ICANZ System Reference R0600

Structure

Metal roof cladding at 22.5° pitch, 40mm battens over rafters with a sarking membrane between, min. 75mm high noggins between rafter and 10mm plasterboard raked ceiling with exposed rafters. Note: where blanket insulation is installed is assumed to be over battens. Minimum 75mm noggins between rafters positioned to allow 20mm clearance below sagged sarking membrane or foil faced blanket and a 10mm plasterboard ceiling lining pushed up between the rafters and fixed to the nogging. This application results in the following dimensions:

Bare roof: 40mm batten, 75mm (noggin) and 10mm (plasterboard). Minimum 85mm concealed depth of rafter.

Vapour permeable membrane: 40mm (air gap above membrane), 20mm (air gap under membrane), 75mm (noggin) and 10mm (plasterboard). Minimum 105mm concealed depth of rafter.

Single-sided foil: 40mm (air gap above membrane), 20mm (air gap under membrane), 75mm (noggin) and 10mm (plasterboard). Minimum 105mm concealed depth of rafter.

Double-sided antiglare: 40mm (air gap above membrane), 20mm (air gap under membrane), 75mm (noggin) and 10mm (plasterboard). Minimum 105mm concealed depth of rafter.

Double sided bubble/foam foil R_m0.2 (7mm): 40mm (air gap above membrane), 20mm (air gap under membrane) and 75mm (noggin) and 10mm (plasterboard). Minimum 105mm concealed depth of rafter.

Foil faced R1.3 blanket: 60mm (foil faced blanket), 20mm (air gap), 75mm (noggin) and 10mm (plasterboard). Minimum 125mm concealed depth of rafter.

Foil faced R1.8 blanket: 80mm (foil faced blanket), 20mm (air gap), 75mm (noggin) and 10mm (plasterboard). Minimum 145mm concealed depth of rafter.

Foil faced R2.5 blanket: 100mm (foil faced blanket), 20mm (air gap), 75mm (noggin) and 10mm (plasterboard). Minimum 165mm concealed depth of rafter.

Insulation installation

Where applicable, all roof sarking membranes shall be installed under battens in accordance with AS/NZS 4200.2 to facilitate drainage. This system is not recommended without the use of a sarking membrane. Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards and a 40mm air space being created between the membrane and the roof cladding. When using sarking, the membrane shall have minimum 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust. When a sarking has been used thermal performance is calculated using a 40mm upper airspace achieved using 40mm battens. Metal clad cathedral roofs are considered to be non-ventilated. Typically, a ventilated roof system cannot be constructed for this roof type. For foil faced blanket applications, 40mm high batten are used whilst allowing blanket to sag between rafters to regain nominal thickness.

Batten air cavities assumed to be non-ventilated for calculation purposes only. Open end cladding profiles, flashing junctions and poor membrane installation workmanship may affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces. Oxidation of aluminium foil will affect the thermal performance of the surface and the adjacent air space. The effectiveness of a roof sarking membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage. Effectiveness of membranes to control water vapour, air infiltration, and/or ember entry require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal; refer to ICANZ member for advice. Where nominated in the performance tables, bulk insulation batts are positioned between rafters on the ceiling lining.

Notes

- Condensation risk may result for metal roofs with no insulation at the roof line when combined with high R-value ceiling batts. Further condensation risk maybe heightened in homes having vapour barrier sarking material positioned directly under the metal roof cladding.
- Other reasons for an increase in frequency of condensation occurrence may relate to homes having elevated humidity levels within the building when combined with the use of foil membranes in contact with metal cladding, the use of metal framing structure, or the use of recessed down lights. Please consult an ICANZ member for further advice.
- Penetration through the ceiling lining allowing air infiltration may affect the thermal performance. Recessed down lights are not recommended for use in cathedral ceilings as they allow thermal bridging paths and potentially the direct transfer of humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- Thermal calculations are based on insulation path only. Gaps in the bulk insulation layer on the ceiling due to down light clearances, vent grills, heating duct

outlets, return air grills or un-insulated work platforms are to be compensated for by using adjustment table J1.3 of BCA volume 1 or table 3.12.1.1b of BCA volume 2.

- Foil faced blankets greater than R_m1.3 require a greater recovery depth and a roof spacer system may be required.
- For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. All penetrations through the vapour barrier must be sealed.
- Bulk insulation blankets made from non-combustible mineral wool when faced onto foil are recommended in bush fire prone areas in order to prevent burning embers entering corrugated roof profile openings. Non-combustible mineral wool ceiling batt insulation is also recommended for bush fire prone areas; refer to ICANZ member for advice.
  refer to ICANZ manufacturer for advice.

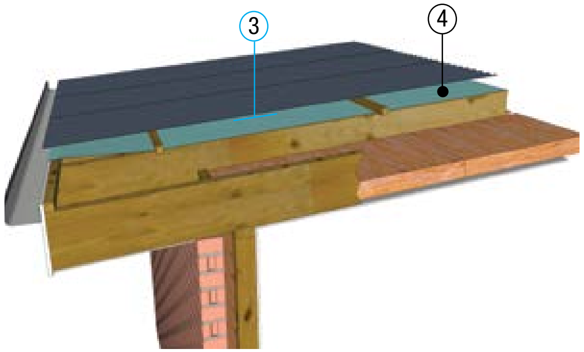
Element No.		BARE ROOF		VAPOUR PERMEABLE MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2		FOIL FACED R1.3 BLANKET		FOIL FACED R1.8 BLANKET		FOIL FACED R2.5 BLANKET	
		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation	
		R0600NVW	R0600NVS	R0690NVW	R0690NVS	R0610NVW	R0610NVS	R0620NVW	R0620NVS	R0630NVW	R0630NVS	R0640NVW	R0640NVS	R0650NVW	R0650NVS	R0660NVW	R0660NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	40mm Air gap			0.17	0.16	0.18	0.16	0.47	0.62	0.46	0.58						
4	Sarking OR Blanket R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	1.38	1.21	1.90	1.69	2.64	2.35
5	20mm Air gap	0.17	0.17	0.17	0.17	0.58	1.13	0.61	1.18	0.60	1.03	0.68	1.22	0.71	1.25	0.75	1.28
6.0	Ceiling Insulation (see table below)																
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15	0.11	0.15
	Total R-value **WITHOUT** insulation	0.38	0.42	0.55	0.58	0.97	1.5	1.3	2.1	1.5	2.1	2.3	2.7	2.8	3.2	3.6	3.9

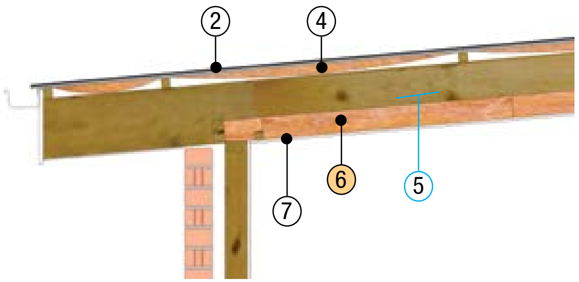
Total R-value **INCLUDING** insulation and air spaces

a	Concealed depth of rafter	85mm		105mm		105mm		105mm		112mm		125mm		145mm		165mm	
6.1	Ceiling insulation R2.0 (75mm)	2.5	2.3	2.7	2.5	3.1	3.0	3.5	3.4	3.7	3.6	4.3	4.0	4.9	4.5	5.6	5.2
b	Concealed depth of rafter	100mm		120mm		120mm		120mm		127mm		140mm		160mm		180mm	
6.2	Ceiling insulation R2.5 (90mm)	3.0	2.8	3.2	3.0	3.7	3.4	4.0	3.9	4.2	4.1	4.9	4.5	5.4	5.0	6.1	5.6
c	Concealed depth of rafter	130mm		150mm		150mm		150mm		157mm		170mm		190mm		210mm	
6.3	Ceiling insulation R3.0 (120mm)	3.6	3.3	3.7	3.4	4.2	3.9	4.6	4.4	4.7	4.5	5.4	5.0	5.9	5.5	6.6	6.1
d	Concealed depth of rafter	160mm		180mm		180mm		180mm		187mm		200mm		220mm		240mm	
6.4	Ceiling insulation R4.0 (150mm)	4.6	4.2	4.8	4.4	5.3	4.9	5.7	5.4	5.8	5.5	6.4	5.9	7.0	6.4	7.7	7.1
e	Concealed depth of rafter	190mm		210mm		210mm		210mm		217mm		230mm		250mm		270mm	
6.5	Ceiling insulation R5.0 (180mm)	5.7	5.2	5.8	5.3	6.3	5.8	6.7	6.3	6.9	6.4	7.5	6.9	8.0	7.4	8.8	8.0
f	Concealed depth of rafter	190mm		210mm		210mm		210mm		217mm		230mm		250mm		270mm	
6.6	Ceiling insulation R5.4 (180mm)	6.1	5.6	6.2	5.7	6.8	6.2	7.2	6.7	7.3	6.8	7.9	7.3	8.5	7.7	9.2	8.4

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane or insulation blanket, second, the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.6) from the lower table which results in a concealed depth of rafter (items a - f). To allow for some exposed rafter the total rafter depth specified will need to be greater than the concealed depth of rafter dimension for the corresponding ceiling insulation thickness. The concealed depth of rafter is the amount of rafter that will be hidden and includes an allowance for 20mm air gap clearance from the underside of roof sarking membrane to the ceiling insulation as per AS 3999. The insulation should be positioned as high as possible between the rafters (while maintaining 20mm clearance) to maximise the exposed rafter dimension. The rafters will need to be increased in size to accommodate higher R-values and still maintain a portion of exposed rafter according to the desired architectural look. Altering the air gap and/or insulation R-value outside the examples given may result in a different Total R-value. Please consult an ICANZ member for thermal performance for different configurations.

R0700 - FLAT METAL ROOF WITH PLASTERBOARD CEILING (concealed rafters)





Air Layer   Ceiling Insulation Layer

ICANZ System Reference R0700

Structure

Metal roof between 0° and 5° pitch, 40mm battens over 290mm rafters with a membrane between and a 10mm plasterboard ceiling lining fixed to bottom of rafters and insulation laid on the ceiling lining. Note: where blanket insulation is installed, this is over battens. The following dimensions apply to the base roof construction in order to calculate their respective air cavities:
Bare roof: 40mm batten and 290mm rafter forms a 330mm air cavity.
Vapour permeable membrane: 40mm air gap (above membrane) and 290mm air gap (rafter space below membrane).
Single-sided foil: 40mm air gap (above membrane) and 290mm air gap (rafter space below membrane).
Double-sided antiglare: 40mm air gap (above membrane) and 290mm air gap (rafter space below membrane).
Double-sided bubble/foam foil R_m0.2 (7mm): 40mm air gap (above membrane), 290mm air gap (rafter space below membrane) and 7mm (bubble/foam foil) forms a minimum 283mm air cavity (below the membrane).
Foil faced R1.3 blanket: 40mm batten, 290mm rafter with 60mm foil faced blanket forms a 270mm air cavity (below the blanket).
Foil faced R1.8 blanket: 40mm batten, 290mm rafter with 80mm foil faced blanket forms a 250mm air cavity (below the blanket).
Foil faced R2.5 blanket: 40mm batten, 290mm rafter with 100mm foil faced blanket forms a 230mm air cavity (below the blanket).

Insulation installation

Where applicable, roof membranes shall be installed under battens in accordance with AS/NZS 4200.2. Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards and a 40mm air space between the membrane and the roof cladding. When using membranes as sarking, they shall have minimum 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust. Metal clad cathedral roofs are considered to be non-ventilated. Typically, a ventilated roof system cannot be constructed for this roof type. For foil faced blanket applications, 40mm high batten are used whilst allowing blanket to sag between rafters to regain nominal thickness.
Batten air cavities assumed to be non-ventilated for calculation purposes only. **Open end cladding profiles, flashing junctions and poor membrane installation workmanship will affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces.** Oxidation of aluminium foil will affect the thermal performance of the surface and the adjacent air space. Effectiveness of a membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage. Effectiveness of membranes to control water vapour, air infiltration, and/or ember entry require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal; refer to ICANZ members for advice. Where nominated in the performance tables, bulk insulation batts are positioned between rafters on the ceiling lining.

Notes

- Condensation risk may result for metal roofs with no insulation at the roof line when combined with high R-value ceiling batts. Further condensation risk maybe heightened in homes having vapour barrier membrane material positioned directly under the metal roof cladding.
- Other reasons for an increase in frequency of condensation occurrence may relate to homes having elevated humidity levels within the building when combined with the use of foil membrane in contact with metal cladding, the use of metal framing structure, or the use of recessed down lights. Please consult an ICANZ member for further advice.
- Within flat roofs with very low pitch the likelihood of accumulated condensation on the underside of cladding or membrane materials dripping onto insulation below is increased. Increased consideration should be given to preventing condensation in this case.
- Penetration through the ceiling lining allowing air infiltration may affect the thermal performance. Recessed down lights are not recommended for use in cathedral ceilings as they allow thermal bridging paths and potentially the direct transfer of humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- Thermal calculations are based on insulation path only no allowance has been made for the effects of thermal bridging on the framing paths or gaps in the bulk insulation layer on the ceiling due to down light clearances, vent grills, heating duct outlets, return air grills or un-insulated work platforms. These are to be compensated for by using adjustment table J1.3 of BCA volume 1 or table 3.12.1.1b of BCA volume 2.
- Foil faced blankets greater than R_m1.3 (60mm thickness) require a greater recovery depth and a roof spacer system may be required.
- For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. All penetrations through the vapour barrier must be sealed.

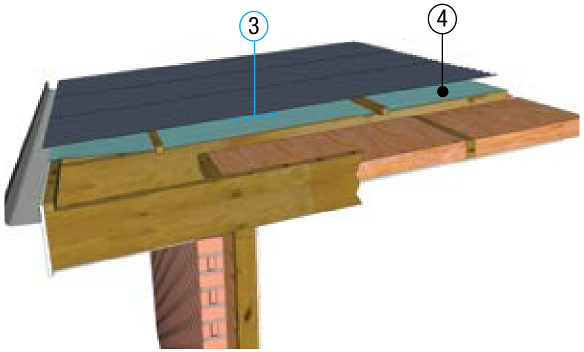
- Bulk insulation blankets made from non-combustible mineral wool when faced onto foil are recommended in bush fire prone areas to prevent the ingress of burning embers. Non-combustible mineral wool ceiling batt insulation is also recommended for bush fire prone areas; refer to ICANZ members for advice.
- Calculations are carried out in accordance with AS/NZS 4859.1 without unsupported extrapolations.

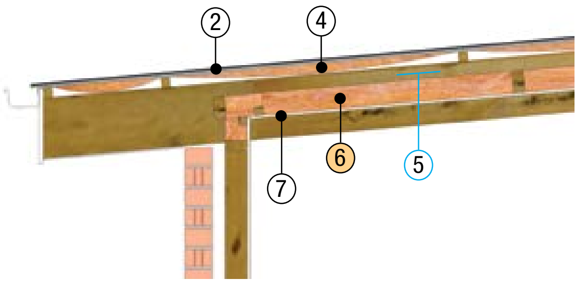
Element No.		BARE ROOF		VAPOUR PERMEABLE MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m 0.2)		FOIL FACED R1.3 BLANKET		FOIL FACED R1.8 BLANKET		FOIL FACED R2.5 BLANKET	
		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation	
		R0700NVW	R0700NVS	R0790NVW	R0790NVS	R0710NVW	R0710NVS	R0720NVW	R0720NVS	R0730NVW	R0730NVS	R0740NVW	R0740NVS	R0750NVW	R0750NVS	R0760NVW	R0760NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	40mm Air gap			0.17	0.16	0.18	0.16	0.45	0.64	0.44	0.59						
4	Sarking OR Blanket R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	1.38	1.21	1.90	1.68	2.64	2.35
5.0	Rafter remaining air space	0.17	0.17	0.17	0.18	0.56	1.45	0.59	1.49	0.57	1.27	0.66	1.52	0.69	1.55	0.72	1.57
6.0	Ceiling Insulation (see table below)																
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16
	Total R-value **WITHOUT** insulation	0.38	0.43	0.55	0.60	0.95	1.9	1.3	2.4	1.4	2.3	2.3	3.0	2.8	3.5	3.6	4.2

Total R-value **INCLUDING** insulation and air spaces

5.1	Rafter remaining air space	215mm		175mm		175mm		175mm		168mm		155mm		135mm		115mm	
6.1	Ceiling insulation R2.0 (115mm)	2.5	2.3	2.7	2.5	3.2	3.9	3.6	4.4	3.7	4.3	4.4	5.0	4.9	5.5	5.7	6.1
5.2	Rafter remaining air space	190mm		150mm		150mm		150mm		143mm		130mm		110mm		90mm	
6.2	Ceiling insulation R2.5 (140mm)	3.0	2.8	3.2	3.0	3.7	4.4	4.1	4.9	4.2	4.8	4.9	5.5	5.5	5.9	6.3	6.6
5.3	Rafter remaining air space	170mm		130mm		130mm		130mm		123mm		110mm		90mm		70mm	
6.3	Ceiling insulation R3.0 (160mm)	3.6	3.3	3.7	3.5	4.3	4.9	4.7	5.4	4.8	5.3	5.5	6.0	6.1	6.4	6.8	6.9
5.4	Rafter remaining air space	145mm		105mm		105mm		105mm		98mm		85mm		65mm		45mm	
6.4	Ceiling insulation R3.5 (185mm)	4.1	3.8	4.3	3.9	4.8	5.4	5.2	5.9	5.3	5.8	6.1	6.4	6.6	6.7	7.3	7.1
5.5	Rafter remaining air space	115mm		75mm		75mm		75mm		68mm		55mm		35mm		15mm	
6.5	eiling insulation R4.0 (215mm)	4.6	4.2	4.8	4.4	5.4	5.7	5.7	6.2	5.9	6.2	6.6	6.6	7.1	6.8	7.6	7.0
5.6	Rafter remaining air space	90mm		50mm		50mm		50mm		43mm		30mm		10mm		Insufficient space	
6.6	Ceiling insulation R5.0 (240mm)	5.7	5.2	5.9	5.4	6.4	6.4	6.8	6.9	6.9	6.9	7.6	7.1	7.7	7.1		
5.7	Rafter remaining air space	70mm		30mm		30mm		30mm		23mm		10mm		Insufficient space		Insufficient space	
6.7	Ceiling insulation R6.0 (260mm)	6.7	6.2	6.9	6.3	7.5	7.0	7.9	7.5	8.0	7.5	8.3	7.6				

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane or insulation blanket, second, the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.7) from the lower table which results in the remaining air space (item 5.1 - 5.7) whilst utilising a 290mm rafter. Varying the sizes of support members will allow alternative combinations and results. Please consult an ICANZ member for alternative thermal results from deeper rafters.





Air Layer   Ceiling Insulation Layer

ICANZ System Reference R0800

Structure

Metal roof between 0° and 5° pitch, 40mm battens over rafters with a membrane between, min. 75mm high noggins between rafter and 10mm plasterboard raked ceiling with exposed rafters. Note: where blanket insulation is installed, this is assumed to be over battens. Minimum 75mm noggins between rafters positioned to allow 20mm clearance below the membrane or foil faced blanket and a 10mm plasterboard ceiling lining pushed up between the rafters and fixed to the noggings. This application results in the following dimensions:

Bare roof: 40mm batten, 75mm noggin and 10mm plasterboard. Minimum 85mm concealed depth of rafter.

Vapour permeable membrane: 40mm air gap (above membrane), 20mm air gap (under membrane), 75mm noggin and 10mm plasterboard. Minimum 105mm concealed depth of rafter.

Single-sided foil: 40mm air gap (above membrane), 20mm air gap (under membrane), 75mm noggin and 10mm plasterboard. Minimum 105mm concealed depth of rafter.

Double-sided antiglare: 40mm air gap (above membrane), 20mm air gap (under membrane), 75mm noggin and 10mm plasterboard. Minimum 105mm concealed depth of rafter.

Double sided bubble/foam foil R_m0.2 (7mm): 40mm air gap (above membrane), 20mm air gap (under membrane) and 75mm noggin and 10mm plasterboard. Minimum 105mm concealed depth of rafter.

Foil faced R1.3 blanket: 60mm foil faced blanket, 20mm air gap, 75mm noggin and 10mm plasterboard. Minimum 125mm concealed depth of rafter.

Foil faced R1.8 blanket: 80mm foil faced blanket, 20mm air gap, 75mm noggin and 10mm plasterboard. Minimum 145mm concealed depth of rafter.

Foil faced R2.5 blanket: 100mm foil faced blanket, 20mm air gap, 75mm noggin and 10mm plasterboard. Minimum 165mm concealed depth of rafter.

Insulation installation

Where applicable, roof membranes shall be installed under battens in accordance with AS/NZS 4200.2. Total R-value calculations incorporating membranes are based on the brightest aluminium surface facing downwards and a 40mm air space between the membrane and the roof cladding. When using membranes as sarking, they shall have minimum 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust. Metal clad cathedral roofs are considered to be non-ventilated. Typically, a ventilated roof system cannot be constructed for this roof type. For foil faced blanket applications, 40mm high battens are used whilst allowing blanket to sag between rafters to regain nominal thickness.

Batten air cavities assumed to be non-ventilated for calculation purposes only. **Open end cladding profiles, flashing junctions and poor membrane installation workmanship may affect total thermal performance due to air movement and dust accumulation on upward facing foil surfaces.** Oxidation of aluminium foil will affect the thermal performance of the surface and the adjacent air space. Effectiveness of a membrane requires any tears to be repaired with a suitable non shrink tape to facilitate drainage. Effectiveness of membranes to control water vapour, air infiltration, and/or ember entry require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal; refer to ICANZ member for advice. Where nominated in the performance tables, bulk insulation batts are positioned between rafters on the ceiling lining.

Notes

- Condensation risk may result for metal roofs with no insulation at the roof line when combined with high R-value ceiling batts. Further condensation risk maybe heightened in homes having vapour barrier membrane material positioned directly under the metal roof cladding.
- Other reasons for an increase in frequency of condensation occurrence may relate to homes having elevated humidity levels within the building when combined with the use of foil membrane in contact with metal cladding, the use of metal framing structure, or the use of recessed down lights. Please consult an ICANZ member for further advice.
- Within flat roofs with very low pitch the likelihood of accumulated condensation on the underside of cladding or membrane materials dripping onto insulation below is increased. Increased consideration should be given to preventing condensation in this case.
- Penetration through the ceiling lining allowing air infiltration may affect the thermal performance. Recessed down lights are not recommended for use in cathedral ceilings as they allow thermal bridging paths and potentially the direct transfer of humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- Thermal calculations are based on insulation path only. Gaps in the bulk insulation layer on the ceiling due to down light clearances, vent grills, heating duct

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outlets, return air grills or un-insulated work platforms are to be compensated for by using adjustment table J1.3 of BCA volume 1 or table 3.12.1.1b of BCA volume 2.

- Foil faced blankets greater than R_m1.3 require a greater recovery depth and a roof spacer system may be required.
- **For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. All penetrations through the vapour barrier must be sealed.**
- Bulk insulation blankets made from non-combustible mineral wool when faced onto foil are recommended in bush fire prone areas in order to prevent burning embers entering corrugated roof profile openings. Non-combustible mineral wool ceiling batt insulation is also recommended for bush fire prone areas; refer to ICANZ member for advice.
- Calculations are carried out in accordance with AS/NZS 4859.1 without unsupported extrapolations.

Element No.		BARE ROOF		VAPOUR PERMEABLE MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2		FOIL FACED R1.3 BLANKET		FOIL FACED R1.8 BLANKET		FOIL FACED R2.5 BLANKET	
		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation		No ceiling insulation	
		R0800NVW	R0800NVS	R0890NVW	R0890NVS	R0810NVW	R0810NVS	R0820NVW	R0820NVS	R0830NVW	R0830NVS	R0840NVW	R0840NVS	R0850NVW	R0850NVS	R0860NVW	R0860NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	40mm Air gap			0.17	0.16	0.18	0.16	0.44	0.64	0.45	0.59						
4	Sarking OR Blanket R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	1.38	1.21	1.90	1.68	2.64	2.35
5	Rafter remaining air space	0.17	0.17	0.17	0.18	0.56	1.45	0.59	1.49	0.57	1.27	0.66	1.52	0.69	1.55	0.72	1.57
6.0	Ceiling Insulation (see table below)																
7	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
8	Indoor Air-Film	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16
	Total R-value **WITHOUT** insulation	0.38	0.43	0.55	0.60	0.95	1.9	1.3	2.4	1.4	2.3	2.3	3.0	2.8	3.5	3.6	4.2

Total R-value **INCLUDING** insulation and air spaces

a	Concealed depth of rafter	85mm		105mm		105mm		105mm		112mm		125mm		145mm		165mm	
6.1	Ceiling insulation R2.0 (75mm)	2.5	2.3	2.7	2.5	3.1	3.0	3.4	3.5	3.6	3.6	4.3	4.0	4.9	4.5	5.6	5.2
b	Concealed depth of rafter	100mm		120mm		120mm		120mm		127mm		140mm		160mm		180mm	
6.2	Ceiling insulation R2.5 (90mm)	3.0	2.8	3.2	3.0	3.6	3.4	4.0	3.9	4.2	4.1	4.9	4.5	5.4	5.0	6.1	5.7
c	Concealed depth of rafter	130mm		150mm		150mm		150mm		157mm		170mm		190mm		210mm	
6.3	Ceiling insulation R3.0 (120mm)	3.6	3.3	3.7	3.4	4.2	3.9	4.6	4.4	4.7	4.5	5.4	5.0	5.9	5.5	6.6	6.1
d	Concealed depth of rafter	160mm		180mm		180mm		180mm		187mm		200mm		220mm		240mm	
6.4	Ceiling insulation R4.0 (150mm)	4.6	4.2	4.8	4.4	5.3	4.9	5.6	5.4	5.8	5.5	6.4	5.9	7.0	6.4	7.7	7.1
e	Concealed depth of rafter	190mm		210mm		210mm		210mm		217mm		230mm		250mm		270mm	
6.5	Ceiling insulation R5.0 (180mm)	5.7	5.2	5.8	5.3	6.3	5.8	6.7	6.3	6.9	6.5	7.5	6.9	8.0	7.4	8.8	8.0
f	Concealed depth of rafter	190mm		210mm		210mm		210mm		217mm		230mm		250mm		270mm	
6.6	Ceiling insulation R5.4 (180mm)	6.1	5.6	6.3	5.7	6.8	6.2	7.1	6.7	7.3	6.8	7.9	7.3	8.5	7.8	9.2	8.4

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Total R-values presented in these tables are based on first selecting the type of sarking membrane or insulation blanket, second, the heat flow direction, and finally the required ceiling insulation value and resulting Total R-value (item 6.1 – 6.6) from the lower table which results in a concealed depth of rafter (items a - f). To allow for some exposed rafter the total rafter depth specified will need to be greater than the concealed depth of rafter dimension for the corresponding ceiling insulation thickness. The concealed depth of rafter is the amount of rafter that will be hidden and includes an allowance for 20mm air gap clearance from the underside of roof sarking membrane to the ceiling insulation as per AS 3999. The insulation should be positioned as high as possible between the rafters (while maintaining 20mm clearance) to maximise the exposed rafter dimension. The rafters will need to be increased in size to accommodate higher R-values and still maintain a portion of exposed rafter according to the desired architectural look. Altering the air gap and/or insulation R-value outside the examples given may result in a different Total R-value. Please consult an ICANZ member for thermal performance for different configurations.

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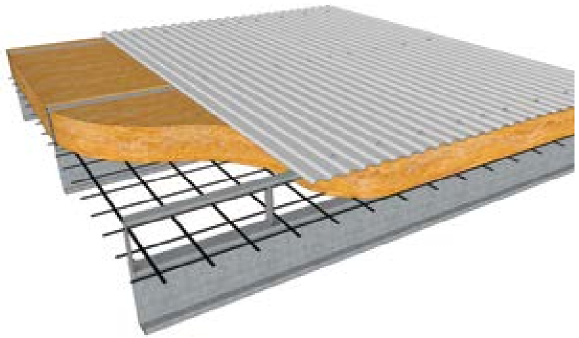
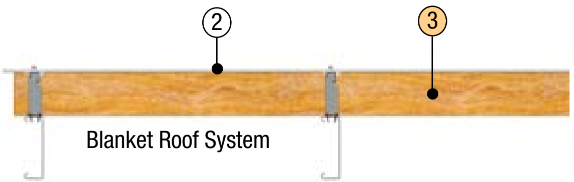
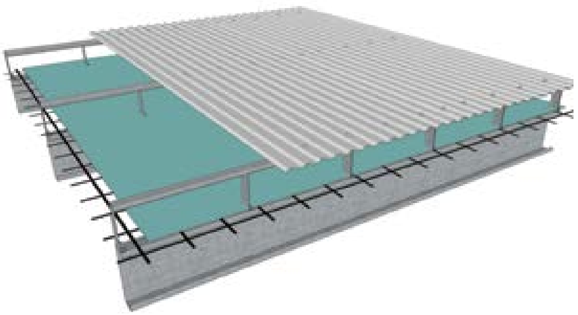
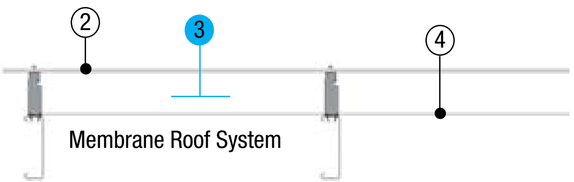
R0900 - FLAT METAL ROOF WITH NO CEILING (warehouse)









Air Layer   Roof Blanket Layer

ICANZ System Reference R0900

Structure

Low slope metal roofs between 0° and 5° roof slope including either air gap between cladding and a membrane or foil faced blanket installed with bulk insulation in contact with the cladding. A suitable spacer system shall be adopted to provide the airspace quoted for each application or the required cavity for bulk insulation blanket to recover to its nominal thickness.

The following air cavity dimensions 0mm, 25mm, 40mm, 55mm, 75mm, and 100mm apply to each of the base roof construction in order to calculate their thermal performances for the following systems:

Vapour Permeable membrane: Metal sheeting with air gap (ranges from 0 to 100mm) and vapour permeable membrane.

Single-sided foil: Metal sheeting with air gap (ranges from 0 to 100mm) and single-sided foil membrane.

Double-sided antiglare: Metal sheeting with air gap (ranges from 0 to 100mm) and double-sided antiglare membrane.

Double sided bubble/foam foil R_m0.2 (7mm): Metal sheeting with air gap (ranges from 0 to 100mm) and double-sided bubble/foam foil.

Foil faced blanket systems have insulation in contact with the cladding and contain no air cavities as per the following system:

Foil faced blankets: Metal sheeting and foil faced blanket (60-145mm, with suitable spacer for insulation recovery).

Insulation installation

Where applicable, all roofing membranes shall be rolled out over supporting safety mesh. The upper air cavity gap clearance is measured between roof cladding and top surface of roofing membrane. AS/NZS 4389 requires the safety mesh to be pulled taut so that there should be no sag in the mesh and the upper air gap can only be increased by taller batten heights or added spacing systems. **Single side or double sided foil membranes are based on having the brightest foil surface facing downwards onto the mesh towards the indoor occupied space.** When using a membrane as sarking, laps and joins shall have min 150mm overlap in accordance with AS/NZS 4200.2. When utilising membranes for air control or moisture control the membranes will require taping and any tears to be repaired.

R0900 roof is considered to have the lower "occupied" space as having still air (non-ventilated) with the internal air film resistance calculated at an angle of 5° slope. Air cavities developed by either battens or spacers between the cladding and foil membranes are assumed to be non-ventilated for calculation purposes only.

Open ends at metal cladding profile provide ingress of dust and settlement on upward facing foil surfaces. Calculations below assume open end profiles allowing slight dust cover and de-rating of the foil performance as per AS/NZS 4859.1 requirements. Air gap conditions such as ventilation air movements due differential pressure changes, condensation, oxidation of aluminium foil, poor workmanship may affect the thermal performance of foil surfaces and/or the foils claimed air space thermal performance. Foil performance will be reduced by poor sealing of lap joints, tears and gaps allows venting between lower air cavity and upper batten cavities thereby affecting the claimed thermal performance of that air cavity element. Effectiveness of all membranes require any tears or gaps to be repaired with a suitable non-shrink tape to maintain a seal to control water vapour, water, air infiltration, and/or ember entry; refer to ICANZ member for advice.

For foil faced blanket applications, varying spacer heights are to be used to suit insulation blanket to allow recovery to the products respective nominal thickness. Miss-matched spacer heights to blanket thickness will reduce recovery and directly affect bulk insulation material R-value thermal performance claims.

Notes

- Condensation risk may be increased for metal roofs having very little thermal resistance between a membrane and the roof sheeting. Foil membranes with small upper air cavities may not provide enough thermal resistance to prevent condensation on the underside of the membrane.
- Other reasons for an increase in frequency of condensation occurrence may relate to occupied spaces having elevated humidity levels when combined with the use of foil membranes in contact with metal structure or cladding or the use of metal framing structure. Please consult an ICANZ member for further advice.
- For roofs with very low pitch the likelihood of accumulated condensation on the underside of cladding or membrane dripping onto occupants or workspaces below is increased.
- A multi-layer system may be required as an alternative roof insulation system for climate zones 7 & 8 requiring higher winter insulation values whilst maintaining high condensation risk protection and suitable drying paths. Please consult an ICANZ member for alternative thermal results for systems with increased condensation control and drying potential.
- In membrane only applications utilising spacer systems it is recommended to lap and tape all joins as to eliminate membrane lap flapping driven by wind pressure fluctuations. A similar concern may arise when a light weight faced blanket solution has a spacer system height greater than the faced blanket nominal thickness.

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- Penetration through any membrane lining allowing air infiltration may affect thermal performance claims. Penetrations may also provide ingress for humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. All penetrations through the vapour barrier must be sealed.
- Foil faced mineral wool (blanket component is non-combustible) blankets and mineral wool non-combustible ceiling batt insulation are recommended in bush fire prone areas in order to prevent burning embers entering corrugated roof profile openings when full coverage is applied; refer to ICANZ member for advice.
- Total R-values are based on the insulation path only; no allowance has been made for the effects of thermal bridging.
- Calculations are carried out in accordance with AS/NZS 4859.1 without unsupported extrapolations.

Element No.		MEMBRANE ROOF SYSTEMS									
		BARE ROOF		VAPOUR PERMEABLE MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL, R_m0.2	
		Without air gap		Without air gap		Without air gap		Without air gap		Without air gap	
		R0900NVW	R0900NVS	R0990NVW	R0990NVS	R0910NVW	R0910NVS	R0920NVW	R0920NVS	R0930NVW	R0930NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	Non-ventilated air gap (see below)										
4	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20
5	Indoor Air-Film	0.11	0.16	0.11	0.16	0.23	0.76	0.23	0.76	0.23	0.75
	Total R-value **WITHOUT** insulation	0.15	0.20	0.25	0.20	0.27	0.80	0.27	0.80	0.47	0.99
Total R-value **WITH** increased air spaces											
3.1	25mm spacer and air gap			0.31	0.35	0.4	0.9	0.7	1.3	0.9	1.5
3.2	40mm spacer and air gap			0.31	0.37	0.4	1.0	0.7	1.4	0.9	1.6
3.3	55mm spacer and air gap			0.32	0.37	0.4	1.0	0.7	1.5	0.9	1.6
3.4	75mm spacer and air gap			0.32	0.37	0.4	1.0	0.7	1.6	0.9	1.7
3.5	100mm spacer and air gap			0.31	0.37	0.4	1.0	0.7	1.6	0.8	1.7

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

Table 1 - Membrane Roof System Performance

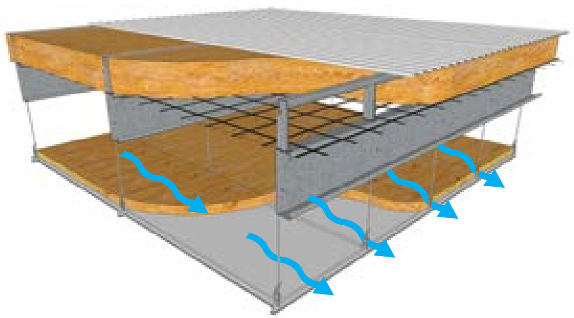
In summary, the Total R-values presented in this table is based on first selecting the type of sarking membrane, second, the heat flow direction, and finally the desired air space and resulting Total R-value (item 3.1 – 3.5) created using a spacer fixed to the purlins and the membrane being rolled out across the taut safety mesh. Please consult an ICANZ member for applications having a pitch greater than 5 degrees.

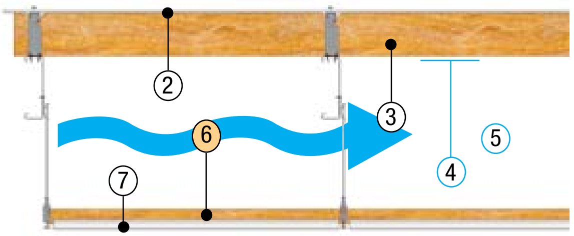
Element No.		BLANKET ROOF SYSTEMS			
		FOIL FACED BLANKET		FACED BLANKET (NON-FOIL)	
		No blanket		No blanket	
		R0940NVW	R0940NVS	R0960NVW	R0960NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00
3	Blanket material value (see below)				
4	Indoor Air-Film	0.23	0.76	0.11	0.16
	Total R-value **WITHOUT** insulation	0.27	0.80	0.15	0.20
R-value **WITH** Roofing Blanke					
3.1	R1.3 blanket, 60mm	1.6	2.0	1.5	1.4
3.2	R1.4 blanket, 70mm	1.7	2.1	1.6	1.5
3.3	R1.8 blanket, 80mm	2.2	2.5	2.0	3.1
3.4	R2.3 blanket, 100mm	2.7	3.0	2.6	2.4
3.5	R2.5 blanket, 100mm	2.9	3.2	2.8	2.6
3.6	R3.0 blanket, 130mm	3.4	3.6	3.3	3.1
3.7	R3.3 blanket, 140mm	3.7	3.9	3.6	3.3
3.8	R3.6 blanket, 145mm	4.1	4.2	3.9	3.6

Table 2 - Blanket Roof System Performance

In summary, the Total R-values presented in this table is based on first selecting the type of insulation blanket, second, the heat flow direction, and finally the required blanket R-value and resulting Total R-value (item 3.1 – 3.8). The blankets are installed using a spacer system allowing adequate space to provide full recovery of the insulation blanket between the taut safety mesh and the roof sheeting.

R1100 - FLAT METAL ROOF WITH SUSPENDED CEILING PLENUM RETURN (ventilated)





Air Layer   Ceiling Insulation Layer

ICANZ System Reference R1100

Structure

Metal sheet roof at an angle of 0° to 5° pitch and supported by steel purlins with a suspended 10mm horizontal plasterboard ceiling below. Ventilated air cavity below foil faced blanket used as return air plenum. Bulk insulation batts on ceiling provide acoustic benefit only as they are inside the thermal envelope. Foil faced blanket is supported by safety mesh above the ventilated return air plenum. The spacer size must allow for full blanket thickness recovery along the insulation path.

Insulation installation

All roofing blankets shall be rolled out over supporting safety mesh. AS/NZS 4389 requires the safety mesh to be pulled taut such that there should be no sag in the mesh and the available space for insulation recovery can only be increased in thickness by using taller batten heights or added spacing systems. Foil faced blankets will always have the bright foil surface facing downwards onto the mesh towards the ceiling void. The facing membrane shall have min 150mm overlap at all end laps and side laps in accordance with AS/NZS 4200.2 and may require taping to prevent convection air movements between air cavities and the insulation blanket separated by the membrane facing.

This system is considered to have a ceiling void air movement of 0.5m/s due to the use as a return air plenum. This results in a surface air film of R0.08. Commonly chilled ceiling and chilled beam systems may use the ceiling void to carry air. As the air through the plenum will return back to the air handling unit it is considered as conditioned air forming part of the conditioned space. The ceiling therefore does not form the boundary to the thermal envelope; rather the underside of the roof lining becomes the thermal envelope. The service cavity, ceiling insulation and ceiling lining are not considered in thermal calculations.

The performance tables are based on the respective R-value blanket type under the roof utilising spacer system to prevent compression. Insulation on top of the ceiling will contribute to acoustic control but will not increase the R-value of the system.

Environmental conditions such as ventilation air movements due to differential pressure changes, condensation, oxidation of Aluminium foil, poor workmanship may affect the performance of foil facing surfaces and/or the foil's claimed air space thermal performance.

For foil faced blanket applications, varying batten spacer heights are to be used to suit insulation blanket so to regain the products respective nominal thickness. Miss-matched spacer heights to blanket thickness will reduce recovery and directly affect bulk insulation material R-value thermal performance claims.

Effectiveness of all facing membranes require any tears or gaps to be repaired with a suitable non shrink tape to maintain a seal to control vapour and air infiltration; refer to ICANZ member for advice.

Notes

- Penetration through the membrane facing allowing air infiltration into the blanket may affect thermal performance claims. Penetrations may also provide ingress for humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- **For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. Unsealed penetrations through the vapour barrier are not recommended.** An alternative roof insulation system may be required for climate zones 7 & 8 with higher winter insulation values whilst maintaining high condensation risk protection and suitable drying paths. Please consult an ICANZ member for the thermal performance of alternative systems with increased condensation control and drying potential.
- Foil faced mineral wool (blanket component is non-combustible) blankets and mineral wool non-combustible ceiling batt insulation are recommended in bush fire nominated areas. Non-combustible mineral wool ceiling batt insulation is also recommended for BAL areas; refer to ICANZ member for advice.

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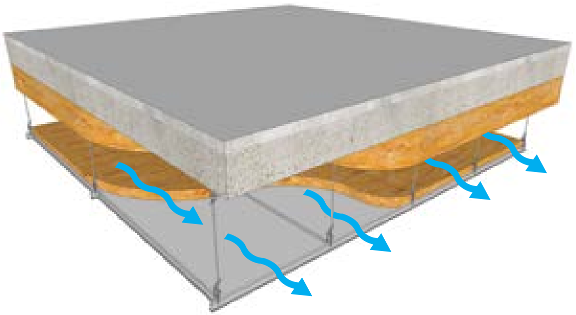
Element No.		FOIL FACED R1.3 BLANKET		FOIL FACED R1.8 BLANKET		FOIL FACED R2.5 BLANKET		FOIL FACED R3.0 BLANKET		FOIL FACED R3.3 BLANKET		FOIL FACED R3.6 BLANKET	
		Air plenum		Air plenum		Air plenum		Air plenum		Air plenum		Air plenum	
		R1100NVW	R1100NVS	R1110NVW	R1110NVS	R1120NVW	R1120NVS	R1130NVW	R1130NVS	R1140NVW	R1140NVS	R1150NVW	R1150NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Blanket Thermal Resistance	1.37	1.24	1.89	1.72	2.63	2.38	3.16	2.86	3.47	3.15	3.79	3.43
4	Ceiling Plenum Air Film	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
5	Return-air Plenum	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
6	Acoustic Insulation (see table below)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7	10mm Plasterboard	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8	Indoor Air-Film	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Total R-value **WITHOUT** insulation	1.5	1.4	2.0	1.8	2.8	2.5	3.3	3.0	3.6	3.3	3.9	3.6

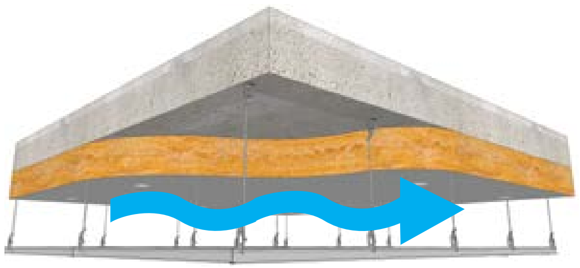
Total R-value **WITH** ceiling insulation and ceiling void

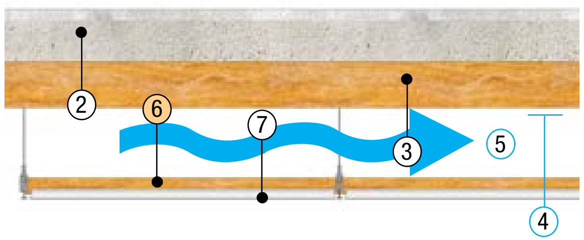
5	Ventilated Air Plenum	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.1	Acoustic Insulation R1.2 (50mm)	1.5	1.4	2.0	1.8	2.8	2.5	3.3	3.0	3.6	3.3	3.9	3.6
5	Ventilated Air Plenum	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.2	Acoustic Insulation R1.7 (75mm)	1.5	1.4	2.0	1.8	2.8	2.5	3.3	3.0	3.6	3.3	3.9	3.6
5	Ventilated Air Plenum	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.3	Acoustic Insulation R2.0 (75mm)	1.5	1.4	2.0	1.8	2.8	2.5	3.3	3.0	3.6	3.3	3.9	3.6
5	Ventilated Air Plenum	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.4	Acoustic Insulation R2.5 (110mm)	1.5	1.4	2.0	1.8	2.8	2.5	3.3	3.0	3.6	3.3	3.9	3.6

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Total R-values presented in this table is based on first selecting the type of sarking membrane, second, the heat flow direction, and finally the R-value batt and thickness (item 6.1 - 6.4) on the ceiling lining whilst utilising a services cavity of 300mm or greater (Item 5) as a return air plenum. Please consult an ICANZ member for applications having a pitch greater than 5 degrees or for thermal calculations for narrower services cavities.







Air Layer   Ceiling Insulation Layer

ICANZ System Reference R1300

Structure

Flat concrete roof supporting a suspended 10mm plasterboard ceiling parallel to roof forming a ventilated return air plenum between the underside of the slab or foil faced board/blanket and the top of the ceiling or insulation. The bulk insulation ceiling batts will provide acoustic benefit only.
Without blanket: Concrete slab supporting suspended ceiling providing air cavity between underside of the slab to top of ceiling
Foil faced blanket systems: Foil faced board/blanket supported by suitable masonry fixings above a return air plenum. Fixings must allow for full blanket thickness recovery along the insulation path.

Insulation installation

The insulation is pinned to the soffit using plastic anchors or similar and the membrane facing joins taped. A concrete roof is considered to have a ceiling void air cavity to be ventilated.
This system is considered to have a ceiling void air movement of 0.5m/s due to the use as a return air plenum. This results in a surface air film of R0.08. Commonly chilled ceiling and chilled beam systems may use the ceiling void to carry air. As the air through the plenum will return back to the air handling unit it is considered as conditioned air forming part of the conditioned space. Therefore the ceiling does not form the boundary to the thermal envelope; rather the underside of the roof lining becomes the thermal envelope. The service cavity, ceiling insulation and ceiling lining are not considered in thermal calculations.
The performance tables are based on the respective R-value blanket type under the roof slab fixed to prevent compression whilst utilising a return air plenum between the roof insulation and the ceiling. Insulation on top of the ceiling will contribute to acoustic control but will not increase the R-value of the system.
Effectiveness of all membrane facings require any tears or gaps to be repaired with a suitable non shrink tape to maintain a seal to control water vapour and air infiltration; refer to insulation manufacturer for advice.

Notes

- Condensation risk may result for concrete slab roofs having very little thermal resistance of board or blanket under the slab roof. Foil faced boards/blankets with minimal R-values may not provide enough thermal resistance to prevent condensation on the underside of the facing. Further condensation risk maybe heightened in slab roof systems having elevated humidity levels within the building and free air exchange from the occupied space to the ceiling void caused by recessed fixtures such as down lights, vent grills, heating/cooling duct outlets or return air grills. Please consult an ICANZ member for further advice.
- For roofs with very low pitch the likelihood of accumulated condensation on the underside of bare concrete (no board or blanket) dripping onto ceiling insulation is increased. Increased consideration should be given to preventing condensation in this case.
- Penetration through the membrane lining allowing air infiltration may affect thermal performance claims. Penetrations may also provide ingress for humid air into the construction system increasing the risk of interstitial condensation. Please consult an ICANZ member for further advice.
- **For applications dependant on a vapour barrier treatment, all joins shall be adequately taped. Unsealed penetrations through the vapour barrier are not recommended.** An alternative roof insulation system may be required for climate zones 7 & 8 with higher winter insulation values whilst maintaining high condensation risk protection and suitable drying paths. Please consult an ICANZ member for the thermal performance of alternative systems with increased condensation control and drying potential.

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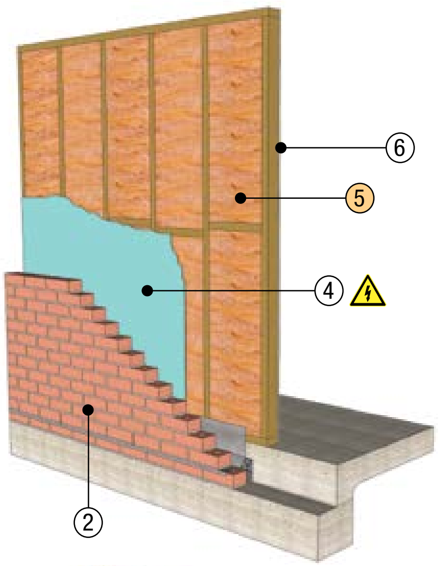
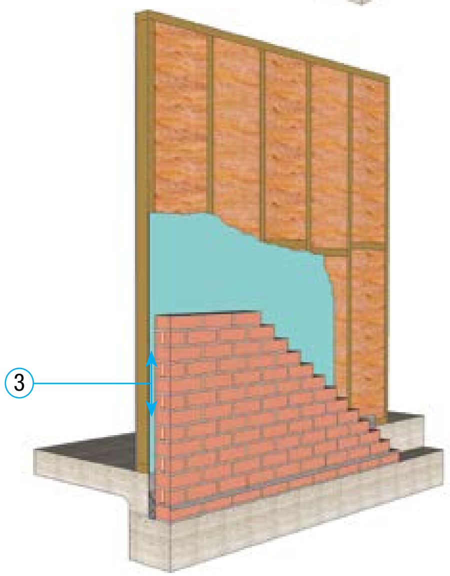
Element No.		WITHOUT BOARD/BLANKET		FOIL FACED R1.3 BOARD/BLANKET		FOIL FACED R1.4 BOARD/BLANKET		FOIL FACED R1.8 BOARD/BLANKET		FOIL FACED R2.3 BOARD/BLANKET		FOIL FACED R2.5 BOARD/BLANKET		FOIL FACED R3.0 BOARD/BLANKET		FOIL FACED R3.3 BOARD/BLANKET	
		Air plenum		Air plenum		Air plenum		Air plenum		Air plenum		Air plenum		Air plenum		Air plenum	
		R1300NVW	R1300NVS	R1310NVW	R1310NVS	R1320NVW	R1320NVS	R1330NVW	R1330NVS	R1340NVW	R1340NVS	R1350NVW	R1350NVS	R1360NVW	R1360NVS	R1370NVW	R1370NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Concrete Slab (150mm)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
3	Blanket Thermal Resistance			1.37	1.24	1.47	1.34	1.89	1.72	2.42	2.20	2.63	2.39	3.15	2.87	3.47	3.15
4	Ceiling Plenum Air Film	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
5	Return-air Plenum	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
6	Acoustic Insulation (see table below)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7	10mm Plasterboard	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8	Indoor Air-Film	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Total R-value **WITHOUT** insulation	0.22	0.22	1.6	1.5	1.7	1.6	2.1	1.9	2.6	2.4	2.9	2.6	3.4	3.1	3.7	3.4

Total R-value **WITH** ceiling insulation and ceiling void

5	Remaining air gap size	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.1	Ventilated Air Plenum	0.22	0.22	1.6	1.5	1.7	1.6	2.1	1.9	2.6	2.4	2.9	2.6	3.4	3.1	3.7	3.4
5	Remaining air gap size	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.2	Ventilated Air Plenum	0.22	0.22	1.6	1.5	1.7	1.6	2.1	1.9	2.6	2.4	2.9	2.6	3.4	3.1	3.7	3.4
5	Remaining air gap size	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.3	Ventilated Air Plenum	0.22	0.22	1.6	1.5	1.7	1.6	2.1	1.9	2.6	2.4	2.9	2.6	3.4	3.1	3.7	3.4
5	Remaining air gap size	≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm		≥300mm	
6.4	Ventilated Air Plenum	0.22	0.22	1.6	1.5	1.7	1.6	2.1	1.9	2.6	2.4	2.9	2.6	3.4	3.1	3.7	3.4

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in this table is based on first selecting the type of sarking membrane, second, the heat flow direction, and finally the R-value batt and thickness (item 6.1 - 6.4) on the ceiling lining whilst utilising a services cavity of 300mm or greater (Item 5) as a return air plenum.
Please consult an ICANZ member for applications having a pitch greater than 5 degrees or for thermal calculations for narrower services cavities.





Air Layer Wall Insulation Layer

ICANZ
THE RIGHT INSULATION MATTERS

ICANZ System Reference W0100

Structure

Brick Veneer construction using 110mm masonry brick, 50mm brick cavity, 90mm timber stud, and 10mm plaster wall lining.
The following dimensions apply to the base wall constructions in order to calculate their respective air cavities:
No membrane: 50mm brick cavity + 90mm stud cavity = 140mm air cavity
Vapour permeable membrane: 50mm (brick cavity); and 90mm (stud air cavity)
Single-sided foil: 50mm (brick cavity); and 90mm (stud air cavity)
Double-sided antiglare: 50mm (brick cavity); and 90mm (stud air cavity)
Double-sided antiglare bubble/foam Foil R_m0.2 (7mm): 43mm (brick cavity) = 50mm (brick cavity) - 7mm (membrane thickness); and 90mm (stud air cavity)
Double-sided antiglare EPS board R_m0.37 (15mm): 35mm (brick cavity) = 50mm (brick cavity) - (15mm board thickness); and 90mm (stud air cavity)

Insulation installation

Where applicable, all membranes shall be positioned externally to stud framing. Thicker reflective cellular membranes have had their brick cavity air space reduced respectively to account for the thickness of the product. All foil based membranes are based on having the brightest foil surface facing inwards to the stud air space. When using a membrane as sarking, laps and joins shall have min 150mm overlap in accordance with AS/NZS 4200.2. Extruded polystyrene (EPS) boards used as sarking will need to be suitably fixed to the external side of the studs and will require taping to drain liquid water. Stud wall bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like. Bulk insulation nominal thickness greater than cavity clearances and those areas around services may have insulation crushed resulting in loss of thermal performance and risk plaster deformation. **It is recommended that bulk insulation be cut around (chase insulation around) these obstructions, please consult an ICANZ member for further advice.** Brick cavities are considered to be non-ventilated for thermal calculation purposes. However varying environmental conditions may allow venting to brick cavity and/or stud cavities via brick openings, interface joints between doorway or window openings, thereby affecting the claimed performance of the application. **Poor treatment or fitment of wall penetrations and insulation installation workmanship may affect thermal performance. Poor air sealing between window frames and stud frames, poor caulking around architraves and gaps around door jambs may affect total thermal performance.** Effectiveness of membranes for heat, air and moisture control require any tears to be repaired with a suitable non shrink tape. Refer to ICANZ member for further advice.
Where nominated in the performance tables, when bulk insulation is positioned in stud bays, no additional thermal allowance has been considered for applications having a batt nominal thickness less than the stud dimension. In practice it is extremely difficult to ensure an air gap adjacent the foil surface unless special precautions are taken, therefore calculations assume bulk insulation in direct contact with foil surface and no air cavity is formed. For applications having a batt nominal thickness less than the stud dimension and seeking additional benefit of an air gap within the stud bay; please consult an ICANZ member for these special applications which will require spacers to position bulk insulation away from adjacent surfaces to induce a controlled air space thermal performance.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks may result within an external wall structure when using tightly sealed vapour barriers positioned to the external side of the stud and coupled with any combination of the following: cold climate regions, high internal relative humidity levels or high bulk insulation values within stud cavity with a vapour barrier membrane on the outside of the studwork. In these applications it is recommended to use a vapour permeable membrane with air barrier and water barrier properties eliminating the ingress of liquid water and air transported water vapour into the stud bays but still allowing for drying in the event of system failure.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to recessed wall fixtures, wall junctions with internal wall, lintels and services obstructing or limiting wall insulation coverage are not considered within the calculations.
- The effects of air leakage due to recessed wall fixtures, unsealed architraves, unsealed door jambs, unsealed gaps between windows and stud frames or services penetrating linings and membranes, are not considered within the calculations.

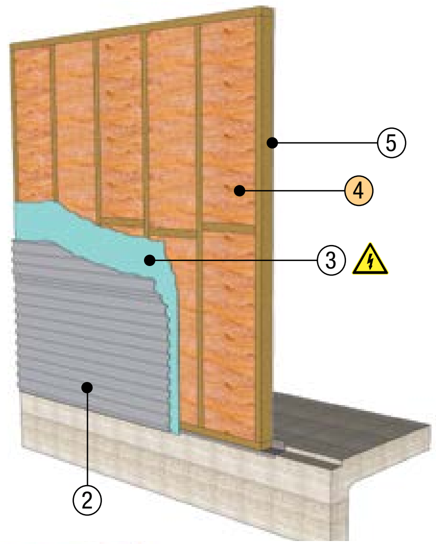
- Membranes having a flammability index of 5 or less and mineral wool (non-combustible fibrous material) wall batt insulation are recommended in bush fire prone areas in order to prevent burning embers entering the stud cavity. EPS solutions are not recommended for bush fire applications.

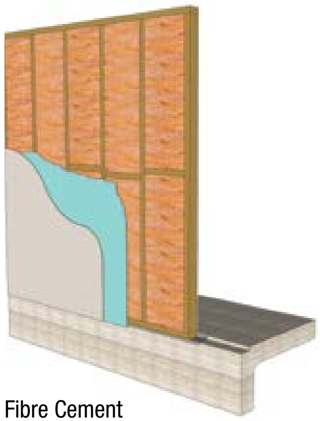
Element No.		**NO MEMBRANE**		**VAPOUR PERMEABLE**		**SINGLE-SIDED FOIL**		**DOUBLE-SIDED ANTIGLARE**		**DOUBLE-SIDED BUBBLE/ FOAM**		**DOUBLE-SIDED ANTIGLARE EPS**	
		No stud insulation		**No stud insulation**		**No stud insulation**		**No stud insulation**		**No stud insulation**		**No stud insulation**	
		W0100NVW	W0100NVS	W0190NVW	W0190NVS	W0110NVW	W0110NVS	W0120NVW	W0120NVS	W0130NVW	W0130NVS	W0140NVW	W0140NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	110mm Brickwork	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18		
3	Non-ventilated brick cavity			0.19	0.16	0.20	0.16	0.71	0.58	0.69	0.57	0.88	0.71
4	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.38	0.36
5	Air Gap (90mm Studs), OR	0.18	0.16	0.17	0.16	0.68	0.63	0.68	0.67	0.63	0.62	0.71	0.70
5.0	Wall Insulation (see table below)												
6	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7	Indoor Air-Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.57	0.56	0.76	0.72	1.3	1.2	1.8	1.7	1.9	1.8	2.4	2.2
Total R-value **WITH** ceiling insulation and ceiling void													
5.1	Stud Wall Batts R1.5 (75mm)	2.2	2.0	2.2	2.0	2.2	2.0	2.7	2.5	2.9	2.7	3.3	3.0
5.2	Stud Wall Batts R2.0 (90mm)	2.7	2.5	2.7	2.5	2.7	2.5	3.3	3.0	3.5	3.2	3.8	3.5
5.3	Stud Wall Batts R2.5 (90mm)	3.2	3.0	3.2	3.0	3.2	3.0	3.8	3.5	4.0	3.6	4.4	4.0
5.4	Stud Wall Batts R2.7 (90mm)	3.4	3.1	3.4	3.1	3.4	3.1	4.1	3.7	4.2	3.8	4.6	4.2

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

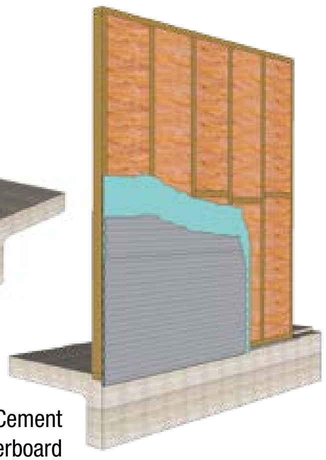
In summary, the Total R-values presented in this table is based on first selecting the type of membrane or sarking board type which is fixed to the outside of the studwork, second, the heat flow direction, and finally the R-value batt and thickness (item 5.1 - 5.4) within the stud void. In the insulated wall scenarios it is assumed that the insulation will fully replace the air void in the stud bay irrespective of the insulation thickness

W0200 - LIGHTWEIGHT CLADDING (direct fixing to stud)





Fibre Cement Cladding



Fibre Cement Weatherboard Cladding

Air Layer   Wall Insulation Layer

ICANZ System Reference W0200

Structure

Light weight cladding fixed directly onto stud. Light weight cladding includes: steel sheeting, fibre cement board cladding or fibre cement weatherboard. Based on 90mm timber or steel stud, and 10mm plaster wall lining the following dimensions apply to the base wall constructions in order to calculate their respective air cavities:

No membrane: 90mm (stud air cavity)
Vapour permeable membrane: 90mm (stud air cavity)
Single-sided foil: 90mm (stud air cavity)
Double-sided antiglare: 90mm (stud air cavity)
Double-sided antiglare bubble/foam Foil R_m0.2 (7mm): 90mm (stud air cavity); 7mm thick membrane between stud and cladding
Double-sided antiglare EPS board R_m0.37 (15mm): 90mm (stud air cavity); 15mm board between stud and cladding
Note: all values given in the table below are calculated based on steel sheeting. For fibre cement board cladding an additional R0.02 may be added to the value given. For fibre cement weatherboard an additional R0.03 may be added to the value given. According to AS/NZS 4859.1 Section 3.1, R-values should be rounded to two significant figures.

Insulation installation

Where applicable, all sarking membranes shall be positioned externally to stud framing. All foil based membranes are based on having the brightest reflective surface fWhere applicable, all membranes shall be positioned externally to stud framing. All foil based membranes are based on having the brightest foil surface facing inwards to the stud air space. When using a membrane as sarking, laps and joins shall have min 150mm overlap in accordance with AS/NZS 4200.2. Extruded polystyrene (EPS) boards used as sarking will require taping to shed liquid water. Insulation boards when utilising membranes for air control or moisture control the membranes will require taping and any tears to be repaired. Stud wall bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like. Bulk insulation nominal thickness greater than cavity clearances and those areas around services will result in crushing of the insulation reducing thermal performance and risk plaster and/or external cladding deformation. It is recommended that bulk insulation be cut around (chase insulation around) these obstructions, please consult an ICANZ member for further advice.

Light weight cladding systems are considered to be non-ventilated for thermal calculation purposes. However varying environmental conditions may allow venting through expansion joints, interface joints between doorway or window openings, thereby affecting the claimed performance of the application. **Poor treatment or fitment of wall penetrations and insulation installation workmanship may affect thermal performance. Poor sealing between window frames and stud frames, poor caulking around architraves and gaps around door jambs may affect total thermal performance.** Effectiveness of membranes for heat, air and moisture control require any tears to be repaired with a suitable non shrink tape. Refer to ICANZ member for further advice.

Where nominated in the performance tables, when bulk insulation is positioned in stud bays, no additional thermal allowance has been considered for applications having a batt nominal thickness less than the stud dimension. In practice it is extremely difficult to ensure an air gap adjacent the foil surface unless special precautions are taken, therefore calculations assume bulk insulation in direct contact with foil surface and no air cavity is formed. For applications having a batt nominal thickness less than the stud dimension and seeking additional benefit of an air gap within the stud bay; please consult an ICANZ member for these special applications which will require spacers to position bulk insulation away from adjacent surfaces to induce a controlled air space thermal performance.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks may result within an external wall structure when using tightly sealed vapour barriers positioned to the external side of the stud and coupled with any combination of the following: cold climate regions, high internal relative humidity levels or high bulk insulation values within the stud cavity with a vapour barrier membrane in contact with outer cladding. In these applications it is recommended to use a vapour permeable membrane whilst restricting the ingress of liquid water and air transported water vapour into the stud bays. In regions prone to moisture related problems, highly shaded sites or walls receiving no direct sunlight, it is recommended to use ICANZ system W0300. The air space provided by this external batten will provide suitable venting and drying effects to the

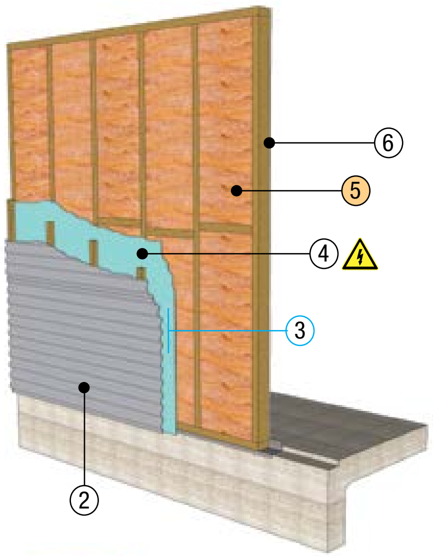
back of the cladding. Other spacer systems are available which allow much smaller drying cavities with direct fix W0200 systems. Please consult an ICANZ member for alternative drying methods behind direct fix cladding.

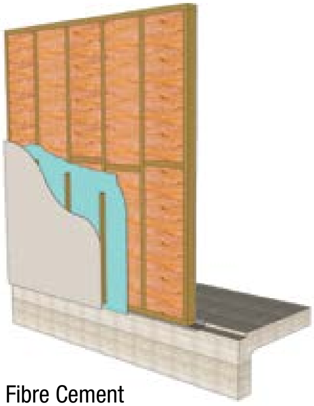
- For metal stud framing construction, it is a requirement to use a thermal break material over the membranes having a material R-value not less than R_m0.2.
  TIP: When using thermal break strips over metal frames ensure they are mounted on the membrane locating each strip over the metal framing member. Horizontal strips are to be given a 5 degree slope and be trimmed 10mm on the lower slope short of the vertical strip. This will allow a drainage point for each stud bay.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to recessed wall fixtures, wall junctions with internal wall, lintels and services obstructing or limiting wall insulation coverage are not considered within the calculations.
- The effects of air leakage due to recessed wall fixtures, unsealed architraves, unsealed door jambs, unsealed gaps between windows and stud frames or services penetrating linings and membranes, are not considered within the calculations.
- Membranes having a flammability index of 5 or less and mineral wool (non-combustible fibrous material) wall batt insulation are recommended in bush fire prone areas in order to prevent burning embers entering the stud cavity. EPS solutions are not recommended for bush fire applications.

Element No.		NO MEMBRANE		VAPOUR PERMEABLE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE		DOUBLE-SIDED BUBBLE/ FOAM FOIL R_m0.2		DOUBLE-SIDED ANTIGLARE EPS BOARD R_m 0.37, 15mm	
		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation	
		W0200NVW	W0200NVS	W0290NVW	W0290NVS	W0210NVW	W0210NVS	W0220NVW	W0220NVS	W0230NVW	W0230NVS	W0240NVW	W0240NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Light weight cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.38	0.35
4	Air Gap (90mm Studs), OR	0.18	0.15	0.18	0.15	0.68	0.57	0.68	0.57	0.64	0.57	0.71	0.65
4.0	Wall Insulation (see table below)												
5	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
6	Indoor Air-Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.40	0.37	0.40	0.37	0.90	0.79	0.90	0.79	1.1	0.99	1.3	1.2
Total R-value **WITH** added insulation													
4.1	Stud Wall Batts R1.5 (75mm)	1.8	1.6	1.8	1.6	1.8	1.6	1.8	1.6	2.0	1.9	2.2	2.0
4.2	Stud Wall Batts R2.0 (90mm)	2.3	2.1	2.3	2.1	2.3	2.1	2.3	2.1	2.5	2.3	2.7	2.5
4.3	Stud Wall Batts R2.5 (90mm)	2.9	2.6	2.9	2.6	2.9	2.6	2.9	2.6	3.0	2.8	3.2	3.0
4.4	Stud Wall Batts R2.7 (90mm)	3.1	2.8	3.1	2.8	3.1	2.8	3.1	2.8	3.3	3.0	3.4	3.2

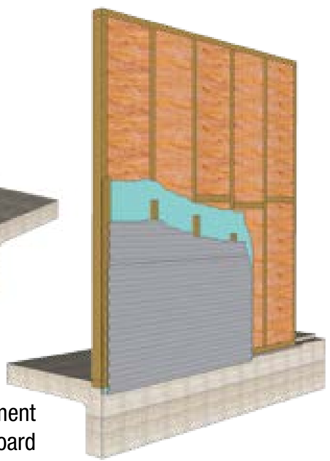
For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Total R-values presented in this table is based on first selecting the type of membrane or sarking board type which is fixed to the outside of the studwork, second, the heat flow direction, and finally the R-value batt and thickness (item 4.1 - 4.4) within the stud void. In the insulated wall scenarios it is assumed that the insulation will fully replace the air void in the stud bay irrespective of the insulation thickness





Fibre Cement Cladding +0.02m2.k/W



Fibre Cement Weatherboard Cladding

Air Layer   Wall Insulation Layer

ICANZ THE RIGHT INSULATION MATTERS

ICANZ System Reference W0300

Structure

Light weight cladding fixed to 35mm battens with 90mm timber stud frame and 10mm plaster wall lining. Light weight cladding includes: steel sheeting (0.42mm), fibre cement board cladding (4.5mm) or fibre cement weatherboard (7.5mm). The following dimensions apply to the base wall construction in order to calculate their respective air cavity R-value equivalent:
No membrane: 125mm (air gap) = 35mm (batten) + 90mm (stud width)
Vapour permeable membrane: 35mm (batten cavity) and 90mm (stud air cavity)
Single-sided foil: 35mm (batten cavity) and 90mm (stud air cavity)
Double-sided antiglare: 50mm (brick cavity) and 90mm (stud air cavity)
Double-sided antiglare bubble/foam Foil R_m0.2 (7mm): 43mm brick air cavity (7mm membrane thickness) and 90mm stud air cavity
Double-sided antiglare EPS board R_m0.37(15mm): 35mm brick air cavity (15mm membrane thickness) and 90mm stud air cavity
Note: all values given in the table below are calculated based on steel sheeting. For fibre cement board cladding an additional R0.02 may be added to the value given. For fibre cement weatherboard an additional R0.03 may be added to the value given. According to AS/NZS 4859.1 Section 3.1, R-values should be rounded to two significant figures.

Insulation installation

Where applicable, all membranes shall be positioned externally to stud framing. All foil membranes are based on having the brightest reflective surface facing inwards to the stud air space. When using a membrane as sarking, laps and joins shall have min 150mm overlap in accordance with AS/NZS 4200.2. When utilising membranes for air control or moisture control the membranes will require taping and any tears to be repaired. Stud wall bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like. Bulk insulation nominal thickness greater than cavity clearances and areas around services may have insulation crushed resulting in loss of thermal performance and risk plaster. It is recommended that bulk insulation be cut around (chase insulation around) these obstructions, please consult an ICANZ member for more information.
Light weight cladding systems are considered to be non-ventilated for thermal calculation purposes. However varying environmental conditions may allow air transfer through expansion joints, poor seals between window frames and stud frames, gaps around architraves and gaps around door jambs there by affecting thermal performance. **Poor treatment or fitment of wall penetrations and insulation installation workmanship may affect thermal performance.**
Battens are the preferred external cladding fixing method which creates a cavity to allow drainage and promote drying through air movement improving the moisture tolerance of the wall system.
Where nominated in the performance tables, when bulk insulation is positioned in stud bays, no additional thermal allowance has been considered for applications having a batt nominal thickness less than the stud dimension. In practice it is extremely difficult to ensure an air gap adjacent the foil surface unless special precautions are taken, therefore calculations assume bulk insulation in direct contact with foil surface and no air cavity is formed. For applications having a batt nominal thickness less than the stud dimension and seeking additional benefit of an air gap within the stud bay; please consult an ICANZ member for these special applications which will require spacers to position bulk insulation away from adjacent surfaces to induce a controlled air space thermal performance.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks may result within an external wall structure when using tightly sealed vapour barriers positioned to the external side of the stud and coupled with any combination of the following: cold climate regions, high internal relative humidity levels or high bulk insulation values within stud cavity with a vapour barrier membrane on the outside of the studwork. In these applications it is recommended to use a vapour permeable membrane with air barrier and water barrier properties eliminating the ingress of liquid water and air transported water vapour into the stud bays but still allowing for drying in the event of system failure.
- For vertical metal battens over metal stud framing construction, it is a requirement to use a thermal break material over the membranes with the thermal break material R-value not less than R_m0.2. Metal battens over metal studs do not require thermal break material unless the batten is vertical such as with

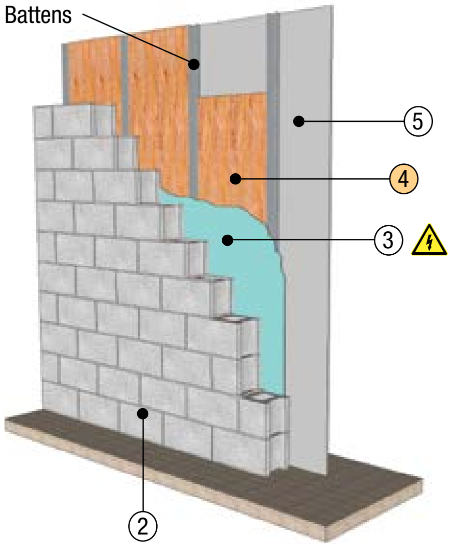
weatherboard or horizontally fixed corrugated metal cladding.
TIP: When using thermal break strips over metal frames ensure they are mounted on the membrane locating each strip over the metal framing member. Horizontal strips are to be given a 5 degree slope and be trimmed 10mm on the lower slope short of the vertical strip. This will allow a drainage point for each stud bay.

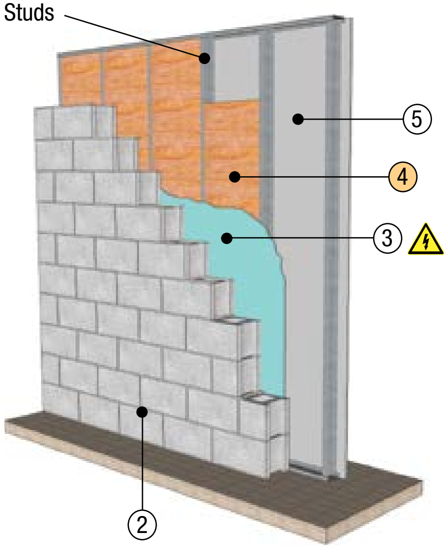
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to recessed wall fixtures, wall junctions with internal wall, lintels and services obstructing or limiting wall insulation coverage are not considered within the calculations.
- The effects of air leakage due to recessed wall fixtures, unsealed architraves, unsealed door jambs, unsealed gaps between windows and stud frames or services penetrating linings and membranes, are not considered within the calculations.
- Membranes having a flammability index of 5 or less and mineral wool (non-combustible fibrous material) wall batt insulation are recommended in bush fire prone areas in order to prevent burning embers entering the stud cavity. EPS solutions are not recommended for bush fire applications.

Element No.		NO MEMBRANE		VAPOUR PERMEABLE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE		DOUBLE-SIDED BUBBLE/ FOAM FOIL R_m0.2		DOUBLE-SIDED ANTIGLARE EPS BOARD R_m0.37 , 15mm	
		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation	
		W0300NVW	W0300NVS	W0390NVW	W0390NVS	W0310NVW	W0310NVS	W0320NVW	W0320NVS	W0330NVW	W0330NVS	W0340NVW	W0340NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Light weight cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Non-ventilated 35mm air gap			0.19	0.16	0.20	0.16	0.72	0.57	0.68	0.55	0.87	0.70
4	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.38	0.36
5	Air Gap (90mm Studs), OR	0.18	0.15	0.18	0.16	0.68	0.60	0.68	0.65	0.63	0.62	0.71	0.70
5.0	Wall Insulation (see table below)												
6	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7	Indoor Air-Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.40	0.37	0.58	0.53	1.1	0.98	1.6	1.4	1.7	1.6	2.2	2.0
Total R-value **WITH** added insulation													
5.1	Stud Wall Batts R1.5 (75mm)	2.0	1.8	2.0	1.8	2.0	1.8	2.6	2.3	2.7	2.5	3.1	2.8
5.2	Stud Wall Batts R2.0 (90mm)	2.5	2.3	2.5	2.3	2.5	2.3	3.1	2.8	3.3	3.0	3.7	3.3
5.3	Stud Wall Batts R2.5 (90mm)	3.0	2.8	3.0	2.8	3.0	2.8	3.6	3.3	3.8	3.5	4.2	3.8
5.4	Stud Wall Batts R2.7 (90mm)	3.3	3.0	3.3	3.0	3.3	3.0	3.9	3.5	4.0	3.7	4.4	4.0

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total System R-values presented in this table is based on first selecting the type of membrane or sarking board type which is fixed to the outside of the studwork, second, the heat flow direction, and finally the R-value batt and thickness (item 5.1 - 5.4) within the stud void. In the insulated wall scenarios it is assumed that the insulation will fully replace the air void in the stud bay irrespective of the insulation thickness.

W0800 - HOLLOW CONCRETE BLOCKWORK





Air Layer Wall Insulation Layer

ICANZ System Reference W0800

Structure

190mm hollow concrete block work with a 10mm internal plasterboard lining fixed to either 40mm battens or to an adjacent 90mm stud frame. The following dimensions apply to the base wall construction in order to calculate their respective air cavity R-value equivalent:
With 40mm Battens:
No membrane: 40mm (batten cavity)
Single-sided foil: 40mm (batten cavity)
Double-sided antiglare bubble/foam Foil R_m0.2 (7mm): 40mm (batten cavity)
With 90mm studwork:
No membrane: 90mm (stud cavity)
Single-sided foil: 90mm (stud cavity)
Double-sided antiglare bubble/foam Foil R_m0.2 (7mm): 90mm (stud cavity)

Insulation installation

Where applicable, all membranes shall be positioned internally to the concrete block work. All foil membranes are based on having the brightest reflective surface facing inwards to the stud or batten air space. When using membranes they shall have min 150mm overlap in accordance with AS/NZS 4200.2 and may require taping to function as a vapour control membrane. Bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like. Bulk insulation is installed by pushing hard up against the brickwork or membrane before fixing the plasterboard. Bulk insulation nominal thickness greater than cavity clearances and those areas around services may have insulation crushed resulting in loss of thermal performance and risk plaster deformation. It is recommended that bulk insulation be cut around (chase insulation around) these obstructions, please consult an ICANZ member.
W0800 systems are considered to be non-ventilated for thermal calculation purposes. However varying environmental conditions may allow air transfer through expansion joints, poor seals between window frames and stud frames, gaps around architraves and gaps around door jambs there by affecting thermal performance.
Poor treatment or fitment of wall penetrations and insulation installation workmanship may affect thermal performance.
Where nominated in the performance tables, when bulk insulation batts are positioned in stud cavities it is assumed the insulation is held against the solid blockwork or membrane using suitable fasteners. An additional thermal performance is gained for applications having a batt nominal thickness less than the stud dimension with a small additional airspace between the insulation and plasterboard lining.

Notes

- **⚠ Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks may result within an external wall structure when using tightly sealed vapour barriers positioned to the external side of the stud and coupled with any combination of the following: cold climate regions, high internal relative humidity levels or high bulk insulation values within stud cavity with a vapour barrier membrane on the outside of the studwork. In these applications it is recommended to use a vapour permeable membrane with air barrier and water barrier properties eliminating the ingress of liquid water and air transported water vapour into the stud bays but still allowing for drying in the event of system failure.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to recessed wall fixtures, wall junctions with internal wall, lintels and services obstructing or limiting wall insulation coverage are not considered within the calculations.
- The effects of air leakage due to recessed wall fixtures, unsealed architraves, unsealed door jambs, unsealed gaps between windows and stud frames or services penetrating linings and membranes, are not considered within the calculations.

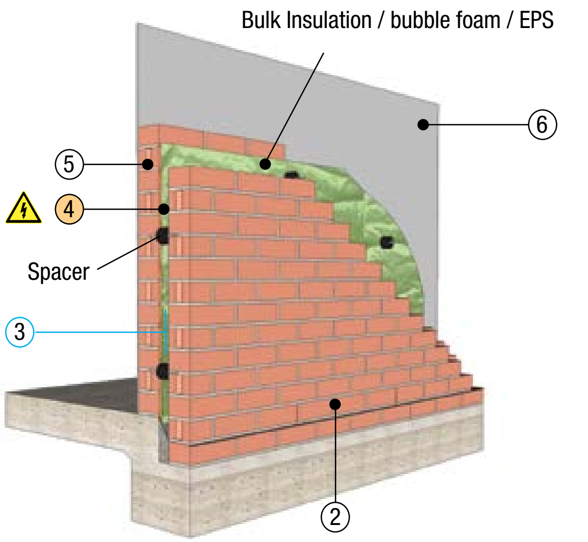
Element No.	Table 1	BATTENED INTERNAL LINING (40mm)					
		NO MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL R_m0.2	
		No batten insulation		No batten insulation		No batten insulation	
		W0800NVW	W0800NVS	W0810NVW	W0810NVS	W0820NVW	W0820NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04
2	Hollow Concrete Block	0.20	0.20	0.20	0.20	0.20	0.20
3	Sarking material			0.00	0.00	0.20	0.20
4	Batten air cavity, OR	0.19	0.16	0.74	0.60	0.72	0.59
4.0	Wall Insulation (see table below)						
5	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06
6	Indoor Air Film	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.61	0.58	1.2	1.0	1.3	1.2
Total R-value **WITH** added insulation							
4.1	Wall Blanket R1.0 (40mm)	1.5	1.4	1.5	1.4	1.7	1.6
		Insufficient space		Insufficient space		Insufficient space	
4.2	Wall Batts R1.5 (75mm)						
		Insufficient space		Insufficient space		Insufficient space	
4.3	Wall Batts R2.0 (90mm)						
		Insufficient space		Insufficient space		Insufficient space	
4.4	Wall Batts R2.5 (90mm)						
		Insufficient space		Insufficient space		Insufficient space	
4.5	Wall Batts R2.7 (90mm)						

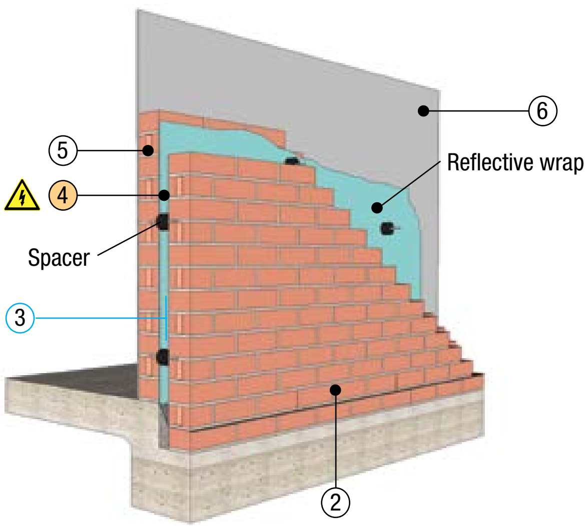
Element No.	Table 2	INTERNAL STUD FRAME (90mm)					
		NO MEMBRANE		SINGLE-SIDED FOIL		DOUBLE-SIDED BUBBLE/ FOAM FOIL R_m0.2	
		No stud insulation		No stud insulation		No stud insulation	
		W0830NVW	W0830NVS	W0840NVW	W0840NVS	W0850NVW	W0850NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04
2	Hollow Concrete Block	0.20	0.20	0.20	0.20	0.20	0.20
3	Sarking material R-value			0.00	0.00	0.20	0.20
4	Stud air cavity, OR	0.18	0.16	0.68	0.60	0.63	0.59
4.0	Wall Insulation (refer to table below)						
5	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06
6	Indoor Air Film	0.12	0.12	0.12	0.12	0.12	0.12
	TTotal R-value **WITHOUT** insulation	0.59	0.58	1.1	1.0	1.3	1.2
Total R-value **WITH** added insulation							
4.1	Wall Blanket R1.0 (40mm)	1.7	1.5	1.7	1.5	1.9	1.8
4.2	Wall Batts R1.5 (75mm)	2.2	2.0	2.2	2.0	2.4	2.2
4.3	Wall Batts R2.0 (90mm)	2.5	2.3	2.5	2.3	2.7	2.5
4.4	Wall Batts R2.5 (90mm)	3.0	2.8	3.0	2.8	3.2	3.0
4.5	Wall Batts R2.7 (90mm)	3.3	3.0	3.3	3.0	3.5	3.2

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

Table 1 – Internal Lining on 40mm Battens
In summary, the Total R-values presented in this table is based on first selecting the type of membrane which is installed between the masonry wall and insulation, second, the heat flow direction, and finally the R-value batt and thickness (item 4.1) within the batten cavity.

Table 2 – Internal Stud Frame (90mm)
In summary, the Total R-values presented in this table is based on first selecting the type of membrane which is installed between the masonry wall and insulation, second, the heat flow direction, and finally the R-value batt and thickness (item 4.1 – 4.5) within the stud cavity.





Air Layer
Wall Insulation Layer

ICANZ
THE RIGHT INSULATION MATTERS

ICANZ System Reference W1000

Structure

Double brick wall with 50 mm brick cavity and cement render or plasterboard internal lining. The following dimensions apply to the 50mm brick cavity in order to define air gap size for calculations:
Un-Insulated Wall: 50mm air gap
Single-sided foil: 50mm air gap, single-sided foil against the inner brick leaf with brightest foil face facing the cavity
Double-sided antiglare: 50mm air gap, double-sided antiglare foil against inner brick leaf face with brightest foil face facing the cavity
Double sided bubble/foam foil R_m0.2 (7mm): 43mm air gap, double-sided antiglare bubble/foam foil against inner brick leaf face with brightest foil face facing the cavity
Double-sided antiglare EPS board R0.37 (15mm): 35mm air gap, double-sided antiglare EPS board against inner brick leaf face with brightest foil face facing the cavity
Bulk insulation blanket (15mm): 35mm air gap, bulk insulation blanket faced with double-sided antiglare foil pushed up against inner brick leaf face with brightest foil face facing the cavity

Insulation installation

Where applicable, all membranes and insulation shall be pushed up against the inner brick leaf using spacer systems, typically located at the brick ties to ensure no contact between the insulation product and the outer leaf. All foil based membranes are based on having the brightest foil surface facing into the air void. When using membranes they shall have min 150mm overlap in accordance with AS/NZS 4200.2 and may require taping to prevent ingress of dust and prevent convection air movements between multiple air cavities separated by the membrane. Bulk insulation shall be installed to maintain its position and thickness.
Membrane and board type insulation products are generally fitted by either building the inner or outer leaf up to 1200-1500mm placing spacers over the brick ties then piercing a layer of membrane or board over the brick ties relying on the spacers to hold the membrane away from the outer leaf brick surface. The second brick leaf can then be built up to match. The second half of the wall is built and insulated in the same manner ensuring that the membrane or board fitted in the cavity is sealed at overlaps or butt joints.
W1000 systems are considered to be non-ventilated for thermal calculation purposes. However varying environmental conditions may allow venting through weep holes and interface joints between doorway or window openings, thereby affecting the claimed performance of the application. **Poor sealing between window frames and masonry wall, poor caulking around architraves and gaps around door jambs may affect total thermal performance.** Effectiveness of membranes for heat, air and moisture control require any tears or gaps to be sealed with a suitable non shrink tape; refer to ICANZ member for further advice.

Notes

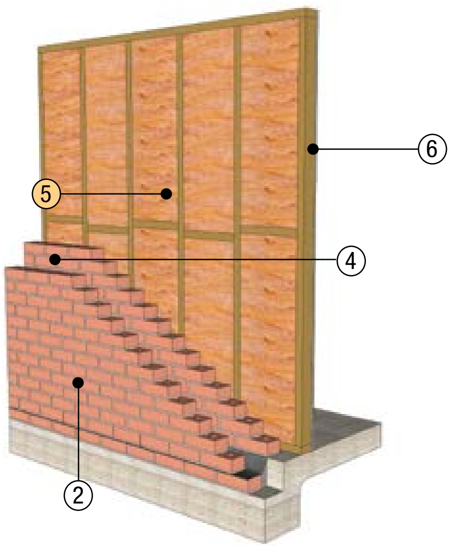
- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Moisture related issues may arise for products which form bridges across the cavity. It is essential that any product or system used installed according to manufacturer's instructions, has been suitably tested with appropriate test reports and is warranted by the manufacturer.
- Total R-values based on insulation path only assuming the installed insulation maintains uniform air gap thicknesses and/or insulation coverage.
- Total R-values based on insulation path only covering the whole area between the inner and outer brick leafs. The effects of thermal bridging through the structure, the effects of gaps in the insulation layer and services obstructing or limiting wall insulation coverage are not considered within the calculations.
- The effects of air leakage due to unsealed architraves, unsealed door jambs, unsealed gaps between windows and the masonry wall or services penetrating the inner leaf, are not considered within the calculations.

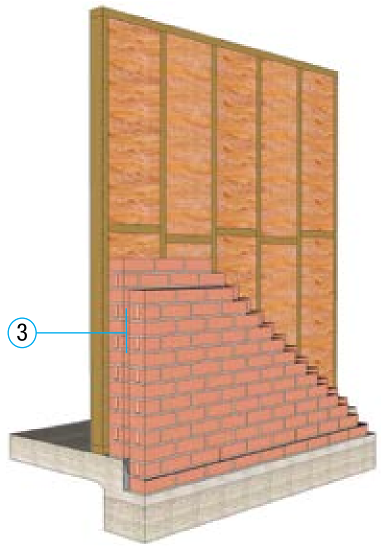
Element No.	INSULATING MATERIAL INSTALLED AGAINST INNER BRICK LEAF	UN-INSULATED WALL		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE		DOUBLE-SIDED BUBBLE/ FOAM R_m0.2, 7mm		DOUBLE-SIDED ANTIGLARE EPS R_m0.37, 15mm		DOUBLE-SIDED BLANKET R_m0.45, 15mm	
				FOIL FACING CAVITY		BRIGHT FOIL FACING CAVITY		BRIGHT FOIL FACING CAVITY		BRIGHT FOIL FACING CAVITY		BRIGHT FOIL FACING CAVITY	
		W1000NVW	W1000NVS	W1011NVW	W1011NVS	W1021NVW	W1021NVS	W1039NVW	W1039NVS	W1041NVW	W1041NVS	W1051NVW	W1050NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	110mm Brickwork	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
3	Air gap	0.19	0.16	0.74	0.60	0.74	0.60	0.73	0.60	0.85	0.71	0.72	0.59
4	Insulating material R-value			0.00	0.00	0.00	0.00	0.20	0.20	0.38	0.35	0.48	0.42
5	110mm Brickwork	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
6	Cement render or plasterboard	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
7	Indoor Air Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value	0.73	0.70	1.3	1.1	1.3	1.1	1.5	1.3	1.8	1.6	1.7	1.6

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Total R-values presented in this table is based on first selecting the respective cavity wall insulation type, second, the heat flow direction and the total R-value of the construction. The calculations assume the insulation partially fills the 50mm brickwork cavity depending on the thickness. AS 4773 requires that at least 35mm clearance is maintained between the insulation and the outer leaf of the brickwork, therefore calculations are given for the insulation and membranes hard up against the inner leaf

W1100 - INTERNALLY INSULATED CAVITY CLAY MASONRY





Air Layer   Wall Insulation Layer

ICANZ System Reference W1100

Structure

Double brick wall with 50 mm cavity and without air gaps between brickwork, insulation and plasterboard internal lining. Appropriate stud dimensions should therefore be used to accommodate wall insulation batts. Direct fixing of plasterboard to brickwork is calculated in the case of an un-insulated wall.

Insulation installation

The internal layer of insulation can be retrospectively fitted using either a batten system fixed to the brickwork which will provide fixing points for the internal lining or an internal stud frame which can be used for larger insulation thicknesses which shall be fixed at floor and ceiling junctions. Refer to ICANZ member for calculations involving insulated cavity systems that may have previously been insulated as per ICANZ W1000.

For batten systems the battens will be run vertically and have sufficient depth to ensure the insulation maintains its position and nominal thickness. For stud wall systems the depth of the studs should be greater or equal to the nominal thickness of the insulation which is fitted between the studs.

W1100 systems are considered to be non-ventilated for thermal calculation purposes. However varying environmental conditions may allow venting through weep holes and interface joints between doorway or window openings, thereby affecting the claimed performance of the application. **Poor sealing between window frames and masonry wall, poor caulking around architraves and gaps around door jambs may affect total thermal performance.** Effectiveness of membranes for heat, air and moisture control require any tears or gaps to be sealed with a suitable non shrink tape; refer to ICANZ member for further advice.

Notes

- Moisture related issues may arise for products which form bridges across the cavity. It is essential that any product or system used installed according to manufacturer's instructions, has been suitably tested with appropriate test reports and is warranted by the manufacturer.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to recessed wall fixtures, wall junctions with internal wall, lintels and services obstructing or limiting wall insulation coverage are not considered within the calculations.
- The effects of air leakage due to unsealed architraves, unsealed door jambs, unsealed gaps between windows and the masonry wall or services penetrating the inner leaf, are not considered within the calculations.

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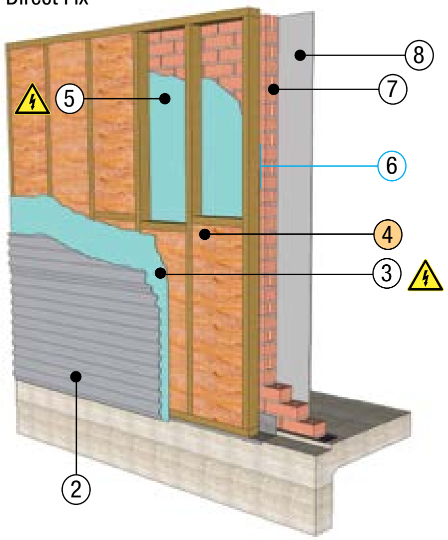
Element No.		UN-INSULATED CAVITY	
		No stud insulation	
		W1100NVW	W1100NVS
	Element Description:	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04
2	110mm Brickwork	0.18	0.18
3	Non-ventilated brick cavity	0.19	0.16
4	110mm Brickwork	0.18	0.18
5.0	Wall Insulation (see table below)		
6	10mm Plasterboard	0.06	0.06
7	Indoor Air Film	0.12	0.12
	Total R-value **WITHOUT** insulation	0.77	0.74

Total R-value **WITH** added insulation

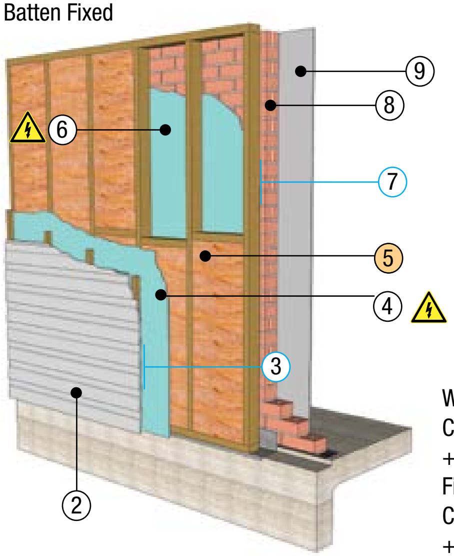
5.1	Stud Wall Batts R1.0 (50mm)	1.8	1.7
5.2	Stud Wall Batts R1.5 (75mm)	2.4	2.2
5.3	Stud Wall Batts R2.0 (90mm)	2.9	2.7
5.4	Stud Wall Batts R2.5 (90mm)	3.4	3.1
5.5	Stud Wall Batts R2.7 (90mm)	3.6	3.3

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in this table is based on first the respective R-value wall batt (item 5.1 – 5.5) from the lower table and the total R-value of the construction. In the insulated walls it is assumed that the insulation will fully replace the air void in the stud bay irrespective of the insulation thickness.

Direct Fix



Batten Fixed



Weatherboard Cladding +0.03m2.k/W
Fibre Cement Cladding +0.02m2.k/W

Air Layer   Wall Insulation Layer

ICANZ System Reference W1200

Structure

External lightweight clad wall with an interior brick leaf and plasterboard lining separated by a 50mm cavity. The internal lining can be either direct fix plasterboard or cement render.

No membrane, no battens: Light weight cladding fixed directly on to 90mm stud with 50mm cavity behind brickwork. A 140mm air gap results in the case of no stud insulation and no membrane.

Vapour Permeable Membranes: Vapour permeable membranes can be used on both sides of the studs or at minimum should be used on the opposite side of the stud frame from any foil membranes.

Single-sided foil, no battens: Light weight cladding fixed directly on to 90mm stud with foil on interior side of stud (foil facing inwards) and 50mm cavity behind brickwork. 90mm stud bay air gap and 50mm inner air gap in case where no stud insulation is installed. A permeable membrane may be used between the studs and the cladding.

No membrane, 40mm battens: Light weight cladding fixed to 40mm batten on 90mm stud with 50mm cavity behind brickwork. A total 180mm air gap results in the case of no stud insulation and no membranes. When batts are installed a 40mm outer air gap and 50mm inner air gap are created.

Double-sided antiglare, 40mm battens: Light weight cladding fixed to 40mm batten. Double sided foil on exterior of 90mm stud (foil facing inwards) and 50mm cavity between the studs and brickwork. A vapour permeable membrane is recommended on the inside of the studs. A 40mm outer air gap, 90mm stud air space and a 50mm inner air gap are created in the case where no stud insulation is installed.

Single-sided foil, 40mm battens: Light weight cladding fixed to 40mm batten. A vapour permeable membrane is recommended on the outside of the studwork. Single-sided foil on interior of 90mm stud and 50mm cavity to the brickwork with the bright foil side facing towards the brick cavity. A total of 40mm outer air gap, 90mm stud cavity and 50mm inner air gap in case where no stud insulation is installed.

Insulation installation

Where applicable, all membranes intended to act as a sarking shall be positioned externally to stud framing. A secondary membrane is recommended on the internal side of the stud frame to prevent air exchange from the cavity into the stud bays. All foil membranes behind the cladding are based on having the brightest foil surface facing inwards to the stud air space. All foil membranes on the inside of the studwork are based on having the brightest surfacing facing the brick work. When using a membrane as sarking, laps and joins shall have min 150mm overlap in accordance with AS/NZS 4200.2. **When utilising membranes for air control or moisture control the membranes will require taping and any tears to be repaired.** Stud wall bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like. Bulk insulation nominal thickness greater than cavity clearances and those areas around services may have insulation crushed resulting in loss of thermal performance. It is recommended that bulk insulation be cut around these obstructions; please consult an ICANZ member for more information.

All cavities are considered to be non-ventilated for thermal calculation purposes. However varying environmental conditions may allow air transfer through expansion joints, poor seals between window frames and stud frames, gaps around architraves and gaps around door jambs there by affecting thermal performance. **Poor treatment or fitment of wall penetrations and insulation installation workmanship may affect thermal performance.**

The preferred external cladding fixing method will incorporate an air cavity and drainage plane to improve moisture tolerance of the wall system. Vertically fixed battens over the top of a water barrier sarking layer will create a cavity to allow drainage and promote drying through air movement. Vapour barriers should not be used on both sides of the studwork.

Where nominated in the tables, when bulk insulation is positioned in stud bays no additional thermal allowance has been considered for applications having a batt nominal thickness less than the stud dimension. In practice it is extremely difficult to ensure an air gap adjacent the foil surface unless special precautions are taken, therefore calculations assume bulk insulation in direct contact with foil surface and no air cavity is formed.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks may result within an external wall structure when using tightly sealed vapour barriers are positioned to the external side of the stud and

coupled with any combination of the following: cold climate regions, high internal relative humidity levels, high bulk insulation levels within stud cavity, or a vapour barrier membrane in contact with outer cladding. In these applications it is recommended to use a vapour permeable membrane whilst restricting the ingress of liquid water and air transported water vapour. In regions prone to moisture related problems, highly shaded sites or walls receiving no direct sunlight, it is recommended to use a battened cavity behind the cladding. Please consult an ICANZ member for alternative drying methods behind direct fix cladding.

- For metal stud framing construction, it is a requirement to use a thermal break material over the membranes having a material R-value not less than R_m0.2. Metal battens over metal studs do not require thermal break material unless the batten is vertical such as with weatherboard or horizontally fixed corrugated metal cladding.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging or gaps in the bulk insulation layer due to services obstructing or limiting wall insulation coverage are not considered within the calculations.
- Membranes having a flammability index of 5 or less and mineral wool (non-combustible fibrous material) wall batt insulation are recommended in bush fire nominated areas in order to prevent burning embers entering the stud cavity.

Table 1		DIRECT FIX CLADDING					
Element No.	EXTERNAL MEMBRANE	NONE		VAPOUR PERMEABLE		VAPOUR PERMEABLE	
	INTERNAL MEMBRANE	NONE		VAPOUR PERMEABLE		SINGLE-SIDED FOIL	
		No stud insulation		No stud insulation		No stud insulation	
		W1200NVW	W1200NVS	W1280NVW	W1280NVS	W1210NVW	W1210NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04
2	Light weight cladding	0.00	0.00	0.00	0.00	0.00	0.00
3	External Membrane			0.00	0.00	0.00	0.00
4	Air Gap (90mm Studs), OR	0.18	0.15	0.18	0.15	0.18	0.15
4.0	Wall Insulation (see table below)						
5	Internal Membrane			0.00	0.00	0.00	0.00
6	Wall Cavity (50mm)			0.19	0.16	0.74	0.60
7	110mm Brickwork	0.18	0.18	0.18	0.18	0.18	0.18
8	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06
9	Indoor Air Film	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.58	0.55	0.77	0.71	1.3	1.2
Total R-value **WITH** added insulation							
4.1	Stud Wall Batts R1.5 (75mm)	2.2	2.0	2.2	2.0	2.9	2.5
4.2	Stud Wall Batts R2.0 (90mm)	2.7	2.5	2.7	2.5	3.5	3.0
4.3	Stud Wall Batts R2.5 (90mm)	3.2	2.9	3.2	2.9	4.0	3.5
4.4	Stud Wall Batts R2.7 (90mm)	3.4	3.1	3.4	3.1	4.2	3.8

Table 2		40mm BATTENED CLADDING							
Element No.	EXTERNAL MEMBRANE	NONE		VAPOUR PERMEABLE		DOUBLE-SIDED ANTIGLARE		VAPOUR PERMEABLE	
	INTERNAL MEMBRANE	NONE		VAPOUR PERMEABLE		VAPOUR PERMEABLE		SINGLE-SIDED FOIL	
		No stud insulation		No stud insulation		No stud insulation		No stud insulation	
		W1220NVW	W1220NVS	W1290NVW	W1290NVS	W1230NVW	W1230NVS	W1240NVW	W1240NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Light weight cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Batten Air Gap (40mm)			0.20	0.16	0.74	0.60	0.20	0.16
4	External Membrane			0.00	0.00	0.00	0.00	0.00	0.00
5	Air Gap (90mm Studs), OR	0.18	0.15	0.18	0.15	0.68	0.67	0.18	0.15
5.0	Wall Insulation (refer to table below)								
6	Internal Membrane			0.00	0.00	0.00	0.00	0.00	0.00
7	Wall Cavity (50mm)			0.19	0.16	0.20	0.17	0.76	0.62
8	110mm Brickwork	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
9	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10	Indoor Air Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.58	0.55	0.96	0.87	2.0	1.8	1.5	1.3
Total R-value **WITH** added insulation									
5.1	Stud Wall Batts R1.5 (75mm)	2.4	2.2	2.4	2.2	3.0	2.7	3.1	2.7
5.2	Stud Wall Batts R2.0 (90mm)	2.9	2.6	2.9	2.6	3.5	3.2	3.7	3.2
5.3	Stud Wall Batts R2.5 (90mm)	3.4	3.1	3.4	3.1	4.1	3.7	4.2	3.7
5.4	Stud Wall Batts R2.7 (90mm)	3.6	3.3	3.6	3.3	4.3	3.9	4.4	3.9

Table 1 – Direct Fix Cladding
In summary, the Total R-values presented in this table is based on first selecting the respective membrane type on the internal and external sides of the studwork, second, the heat flow direction, and finally the R-value batt and thickness (item 4.1 – 4.4) within the stud cavity. In the insulated walls it is assumed that the insulation will fully replace the air void in the stud bay irrespective of the insulation thickness.

Table 2 – 40mm Battened Cladding
In summary, the Total R-values presented in this table is based on first selecting the respective membrane type on the internal and external sides of the studwork, second, the heat flow direction, and finally the R-value batt and thickness (item 5.1 – 5.4) within the stud cavity. In the insulated walls it is assumed that the insulation will fully replace the air void in the stud bay irrespective of the insulation thickness.

All values given in the table are calculated based on steel sheeting. For fibre cement board cladding an additional R0.02 may be added to the value given. For fibre cement weatherboard an additional R0.03 may be added to the value given.

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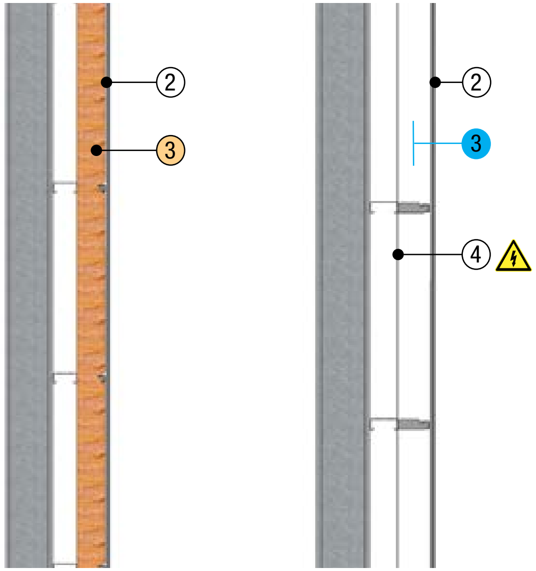
THE RIGHT INSULATION MATTERS

W1300 - METAL CLADDING (warehouse wall, no lining)



Air Layer   Blanket Insulation Layer

ICANZ System Reference W1300

Structure

Metal wall cladding with either air gap between the cladding and membrane material or foil faced blanket installed with bulk insulation in contact with the cladding. A suitable spacer system shall be adopted to provide the airspace quoted for each application or the required cavity for bulk insulation blanket to recover to its nominal thickness.

The following air cavity dimensions 0mm, 25mm, 40mm, 55mm, 75mm, 100mm apply to each of the base wall constructions in order to calculate their thermal performances for un-insulated wall; vapour permeable membrane; single-sided foil; double-sided antiglare; double-sided bubble/foam foil R_m0.2 (7mm).

Vapour Permeable membrane: Steel sheeting, air gap (ranges from 0 to 100mm), vapour permeable membrane.

Single-sided foil: Steel sheeting, air gap (ranges from 0 to 100mm), single-sided foil.

Double-sided antiglare: Steel sheeting, air gap (ranges from 0 to 100mm), double-sided antiglare.

Double sided bubble/foam foil R_m0.2 (7mm): Steel sheeting, air gap (ranges from 0 to 100mm), double-sided bubble/foam foil.

Foil faced blankets: 0.42mm steel sheeting, foil faced blanket with suitable spacer for recovery.

Insulation installation

Where applicable, when using membranes a spacer system shall be included in the system to provide an air gap of 25mm - 100mm between the cladding and any foil or antiglare surface. The membrane shall have min 150mm overlap in accordance with AS/NZS 4200.2 and may require taping to prevent ingress of dust and convection air movements between multiple air cavities separated by the membrane.

For foil faced blanket applications, varying batten or spacer heights are to be used to suit insulation blanket so to regain the products respective nominal thickness. **Mis-matched spacer heights to blanket thickness will reduce recovery and directly affect bulk insulation material R-value thermal performance.**

Air cavities developed by either battens or spacers between the cladding and membranes are assumed to be non-ventilated for calculation purposes only.

Environmental conditions such as ventilation air movements due differential pressure changes, condensation, oxidation of aluminium foil, or poor workmanship may all affect the properties of foil membrane surfaces and overall thermal performance of insulated systems.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Effectiveness of membranes require any tears to be sealed with a suitable non shrink tape to control liquid water, water vapour, air infiltration, and/or ember entry. Foil membrane performance will be reduced by poor sealing of lap joints, tears and gaps allowing venting between cladding air cavity and the internal air thereby affecting the thermal resistance of that air cavity.
- Limiting bulk insulation blankets to fully recover to their nominal thickness will reduce its material R-value.

Element No.	Table 1	MEMBRANE WALL SYSTEMS: UN-INSULATED WALL		VAPOUR PERMEABLE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE		DOUBLE-SIDED BUBBLE/ FOAM FOIL (core material R_m 0.2)	
		Without air gap		Without air gap		Without air gap		Without air gap		Without air gap	
		R0900NVW	R0900NVS	R0990NVW	R0990NVS	R0910NVW	R0910NVS	R0920NVW	R0920NVS	R0930NVW	R0930NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Wall Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0	Non-ventilated air gap (see below)										
4	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20
5	Indoor Air-Film	0.12	0.12	0.12	0.12	0.30	0.30	0.30	0.30	0.30	0.30
	Total R-value **WITHOUT** insulation	0.16	0.16	0.16	0.16	0.34	0.34	0.34	0.34	0.54	0.54
	Total R-value **WITH** increased air gap behind cladding										
3.1	Non-ventilated 25mm air gap			0.34	0.31	0.53	0.49	0.97	0.87	1.2	1.1
3.2	Non-ventilated 40mm air gap			0.34	0.31	0.53	0.50	0.98	0.86	1.2	1.1
3.3	Non-ventilated 55mm air gap			0.34	0.31	0.53	0.49	0.95	0.84	1.1	1.0
3.4	Non-ventilated 75mm air gap			0.34	0.31	0.53	0.49	0.94	0.85	1.1	1.0
3.5	Non-ventilated 100mm air gap			0.34	0.31	0.52	0.49	0.94	0.86	1.1	1.0

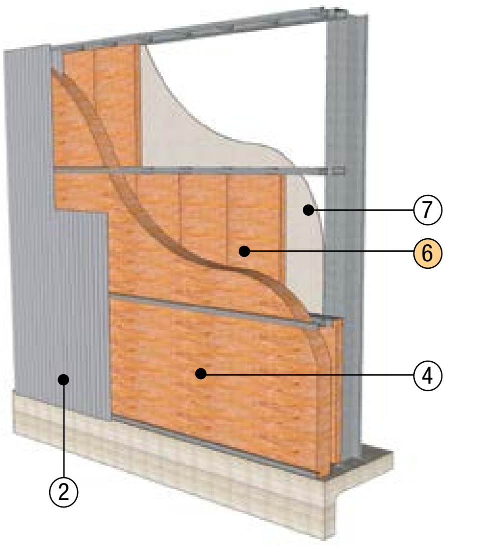
Element No.	Table 2	BLANKET WALL SYSTEMS: FOIL FACED BLANKET		FACED BLANKET (NON-FOIL)	
		No blanket		No blanket	
		R0940NVW	R0940NVS	R0960NVW	R0960NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04
2	Metal Roof Cladding	0.00	0.00	0.00	0.00
3	Blanket material R-value (see below)				
4	Indoor Air-Film	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.16	0.16	0.16	0.16
	Total R-value **WITH** added blanket insulation				
3.1	R1.3 blanket	1.7	1.6	1.5	1.4
3.2	R1.4 blanket	1.8	1.7	1.3	1.6
3.3	R1.8 blanket	2.2	2.0	2.1	1.9
3.4	R2.3 blanket	2.8	2.5	2.6	2.4
3.5	R2.5 blanket	3.0	2.7	2.8	2.5
3.6	R3.0 blanket	3.5	3.2	3.3	3.0
3.7	R3.3 blanket	3.8	3.5	3.6	3.3
3.8	R3.6 blanket	4.1	3.8	3.9	3.6

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

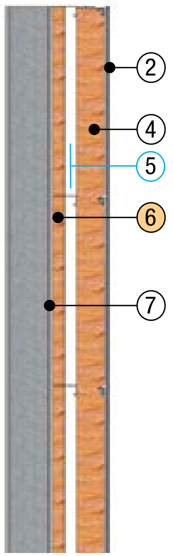
Table 1 - Membrane wall systems
In summary, the Total R-values presented in this table is based on first selecting the respective membrane type which is separated from the metal cladding with a spacer, second, the heat flow direction, and finally the respective air gap thickness (item 3.1 – 3.5).

Table 2 - Blanket wall systems
In summary, the Total R-values presented in this table is based on first selecting the respective insulation blanket facing type, second, the heat flow direction, and finally the insulation blanket R-value (item 3.1 – 3.8).

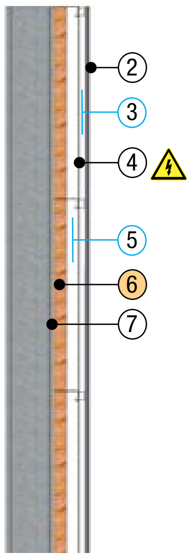
W1400 - METAL CLADDING (warehouse wall, with lining)



Blanket System



Membrane System



Air Layer   Wall Insulation Layer

ICANZ System Reference W1400

Structure

Metal wall cladding on a 40mm batten or spacer system fixed to 100mm steel girts. Either a 40mm air gap between the cladding and membrane material are created with 40mm battens or alternatively a foil faced blanket behind the cladding with a suitable spacer system to allow the blanket to recover to its full nominal thickness and the bulk insulation in contact with the cladding. The system is internally lined with compressed fibre cement board attached to the inside of steel girts. The following dimensions apply to the base wall construction in order to calculate their respective air cavities:
Vapour permeable membrane: 40mm (cladding air gap); and 100mm (girt air gap)
Double-sided Foil: 40mm (cladding air gap); and 100mm (girt air gap)
Double sided bubble/foam foil R_m0.2 (7mm): 40mm (cladding air gap); and 100mm (girt air gap)
Foil faced blankets: 100mm (girt air gap)

Insulation installation

Where applicable, all membranes shall be fixed to the steel girts and a spacer system used to provide a 40mm air gap between the cladding and the membrane. Single side or double sided foil membranes are based on having the brightest foil surface facing into the girt void. When using a membrane as sarking, laps and joins shall have min 150mm overlap in accordance with AS/NZS 4200.2. **When utilising membranes for air control or moisture control the membranes will require taping and any tears to be repaired.**
Air cavities developed by either battens or spacers adjacent foil membranes are assumed to be non-ventilated for calculation purposes only. Calculated values in the performance tables assume an air cavity of 100mm deep is formed by the girts. For calculation purposes a girt cavity less than 100mm will yield lower R-values while a service cavity greater than 100mm will yield an improvement in R-values. Please contact an ICANZ member for advice.

Environmental conditions such as ventilation air movements due differential pressure changes, condensation, oxidation of aluminium foil, poor workmanship may all affect the reflectiveness of foil membrane surfaces and/or the foil's claimed air space thermal performance.
For foil faced blanket applications, varying batten or spacer heights are to be used to suit insulation blanket so to regain the products respective nominal thickness. Effectiveness of all membranes require any tears or gaps to be repaired with a suitable non shrink tape to maintain a seal to control water vapour, water, air infiltration, and/or ember entry; refer to ICANZ member for advice. **Foil surface performance will be reduced by poor sealing of lap joints, tears and gaps which allow venting between lower air cavity and upper batten cavities thereby reducing the claimed thermal performance of that air cavity element.**

Where nominated in the performance tables, when bulk insulation is positioned in the girt void, no additional thermal allowance has been considered for applications having a batt nominal thickness less than the 100mm girt dimension. In practice it is extremely difficult to ensure an air gap adjacent the foil surface unless special precautions are taken, therefore calculations assume bulk insulation in direct contact with foil surface and no air cavity is formed. For applications having a batt nominal thickness less than the girt dimension and seeking additional benefit of an air gap within the girt cavity; please consult an ICANZ member for these special applications which will require spacers to position bulk insulation away from adjacent surfaces to induce a controlled air space thermal performance.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- The performance values in the table are based on matching the respective R-value batt between girts which are always assumed to fill the whole 100mm cavity. Where nominated in the table, thermal performance of bulk insulation when positioned between girts negates any thermal performance provided by the reflective foil's original air space created by girts.
- In practice it is extremely difficult to ensure an air gap adjacent the reflective foil surface unless special precautions are taken, therefore calculations assume bulk insulation in direct contact with foil surface and no air cavity is formed. For applications having a batt nominal thickness less than the stud dimension and seeking additional benefit of a reflective air gap within the air space; Please consult an ICANZ member for alternative thermal results for wider girt cavities and for special applications which will require spacers to position bulk insulation away from adjacent reflective surfaces to induce a controlled air space thermal performance.

- Effectiveness of all sarking membranes require any tears or gaps to be repaired with a suitable non shrink tape to maintain a seal to control liquid water, water vapour, air infiltration, and/or ember entry; refer to sarking manufacturer for advice.
- **Reflective foil performance will be reduced by poor sealing of lap joints, tears and gaps allows venting between cladding air cavity and the internal air thereby the claimed thermal performance of that air cavity element.**

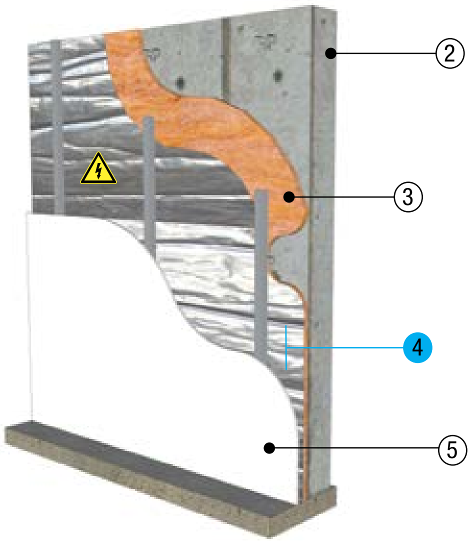
Element No.		VAPOUR PERMEABLE		DOUBLE-SIDED ANTIGLARE		DOUBLE-SIDED BUBBLE/ FOAM FOIL R_m0.2		FOIL FACED R1.4 BLANKET		FOIL FACED R1.8 BLANKET		FOIL FACED R2.3 BLANKET		FOIL FACED R2.5 BLANKET		FOIL FACED R3.0 BLANKET	
		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation	
		W140aNVW	W140aNVS	W1410NVW	W1410NVS	W1440NVW	W1440NVS	W1450NVW	W1450NVS	W1460NVW	W1460NVS	W1470NVW	W1470NVS	W1480NVW	W1480NVS	W1490NVW	W1490NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Metal Wall Cladding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	40mm Air gap	0.19	0.16	0.70	0.58	0.68	0.56										
4	Sarking OR Blanket R-value	0.00	0.00	0.00	0.00	0.20	0.20	1.48	1.32	1.90	1.70	2.43	2.17	2.64	2.36	3.17	2.84
5	Unventilated 100mm air gap	0.18	0.16	0.68	0.65	0.63	0.62	0.68	0.67	0.68	0.67	0.68	0.67	0.68	0.67	0.68	0.67
6.0	Wall Insulation (see table below)																
7	Compressed Fibre Cement Board	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
8	Indoor Air-Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.54	0.49	1.6	1.4	1.7	1.6	2.3	2.2	2.8	2.5	3.3	3.0	3.5	3.2	4.0	3.7

Total R-value **WITH** added wall batt insulation

6.1	Wall Batts R1.5 (75mm)	2.5	2.3	2.5	2.3	2.7	2.4	3.2	2.9	3.6	3.3	4.2	3.8	4.4	4.0	4.9	4.5
6.2	Wall Batts R2.0 (90mm)	3.0	2.8	3.0	2.8	3.2	2.9	3.8	3.4	4.2	3.8	4.7	4.3	4.9	4.5	5.4	4.9
6.3	Wall Batts R2.5 (90mm)	3.6	3.2	3.6	3.2	3.7	3.4	4.3	3.9	4.7	4.3	5.2	4.8	5.4	4.9	6.0	5.4
6.4	Wall Batts R2.7 (90mm)	3.8	3.4	3.8	3.4	3.9	3.6	4.5	4.1	4.9	4.5	5.4	4.9	5.6	5.1	6.2	5.6

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.
In summary, the Total R-values presented in this table is based on first selecting the respective membrane of blanket insulation type, second, the heat flow direction, and finally the bulk insulation R-value and thickness added to the wall (item 6.1 – 6.4).

W1500 - CONCRETE TILT SLAB (internally lined)



Air Layer   Wall Insulation Layer

ICANZ System Reference W1500

Structure

Concrete tilt slab with insulation impaled over furring channel clips. Furring channel of 16mm or 28mm is held vertically by the clips and supports the plasterboard internal lining. The following dimensions apply to the base wall construction in order to calculate their respective air cavities:
R1.1 Board: 16mm furring channel offset 35mm from the concrete. Minimum 51 mm air void, OR
28mm furring channel offset 35mm from the concrete. Minimum 63 mm air void.
R1.2 Board: 16mm furring channel offset 35mm from the concrete. Minimum 51 mm air void, OR
28mm furring channel offset 35mm from the concrete. Minimum 63 mm air void.
R1.5 Board: 16mm furring channel offset 50mm from the concrete. Minimum 66 mm air void, OR
28mm furring channel offset 50mm from the concrete. Minimum 78 mm air void.
R1.8 Board: 16mm furring channel offset 56mm from the concrete. Minimum 72 mm air void, OR
28mm furring channel offset 56mm from the concrete. Minimum 84 mm air void.
R2.0 Board: 16mm furring channel offset 56mm from the concrete. Minimum 72 mm air void, OR
28mm furring channel offset 56mm from the concrete. Minimum 84 mm air void.
R2.2 Board: 28mm furring channel offset 56mm from the concrete. Minimum 84 mm air void.
Double sided EPS antiglare board R_m0.37: 28mm furring channel offset 35mm from the concrete. Minimum 63 mm air void, OR
28mm furring channel offset 50mm from the concrete. Minimum 78 mm air void.

Insulation installation

Tilt up concrete slab wall insulated with fibrous blanket/board insulation, foil faced blanket/board or reflective polystyrene board. Wall clips are mounted to the tilt up slab in which the insulation blanket or board is pierced over the clips and pushed hard up against the concrete tilt slab. A furring channel is clipped into the clips to create sufficient space for the insulation and to minimise compression. The plasterboard is fixed to the furring channels in which an air void will generally result between the insulation or foil surface facing of the blanket or board and the back side of the plasterboard.
When using foil faced blankets, membrane facings shall have min 150mm overlap in accordance with AS/NZS 4200.2. When using foil faced boards or blankets, they will require taping at butt joints to prevent convection air movements between multiple air cavities separated by the board or blanket.
Air cavities developed between the insulation facing and the plasterboard are assumed to be non-ventilated for calculation purposes.
Environmental conditions such as ventilation air movements due differential pressure changes, condensation, oxidation of aluminium foil, poor workmanship may all affect the reflectiveness of foil surfaces and/or the foil's claimed air space thermal performance.
For foil faced blanket or board applications, varying clip sizes and furring channel heights are to be used to suit insulation blanket so to regain the products respective nominal thickness. Effectiveness of all membranes require any tears or gaps to be repaired with a suitable non shrink tape to maintain a seal to control water vapour and air infiltration; refer to ICANZ member for advice. Foil surface performance will be reduced by poor sealing of lap joints, tears and gaps which allow venting between lower air cavity and upper batten cavities thereby reducing the claimed thermal performance of that air cavity element.
Where nominated in the performance tables, bulk insulation blankets and boards are positioned up against the concrete (except double sided EPS), carefully fixed insulation allows additional thermal performance for applications having a nominal thickness less than the available air cavity dimension which an additional air gap is created as specified in the performance tables. For applications which are different to the included systems; please refer to an ICANZ member for advice.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Effectiveness of membranes require any tears to be sealed with a suitable non shrink tape to control liquid water, water vapour, air infiltration, and/or ember entry. Foil membrane performance will be reduced by poor sealing of lap joints, tears and gaps allowing venting between cladding air cavity and the internal air thereby affecting the thermal resistance of that air cavity.
- **Limiting bulk insulation blankets to fully recover to their nominal thickness will reduce its material R-value.**

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Element No.		FOIL FACED FIBROUS INSULATION BOARDS OR BLANKETS											
		R1.1 (38mm)		R1.2 (40mm)		R1.5 (50mm)		R1.8 (63mm)		R2.0 (70mm)		R2.2 (75mm)	
		No Air Gap		No Air Gap		No Air Gap		No Air Gap		No Air Gap		No Air Gap	
		W1500NVW	W1500NVS	W1510NVW	W1510NVS	W1520NVW	W1520NVS	W1530NVW	W1530NVS	W1540NVW	W1540NVS	W1550NVW	W1550NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	Concrete wall	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
3	Wall insulation	1.16	1.05	1.26	1.14	1.58	1.43	1.89	1.72	2.10	1.91	2.31	2.10
4.0	Air gap (see table below)												
5	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
6	Indoor Air-Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** air gap	1.5	1.4	1.6	1.5	1.9	1.8	2.2	2.0	2.4	2.2	2.6	2.4

Total R-value **INCLUDING** air gap

	Fixing Configuration	B2-16		B2-16		C1-16		C3-16		C3-16		Insufficient space	
4.1	16mm furring channel	1.6	1.5	1.7	1.6	2.1	1.9	2.4	2.2	2.5	2.3		
	Fixing Configuration	B2-28		B2-28		C2-28		C3-28		C3-28		C3-28	
4.2	28mm furring channel	1.7	1.5	1.8	1.6	2.1	1.9	2.4	2.2	2.6	2.4	2.8	2.5
	Fixing Configuration	B2-16		B2-16		C1-16		C3-16		C3-16		Insufficient space	
4.3	16mm channel and foil facing	2.0	1.8	2.1	1.9	2.5	2.3	2.6	2.4	2.5	2.3		
	Fixing Configuration	B2-28		B2-28		C2-28		C3-28		C3-28		Insufficient space	
4.4	28mm channel and foil facing	2.3	2.0	2.4	2.2	2.8	2.5	2.9	2.7	2.9	2.7	3.0	2.7

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

Table 1 – Fibrous Insulation Boards or Blankets
In summary, the Total R-values presented in this table is based on first selecting the type of bulk insulation which is installed hard up against the concrete, second, the heat flow direction, and finally the fixing configuration and furring channel size which will result in the in the total R-value (item 4.1 – 4.4).

Element No.		EPS BOARD	
		DOUBLE-SIDED ANTIGLARE EPS BOARD R_m 0.37	
		W1560NVW	W1560NVS
	Element Description:	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04
2	Concrete wall	0.10	0.10
3.0	Air gap (see table below)		
4	EPS Board (15mm)	0.38	0.35
5	Furring channel air gap (28mm)	0.82	0.67
6	10mm Plasterboard	0.06	0.06
7	Indoor Air-Film	0.12	0.12
	Total R-value **WITHOUT** air gap	1.5	1.4

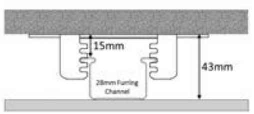
Total R-value **INCLUDING** air gap

Fixing Configuration		B2-28	
3.1	20mm air gap	2.1	1.9
Fixing Configuration		C2-28	
3.2	35mm air gap	2.4	2.0

Table 2 – EPS Board
In summary, the Total System R-values presented in this table is based on first selecting the heat flow direction, secondly the fixing configuration which will result in an air gap of 20mm or 35mm between the concrete and the EPS Board, and finally the total R-value (item 3.1 or 3.2).

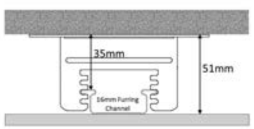
FIXING CONFIGURATIONS

A2-28



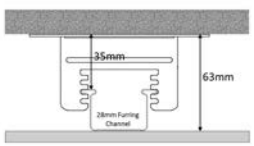
Furring channel offset 15mm from concrete

B2-16



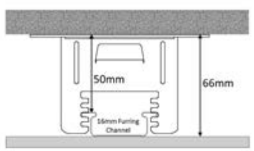
Furring channel offset 35mm from concrete

B2-28



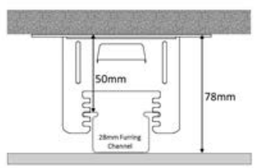
Furring channel offset 35mm from concrete

C1-16



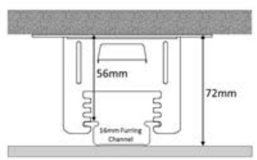
Furring channel offset 50mm from concrete

C2-28



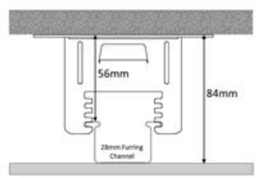
Furring channel offset 50mm from concrete

C3-16

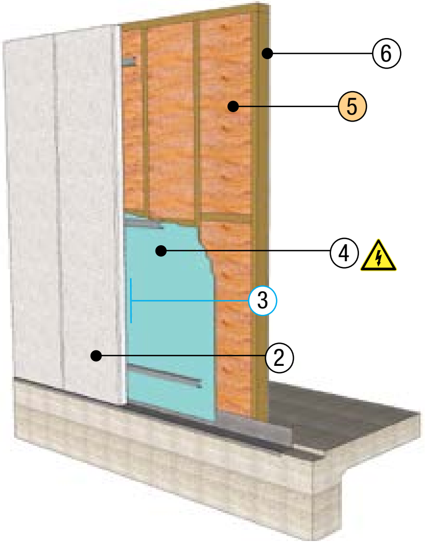


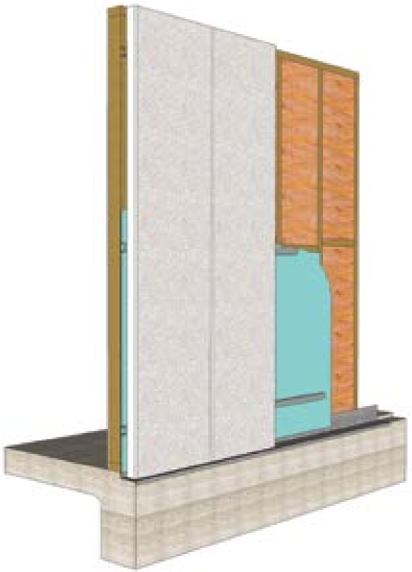
Furring channel offset 56mm from concrete

C3-28



Furring channel offset 56mm from concrete





Air Layer   Wall Insulation Layer

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ICANZ System Reference W1600

Structure

The system consists of 75mm thick steel reinforced Aerated Autoclaved Concrete Panels, fixed vertically to horizontal battens attached to the load-bearing steel or timber stud frame and 10mm plasterboard internal wall lining. The following dimensions apply to the base wall construction in order to calculate their respective air cavity R-value equivalent:
No membrane: 114mm air gap formed by 24mm batten and 90mm stud cavity.
Vapour permeable membrane: 24mm outer air gap and 90mm inner stud cavity
Single-sided foil: 24mm outer air gap and 90mm inner stud cavity
Double-sided antiglare: 24mm outer air gap and 90mm inner stud cavity
Double-sided antiglare bubble/foam Foil R_m0.2 (7mm): 24mm outer air gap and 90mm inner stud cavity
Double-sided antiglare EPS board Rm0.37 (15mm): 24mm outer air gap and 90mm inner stud cavity

Insulation installation

Where applicable, all sarking membranes shall be positioned externally to stud framing. Single side or double sided foil membranes are based on having the brightest highly reflective surface facing inwards to the stud air space. When using a membrane as sarking, laps and joins shall have min 150mm overlap in accordance with AS/NZS 4200.2. Extruded polystyrene (EPS) boards used as sarking will need to be suitably fixed to the external side of the studs and will require taping to drain liquid water. Stud wall bulk insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, electrical cabling or the like. **Bulk insulation nominal thickness greater than cavity clearances and those areas around services may have insulation crushed resulting in loss of thermal performance and risk plaster deformation**. It is recommended that bulk insulation be cut around (chase insulation around) these obstructions, please consult an ICANZ member for further advice.
Cladding cavities are considered to be non-ventilated for thermal calculation purposes only. However varying environmental conditions may allow venting to AAC cladding cavity and/or stud cavities via bottom edge vent openings, thereby affecting the claimed performance of the application. Poor treatment or fitment of AAC panels, wall penetrations, and insulation installation workmanship may affect thermal performance. **Poor sealing between window frames and stud frames, poor caulking around architraves and gaps around door jambs may affect total thermal performance.** Effectiveness of membranes for heat, air and moisture control require any tears or gaps to be repaired with a suitable non shrink tape. Refer to ICANZ member for further advice.
Foil performance will be reduced by poor sealing of lap joints, tears and gaps allows venting between brick and stud air cavities affecting the claimed thermal performance of the adjoining air cavities.
Where nominated in the performance tables, when bulk insulation is positioned in stud bays, no additional thermal allowance has been considered for applications having a batt nominal thickness less than the stud dimension. In practice it is extremely difficult to ensure an air gap adjacent the foil surface unless special precautions are taken, therefore calculations assume bulk insulation in direct contact with foil surface and no air cavity is formed. For applications having a batt nominal thickness less than the stud dimension and seeking additional benefit of an air gap within the stud bay; please consult an ICANZ member for these special applications which will require spacers to position bulk insulation away from adjacent surfaces to induce a controlled air space thermal performance.

Notes

- ⚠ **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks are minimised in this system due to the added R-value of the aerated concrete cladding. For improved moisture resilience it is recommended to use a vapour permeable membrane with air barrier and water barrier properties eliminating the ingress of liquid water and air transported water vapour into the stud bays but still allowing for drying in the event of system failure.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to recessed wall fixtures, wall junctions with internal wall, lintels and services obstructing or limiting wall insulation coverage are not considered within the calculations.

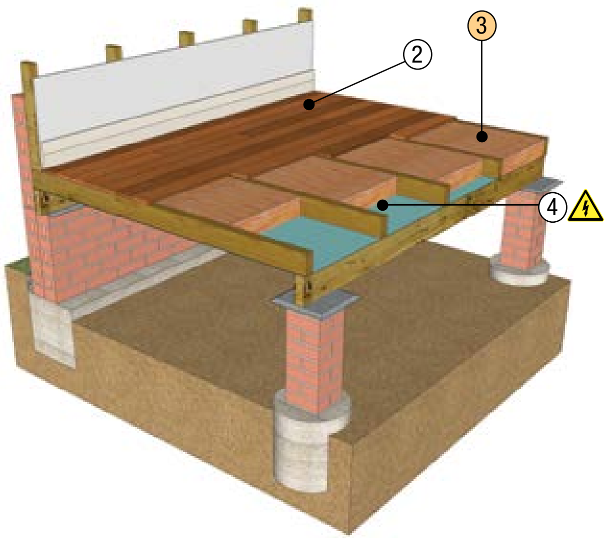
- The effects of air leakage due to recessed wall fixtures, unsealed architraves, unsealed door jambs, unsealed gaps between windows and stud frames or services penetrating linings and membranes, are not considered within the calculations.
- Membranes having a flammability index of 5 or less and mineral wool (non-combustible fibrous material) wall batt insulation are recommended in bush fire prone areas in order to prevent burning embers entering the stud cavity. EPS solutions are not recommended for bush fire applications.

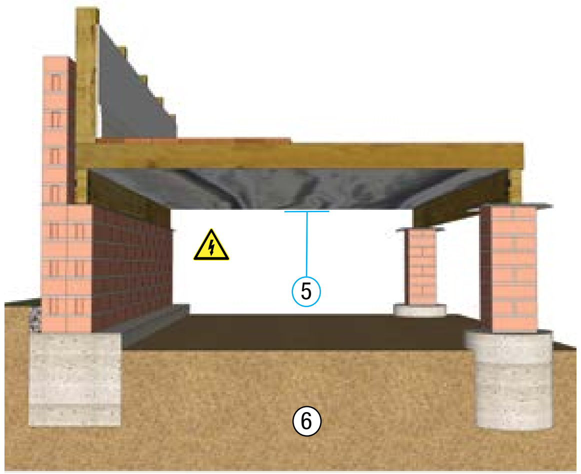
Element No.		NO MEMBRANE		VAPOUR PERMEABLE		SINGLE-SIDED FOIL		DOUBLE-SIDED ANTIGLARE		DOUBLE-SIDED BUBBLE/ FOAM FOIL R_m0.2		DOUBLE-SIDED ANTIGLARE EPS BOARD R_m0.37, 15mm	
		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation		No stud insulation	
		W1600NVW	W1600NVS	W1690NVW	W1690NVS	W1610NVW	W1610NVS	W1620NVW	W1620NVS	W1630NVW	W1630NVS	W1640NVW	W1640NVS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Outdoor Air Film	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2	AAC wall panel	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
3	Non-ventilated 24mm air gap			0.18	0.16	0.18	0.16	0.67	0.59	0.63	0.55	0.82	0.72
4	Sarking material R-value			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.38	0.36
5	Stud air cavity	0.17	0.16	0.17	0.16	0.68	0.66	0.68	0.67	0.63	0.62	0.71	0.70
5.0	Wall Insulation (see table below)												
6	10mm Plasterboard	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7	Indoor Air-Film	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Total R-value **WITHOUT** insulation	0.90	0.89	1.1	1.0	1.6	1.5	2.1	2.0	2.2	2.1	2.6	2.5
Total R-value **WITH** added insulation													
5.1	Stud Wall Batts R1.5 (75mm)	2.5	2.3	2.5	2.3	2.5	2.3	3.0	2.8	3.1	2.9	3.5	3.3
5.2	Stud Wall Batts R2.0 (90mm)	3.0	2.8	3.0	2.8	3.0	2.8	3.5	3.3	3.7	3.4	4.0	3.7
5.3	Stud Wall Batts R2.5 (90mm)	3.5	3.3	3.5	3.3	3.5	3.3	4.0	3.8	4.2	3.9	4.5	4.2
5.4	Stud Wall Batts R2.7 (90mm)	3.7	3.5	3.7	3.5	3.7	3.5	4.2	3.9	4.4	4.1	4.7	4.4

For full instructions on using the tables please see the step-by-step instructions on page 11 and 12.

In summary, the Total R-values presented in this table is based on first selecting the type of membrane or sarking board type which is fixed to the outside of the studwork, second, the heat flow direction, and finally the R-value batt and thickness (item 5.1 - 5.4) within the stud void. In the insulated wall scenarios it is assumed that the insulation will fully replace the air void in the stud bay irrespective of the insulation thickness

F0100 - SUSPENDED TIMBER FLOOR





Air Layer Floor Insulation Layer

ICANZ System Reference F0100

Structure

Timber floor consisting of standard 19mm Tongue and Groove hardwood flooring fixed directly over 90mm floor joist. Bearers will vary depending on their required span and spacing. With no membrane in the flooring system there is no air gap formed. The subfloor cavity will have an associated ground resistance for enclosed subfloors. The following dimensions apply to the base floor construction in order to calculate their respective air cavity R-value equivalent when membranes or insulation boards are incorporated:

Taut membranes under joists: 90mm joist air gap
Membranes over joists: 40mm – 90mm (air gap created by drape)
Double-sided antiglare EPS board: 90mm joist air gap

Insulation installation

Bulk insulation has been assumed to fill the entire joist space of 90mm when used. Thermal performance of air gaps created by membranes has been calculated for two different installation methods; draped over joists and installed below joists. When used with bulk insulation the membrane may be installed over the top of the bearers on the underside of the floor joists, the insulation can then be fitted snugly between the joists before the floor is laid. Alternatively foils can be used without bulk insulation and may be rolled out over the top of the floor joists and draped to create an air void and associated thermal benefit.

Foils draped over the joists may have an upward facing bright or antiglare surface which will improve the performance of the upper air gap. Single side or double sided foil membranes are based on having the brightest highly reflective surface facing downwards to the subfloor air space. When using membranes in floors, they shall be installed in accordance with AS/NZS 4200.2 and will require taping to prevent ingress of dust, convection air movements and air transported water vapour travelling between multiple air cavities separated by the membrane.

Membranes installed under the joists may incorporate upward and downward facing foil surfaces to increase the Total R-value. Any membrane installed in this manner with an upward facing bright foil or antiglare foil surface when installed with bulk insulation fully filling the joist space above will not contribute any R-value for this surface. When bulk insulation is being installed vapour permeable membranes can be used on the underside of floor insulation to allow moisture to escape from the floor system while preventing excessive R-value reductions due to air movement. Vapour permeable membranes in conjunction with bulk insulation will not contribute to the calculated R-value in accordance with AS/NZS 4859.1.

Floor insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, waste pipes electrical cabling or the like. It is recommended that bulk insulation be cut around these obstructions. Bulk insulation nominal thickness greater than joist depth and areas around services may have insulation crushed resulting in loss of thermal performance and risk membrane fixing failure.

Enclosed subfloors are considered to be non-ventilated for thermal calculation purposes only. However varying environmental conditions may allow venting to subfloors, thereby affecting the claimed performance of the application. Poor treatment or fitment of floor penetrations, water pipes, waste pipes, electrical cabling and insulation installation workmanship may affect thermal performance. Poor sealing of floor penetrations may affect total thermal performance. Effectiveness of membranes for heat, air and moisture control require any tears or gaps to be repaired with a suitable non shrink tape; refer to an ICANZ member for advice.

Notes

- Unventilated floor is assumed to be an enclosed subfloor with full perimeter walls with up to 6000mm²/m of ventilation openings and a subfloor height of 0.5m.
- **Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks may result within floor structures using tightly sealed vapour barriers positioned under floors. Subfloors can be excessively humid due to high soil moisture content which can lead to condensation forming on both the upper and lower surfaces of the foil. The likelihood of this occurring can be reduced by using open subfloors, mechanical subfloor ventilation systems, or vapour permeable membranes. This can occur in all climates from cold to tropical and designer should be aware that adequate drying paths through a combination of controlled air movement and vapour permeable fabrics may be required. Please consult an ICANZ member for alternative drying methods in subfloors.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to sanitary piping, electrical cables, and services obstructing or limiting floor insulation coverage are not considered within the calculations.

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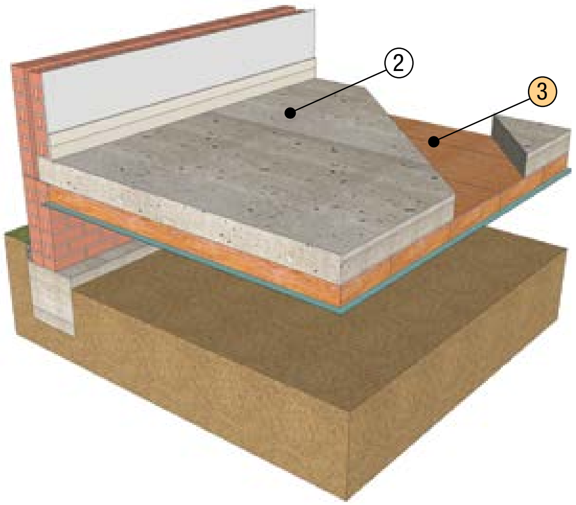
- The effects of air leakage due to leaks around skirting boards, sanitary piping, electrical cables, and services that penetrate the flooring or membranes as well as air leakage through floor board tongue and groove laps are not considered within the calculations.

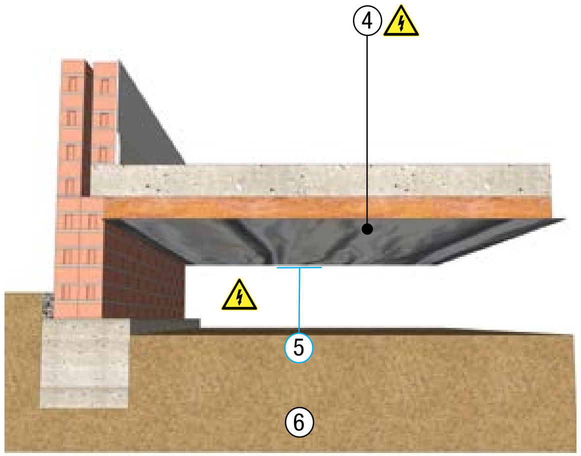
Element No.		INSULATION BATT WITH TAUT MEMBRANE SYSTEM							
		WITHOUT MEMBRANE				TAUT VAPOUR PERMEABLE SARKING			
		No bulk insulation				No bulk insulation			
		Enclosed		Open		Enclosed		Open	
		F0100NVW	F0100NVS	F0100VW	F0100VS	F0110NVW	F0110NVS	F0110VW	F0110VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11
2	Timber floorboards	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
3	Air gap, OR					0.21	0.14	0.21	0.14
3.0	Bulk Insulation (see table below)								
4	Sarking material R-value					0.00	0.00	0.00	0.00
5	Subfloor air film	0.16	0.11	0.08	0.08	0.16	0.11	0.08	0.08
6	Ground thermal resistance	0.58	0.56			0.58	0.56		
	Total R-value **WITHOUT** insulation	1.0	0.90	0.36	0.31	1.2	1.0	0.57	0.45
Total R-value **WITH** added insulation batts									
3.1	Floor batts R2.0 (90mm)	3.1	2.8	2.4	2.3	3.1	2.8	2.4	2.3
3.2	Floor Batts R2.5 (90mm)	3.6	3.3	3.0	2.7	3.6	3.3	3.0	2.7

Element No.	Table 2	RIGID BOARD SYSTEM			
		DOUBLE-SIDED ANTIGLARE EPS BOARD			
		Enclosed		Open	
		F0150NVW	F0150NVS	F0150VW	F0150VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11
2	Timber floorboards	0.12	0.12	0.12	0.12
3	Air Gap (90mm)	1.27	0.41	1.28	0.41
4.0	10mm EPS board	0.25	0.24	0.25	0.24
5	Subfloor air film	0.80	0.23	0.08	0.08
6	Ground thermal resistance	0.58	0.56		
	Total R-value **WITHOUT** insulation	3.2	1.7	1.9	0.96
Total R-value **WITH** added board insulation					
4.1	R0.4 EPS board (15mm)	3.3	1.8	2.0	1.1
4.2	R0.5 EPS board (20mm)	3.4	1.9	2.1	1.2
4.3	R0.7 EPS board (30mm)	3.7	2.2	2.4	1.4
4.4	R1.5 EPS board (60mm)	4.4	2.9	3.1	2.2

Table 1 - Floor Batt Performance
The Total R-values presented in this table is based on first selecting the type of membrane installed under the joists, second, the type of subfloor openness, third, the heat flow direction and finally the R-value batt and thickness (item 3.1 or 3.2) to fill between the joists.
Table 2 - EPS Board Performance
The Total R-values presented in this table is based on first selecting the type of subfloor openness, second, the heat flow direction and finally the R-value and thickness of the Expanded Polystyrene Board (item 4.1 - 4.4).

F0200 - SUSPENDED CONCRETE SLAB





Air Layer Floor Insulation Layer

ICANZ System Reference F0200

Structure

Concrete suspended floor, 150mm thick with no covering and a subfloor of 0.5m in depth.
Decorative faced board or blanket; Concrete with fibrous board or blanket insulation suspended below
Un-faced board or blanket with vapour permeable membrane: Fibrous board or blanket insulation with a vapour permeable membrane below.
Foil-faced board or blanket: Concrete with foil faced fibrous board or blanket insulation suspended below and foil facing down
Single-sided foil: Concrete, air gap (ranges from 0 to 100mm), single-sided foil (foil facing down)
Double-sided antiglare: Concrete, air gap (ranges from 0 to 100mm), double-sided antiglare (bright foil facing down)
Double-sided bubble foam foil: Concrete, air gap (ranges from 0 to 100mm), double-sided bubble foam foil (bright foil facing down)
PIR insulation board: Concrete with foil faced PIR board suspended below (foil facing down)
Double sided antiglare EPS board: Concrete, 20mm air gap, double sided antiglare EPS board (bright foil facing down)

Insulation installation

Bulk insulation blankets or boards can be fixed to the bottom of the concrete using suitable non-conductive fixings with the foil surface facing down. Reflective foil laminates can be fixed to underside of battens to create an air gap above the membrane as outlined in the tabulated values. Other fixing methods can be adopted ensuring a consistent air cavity void is maintained between the slab and foil.
Foils installed with an upper air cavity between the concrete floor and the reflective membrane may have an upward facing bright or antiglare surface which will improve the performance of the air gap. Single side or double sided foil membranes are based on having the brightest highly reflective surface facing downwards to the subfloor air space. When using membranes in floors, they shall have min 150mm overlap in accordance with AS/NZS 4200.2 and may require taping to prevent ingress of unwanted particulates, prevent convection air movements and air transported water vapour travelling between multiple air cavities separated by the membrane. Insulation boards abutted together may require taping for the same reasons as pliable membranes.
In the under joist case the membrane may incorporate upward and downward facing low emissivity surfaces to increase the Total R-value. Any membrane installed in this manner with an upward facing low emissivity bright or antiglare surface when installed with bulk insulation fully filling the joist space above will not contribute any R-value. When bulk insulation is being installed a non-reflective vapour permeable membranes can be used on the underside of floor insulation to allow moisture to escape from the floor system while preventing excessive R-value reductions due to wind washing. Non-reflective membranes in conjunction with bulk insulation will not contribute to the calculated R-value in accordance with AS 4859. However, in practice, vapour permeable air barriers are particularly beneficial in systems with open or well ventilated subfloors.
Floor insulation shall be installed to maintain its position and thickness, other than where it is cut to fit or compressed by water pipes, waste pipes electrical cabling or the like. Bulk insulation nominal thickness greater than joist depth and areas around services may have insulation crushed resulting in loss of thermal performance and risk membrane failure. It is recommended that bulk insulation be cut around (chase insulation around) these obstructions.
Enclosed subfloors are considered to be non-ventilated for thermal calculation purposes only. However varying environmental conditions may allow venting to subfloors, thereby affecting the claimed performance of the application. **Poor treatment or fitment of floor penetrations, water pipes, waste pipes, electrical cabling and insulation installation workmanship may affect thermal performance. Poor sealing of floor penetrations may affect total thermal performance.** Effectiveness of membranes for heat, air and moisture control require any tears or gaps to be repaired with a suitable non shrink tape to maintain a seal to control ingress and/or egress of: liquid water, water vapour, air infiltration, and ember entry; refer to ICANZ sarking manufacturer for advice.
Reflective foil performance will be reduced by poor sealing of lap joints, tears and gaps allows venting between subfloor air and joist air cavities affecting the claimed thermal performance of the adjoining air cavities.

Notes

- **⚠ Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Unventilated floor is assumed to be an enclosed subfloor with full perimeter walls with up to 6000mm²/m of ventilation openings and a subfloor height of 0.5m.
- Condensation risks may result within floor structures using tightly sealed vapour barriers positioned under floors. Subfloors can be excessively humid due to high soil moisture content which can lead to condensation forming on both the upper and lower surfaces of the foil. The likelihood of this occurring can be reduced

by using open subfloors or mechanical subfloor ventilation systems. This can occur in all climates and designers should be aware that adequate drying paths are essential and can be achieved through a combination of controlled air movement and vapour permeable construction materials. Please consult an ICANZ member for alternative drying methods in subfloors.

- The effects thermal bridging or gaps in the bulk insulation layer due to sanitary piping, electrical cables, and services obstructing or limiting floor insulation coverage are not considered within the thermal calculations.
- The effects of air leakage due to leaks around sanitary piping, electrical cables, and services that penetrate the flooring or membranes are not considered within the calculations.

Element No.	Table 1	FIBROUS INSULATION BOARDS OR BLANKETS											
		DECORATIVE FACED BOARD/BLANKET				NON-FACED BOARD/BLANKET & VAPOUR PERMEBALE MEMBRANE				FOIL FACED BOARD/BLANKET			
		No bulk insulation				No bulk insulation				No bulk insulation			
		Enclosed		Open		Enclosed		Open		Enclosed		Open	
		F0200NVW	F0200NVS	F0200VW	F0200VS	F0210NVW	F0210NVS	F0210VW	F0210VS	F0220NVW	F0220NVS	F0220VW	F0220VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11
2	Concrete slab (150mm)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
3.0	Blanket R-value (refer to table below)												
4	Membrane material R-value					0.00	0.00	0.00	0.00				
5	Subfloor air film	0.16	0.11	0.08	0.08	0.16	0.11	0.08	0.08	0.16	0.11	0.08	0.08
6	Ground thermal resistance	0.58	0.56			0.58	0.56			0.58	0.56		
	Total R-value **WITHOUT** insulation	1.0	0.88	0.34	0.29	1.0	0.88	0.34	0.29	1.0	0.88	0.34	0.29
	Total R-value **WITH** added board or blanket insulation												
3.1	R1.4 Board or Blanket	2.5	2.2	1.8	1.7	2.5	2.2	1.8	1.7	3.1	2.4	1.8	1.7
3.2	R1.8 Board or Blanket	2.9	2.6	2.2	2.0	2.9	2.6	2.2	2.0	3.5	2.8	2.2	2.0
3.3	R2.5 Board or Blanket	3.6	3.3	3.0	2.7	3.6	3.3	3.0	2.7	4.2	3.4	3.0	2.7
3.4	R3.0 Board or Blanket	4.1	3.8	3.5	3.2	4.1	3.8	3.5	3.2	4.8	3.9	3.5	3.2

Element No.	Table 3	RIGID BOARD SYSTEM			
		PIR INSULATION BOARD			
		No bulk insulation			
		Enclosed		Open	
		F0230NVW	F0230NVS	F0230VW	F0230VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11
2	Concrete slab (150mm)	0.10	0.10	0.10	0.10
3.0	PIR board R-value (refer to table below)				
4	Subfloor air film	0.16	0.11	0.08	0.08
5	Ground thermal resistance	0.58	0.56		
	Total R-value **WITHOUT** insulation	1.0	0.88	0.34	0.29
	Total R-value **WITH** added PIR board insulation				
3.1	R1.4 Reflective PIR (30mm)	3.0	2.4	1.7	1.7
3.2	R2.3 Reflective PIR (50mm)	3.9	3.3	2.6	2.6
3.3	R3.6 Reflective PIR (80mm)	5.3	4.6	4.0	3.9
3.4	R5.5 Reflective PIR (120mm)	7.1	6.5	5.8	5.7

Element No.	Table 2	FOIL MEMBRANE SYTEM WITH SPACER											
		SINGLE-SIDED FOIL				DOUBLE-SIDED ANTIGLARE				DOUBLE-SIDED BUBBLE/ FOAM R_m0.2			
		Without air gap				Without air gap				Without air gap			
		Enclosed		Open		Enclosed		Open		Enclosed		Open	
		F0250NVW	F0250NVS	F0250VW	F0250VS	F0260NVW	F0260NVS	F0260VW	F0260VS	F0270NVW	F0270NVS	F0270VW	F0270VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11
2	Concrete slab (150mm)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
3.0	Air gap												
4	Membrane material R-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20
5	Subfloor air film	0.80	0.23	0.08	0.08	0.80	0.23	0.08	0.08	0.80	0.23	0.08	0.08
6	Ground thermal resistance	0.58	0.56			0.58	0.56			0.58	0.56		
	Total R-value **WITHOUT** insulation	1.6	1.0	0.34	0.29	1.6	1.0	0.34	0.29	1.8	1.2	0.54	0.49
	Total R-value **WITH** increasing air gap												
3.1	25mm air gap	1.8	1.2	0.53	0.44	2.2	1.4	0.92	0.67	2.4	1.6	1.1	0.9
3.2	100mm air gap	1.8	1.1	0.55	0.44	2.6	1.4	1.3	0.66	2.7	1.6	1.5	0.8

Element No.	Table 4	RIGID BOARD SYSTEM			
		DOUBLE-SIDED ANTIGLARE EPS BOARD			
		Enclosed		Open	
		F0240NVW	F0240NVS	F0240VW	F0240VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11
2	Concrete slab (150mm)	0.10	0.10	0.10	0.10
3	20mm Air gap	0.58	0.44	0.58	0.42
4	10mm EPS board	0.25	0.24	0.25	0.24
5	Subfloor air film	0.80	0.23	0.08	0.08
6	Ground thermal resistance	0.58	0.56	0.00	0.00
	Total R-value **WITHOUT** insulation	2.5	1.7	1.2	0.96
	Total R-value **WITH** added EPS board insulation				
4.1	R0.4 EPS board (15mm)	2.6	1.8	1.3	1.1
4.2	R0.5 EPS board (20mm)	2.7	1.9	1.4	1.2
4.1	R0.7 EPS board (30mm)	3.0	2.2	1.7	1.5
4.2	R1.5 EPS board (60mm)	3.7	3.0	2.4	2.2

Table 1 - Floor Board/Blanket Performance

The Total R-values presented in this table is based on first selecting the type of blanket/board fixed to the underside of the slab, second, the type of subfloor openness, third, the heat flow direction and finally the R-value of the insulation (item 3.1 - 3.4).

Table 2 - Floor Membrane Performance

The Total R-values presented in this table is based on first selecting the type of membrane to be fixed under the slab using spacers, second, the type of subfloor openness, third, the heat flow direction and finally the depth (item 3.1 or 3.2) of the air gap formed by the spacer system.

Table 3 - PIR Board Performance

The Total R-values presented in this table is based on first selecting the type of subfloor openness, second, the heat flow direction and finally the R-value and thickness of the PIR Board (item 3.1 - 3.4).

Table 4 - EPS Board Performance

The Total R-values presented in this table is based on first selecting the type of subfloor openness, second, the heat flow direction and finally the R-value and thickness of the Expanded Polystyrene Board (item 4.1 - 4.4).

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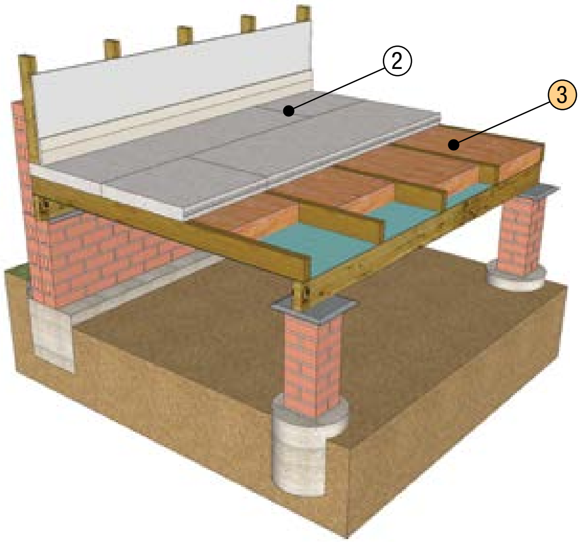
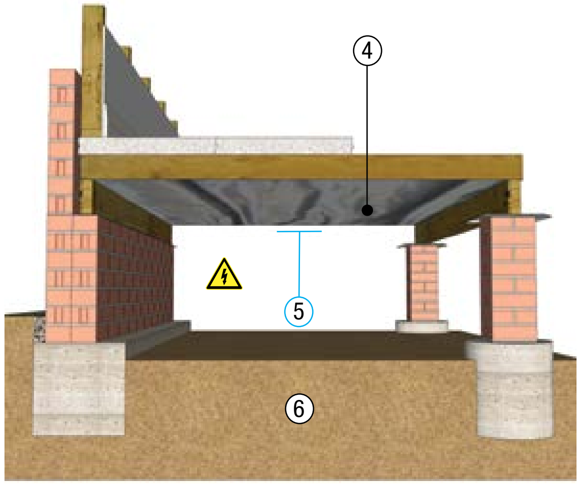
F0300 - SUSPENDED AUTOCLAVED AERATED CONCRETE FLOOR PANEL (AAC)





Air Layer   Floor Insulation Layer

ICANZ System Reference F0300

Structure

Aerated Autoclaved Concrete floor consisting of 75mm re-in forced panel flooring fixed directly over 90mm floor joist with no floor covering. Bearers will vary depending on their required span and spacing. With no membrane in the flooring system there is no air gap formed. The subfloor cavity will have an associated ground resistance for enclosed subfloors. The following dimensions apply to the base floor construction in order to calculate their respective air cavity R-value equivalent when membranes or insulation boards are incorporated:
Taut membranes under joists: 90mm (joist air gap)
Membranes over joists: 0mm – 100mm (air gap created by drape)
Double-sided antiglare EPS board: 90mm (joist air gap)

Insulation installation

Bulk insulation has been assumed to fill the entire joist space of 90mm when used. Thermal performance of air gaps created by membranes has been calculated for two different installation methods; draped over joists and installed below joists. When used with bulk insulation the membrane may be installed over the top of the bearers on the underside of the floor joists, the insulation can then be fitted snugly between the joists before the floor is laid. Alternatively foils can be used without bulk insulation and rolled out over the top of the floor joists and draped to create an air void and associated thermal benefit.
Foils draped over the joists may have an upward facing bright or antiglare surface which will improve the performance of the upper air gap. Single side or double sided foil membranes are based on having the brightest highly reflective surface facing downwards to the subfloor air space. When using membranes in floors, they shall be installed in accordance with AS/NZS 4200.2 and may require taping to prevent ingress of dust, convection air movements and air transported water vapour travelling between multiple air cavities separated by the membrane.
Membranes installed under the joists may incorporate upward and downward facing foil surfaces to increase the Total R-value. Any membrane installed in this manner with an upward facing bright foil or antiglare foil surface when installed with bulk insulation fully filling the joist space above will not contribute any R-value for this surface. When bulk insulation is being installed vapour permeable membranes can be used on the underside of floor insulation to allow moisture to escape from the floor system while preventing excessive R-value reductions due to air movement. Vapour permeable membranes in conjunction with bulk insulation will not contribute to the calculated R-value in accordance with AS/NZS 4859.1.
Enclosed subfloors are considered to be non-ventilated for thermal calculation purposes only. However varying environmental conditions may allow venting to subfloors, thereby affecting the claimed performance of the application. Poor treatment or fitment of floor penetrations, water pipes, waste pipes, electrical cabling and insulation installation workmanship may affect thermal performance. Poor sealing of floor penetrations may affect total thermal performance. Effectiveness of membranes for heat, air and moisture control require any tears or gaps to be repaired with a suitable non shrink tape; refer to an ICANZ member for advice.

Notes

- Unventilated floor is assumed to be an enclosed subfloor with full perimeter walls with up to 6000mm²/m of ventilation openings and a subfloor height of 0.5m.
- **⚠ Installing electrically conductive insulation in close proximity to live electrical cables can present a risk of electrocution. For correct installation instructions refer to AS/NZS 3000 (Cables and Wiring), AS 3999 (Bulk insulation installation) and AS/NZS 4200.2 (Pliable building membranes - Installation requirements).**
- Condensation risks may result within floor structures using tightly sealed vapour barriers positioned under floors. Subfloors can be excessively humid due to high soil moisture content which can lead to condensation forming on both the upper and lower surfaces of the foil. The likelihood of this occurring can be reduced by using open subfloors, mechanical subfloor ventilation systems, or vapour permeable membranes. This can occur in all climates from cold to tropical and designer should be aware that adequate drying paths through a combination of controlled air movement and vapour permeable fabrics may be required. Please consult an ICANZ member for alternative drying methods in subfloors.
- Total R-values based on insulation path only covering the whole area between framing members. The effects of thermal bridging through the structure and the effects of gaps in the bulk insulation layer due to sanitary piping, electrical cables, and services obstructing or limiting floor insulation coverage are not considered within the calculations.
- The effects of air leakage due to leaks around skirting boards, sanitary piping, electrical cables, and services that penetrate the flooring or membranes as well as air leakage through floor board tongue and groove laps are not considered within the calculations.

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Element No.	Table 1	WITHOUT MEMBRANE				TAUT NON-REFLECTIVE SARKING			
		No bulk insulation				No bulk insulation			
		Enclosed		Open		Enclosed		Open	
		F0300NVW	F0300NVS	F0300VW	F0300VS	F0310NVW	F0310NVS	F0310VW	F0310VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11	0.16	0.11	0.16	0.11
2	AAC floor panel	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
3	Air gap, OR					0.21	0.14	0.21	0.14
3.0	Bulk Insulation (see table below)								
5	Sarking material R-value					0.00	0.00	0.00	0.00
6	Subfloor air film	0.16	0.11	0.08	0.08	0.16	0.11	0.08	0.08
7	Ground thermal resistance	0.58	0.56			0.58	0.56		
	Total R-value **WITHOUT** insulation	1.4	1.3	0.75	0.70	1.6	1.4	0.96	0.84
Total R-value **WITH** added insulation batts									
3.1	Floor batts R2.0 (90mm)	3.5	3.2	2.8	2.6	3.5	3.2	2.8	2.6
3.2	Floor Batts R2.5 (90mm)	4.0	3.7	3.4	3.1	4.0	3.7	3.4	3.1

Table 1 - Floor Batt Performance

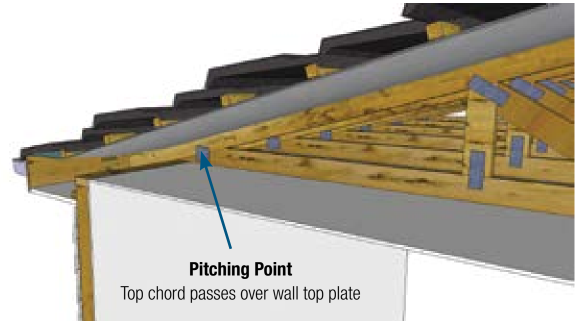
The Total R-values presented in this table is based on first selecting the type of membrane installed under the joists, second, the type of subfloor openness, third, the heat flow direction and finally the R-value batt and thickness (item 3.1 or 3.2) to fill between the joists.

Table 2 - EPS Board Performance

The Total R-values presented in this table is based on first selecting the type of subfloor openness, second, the heat flow direction and finally the R-value and thickness of the Expanded Polystyrene Board (item 4.1 - 4.4).

		BOARD FIXED UNDER JOISTS			
Element No.	Table 2	DOUBLE-SIDED ANTIGLARE EPS BOARD			
		Enclosed		Open	
		F0350NVW	F0350NVS	F0350VW	F0350VS
	Element Description:	WINTER	SUMMER	WINTER	SUMMER
1	Interior air film	0.16	0.11	0.16	0.11
2	AAC floor panel	0.51	0.51	0.51	0.51
3	Air gap	1.28	0.41	1.28	0.41
4.0	10mm EPS board	0.25	0.24	0.25	0.24
5	Subfloor air film	0.80	0.23	0.08	0.08
6	Ground thermal resistance	0.58	0.56		
	Total R-value **WITHOUT** insulation	3.6	2.1	2.3	1.4
Total R-value **WITH** added board insulation					
4.1	R0.4 EPS board (15mm)	3.7	2.2	2.4	1.5
4.2	R0.5 EPS board (20mm)	3.8	2.3	2.5	1.6
4.3	R0.7 EPS board (30mm)	4.1	2.5	2.8	1.8
4.4	R1.5 EPS board (60mm)	4.8	3.3	3.5	2.6

PERIMTER INSULATION

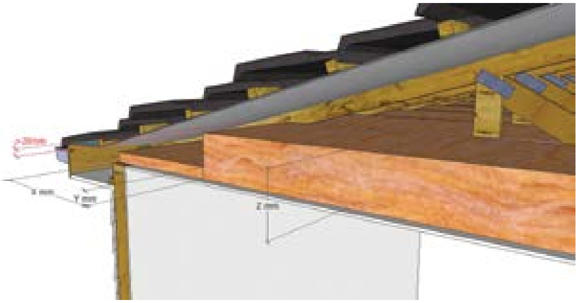


Specialised perimeter insulation batts will be required when the top chord passes directly over the pitching point of the truss. AS 3999 requires a 20mm clearance between the insulation and roof sarking, cladding or roof insulation treatment. This is required as to not restrict air flow from under eave vents as well as to prevent the tracking of liquid condensate from the underside of sarking materials, roof sheeting or roof battens or in extreme climates condensation might even be able to form under roof cladding insulation treatments.

Excess condensation forming on the underside of roof claddings and sarking materials raise risks of excess moisture dripping onto insulation layers below. This can result in; insulation performance degradation, timber rot, nail plate pull-out and structural weakening, mould growth and mildew within the roof structure and high levels of moisture content in the plasterboard resulting in visible ceiling mould.

Under most operating conditions in most climates in Australia it is unlikely that condensation will form under foil faced blankets installed hard up against the cladding as per ICANZ R0200 series. A clearance is still required to allow for under eave ventilation strategies in this case.

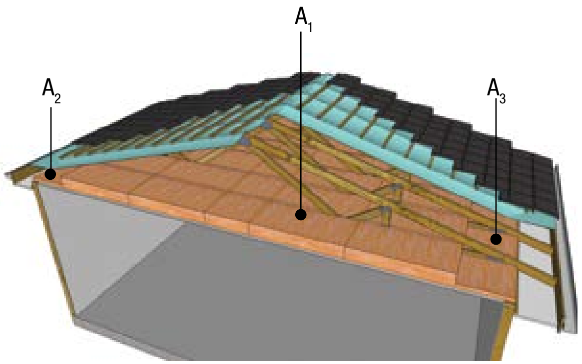
Uninsulated metal roofs have a high risk of condensation forming in all climates in Australia and for optimum condensation control a foil faced blanket is recommended. In cases where foil sarking is used under metal sheet roofing it will provide little protection against condensation forming on the underside of the sarking and condensation risk should be treated as if it were metal sheeting only.



The methods considered suitable for insulating the perimeter of ceilings include utilising high density wall batts available in thickness from 70mm to 90mm as shown by dimension Y in figure 2. The R-values of wall batts range from R1.5 to R2.7. These wall batts may be used to create a perimeter width of either 430mm or 580mm as shown by dimension X in figure 2. Dimensions of 430mm and 580mm are the standard widths of ceiling and wall batts.

As roof trusses cannot typically accommodate the full thickness to accommodate required R-value at the perimeter as per the regulatory requirements, AS 3999 sets out a calculation methodology to account for loss of thermal performance due to lowered perimeter R-values.

Figure 3 and equation 1 below highlight the method by which ceiling insulation may need to be adapted to meet regulatory compliance accounting for perimeter insulation. Alternatively a truss design shown in R0100 or R0200 can be used to eliminate the need for corrections.



The overall total R-value can be calculated using the following calculation:

$$R_T = \frac{A_T}{\frac{A_1}{R_1} + \frac{A_2}{R_2} + \dots\dots\dots + \frac{A_x}{R_x}}$$

where

A_T = total area of ceiling

A_1 = area of insulation with value R_1

A_2 = area of insulation with value R_2

A_x = area of insulation with value R_x

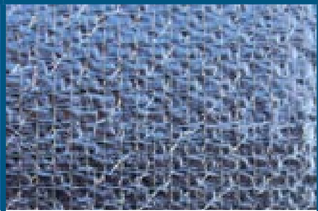
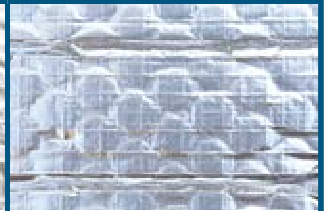
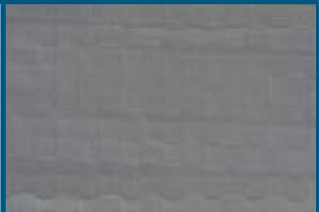
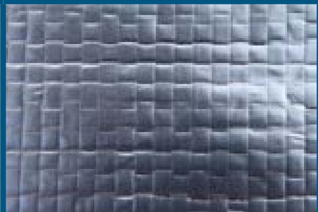
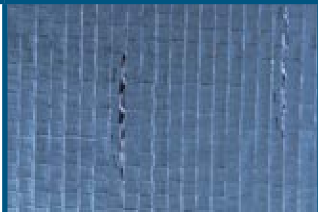
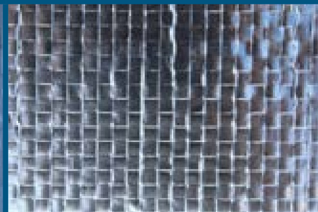
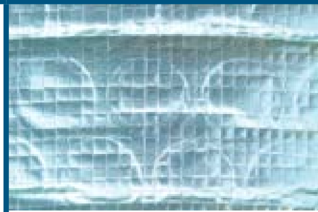
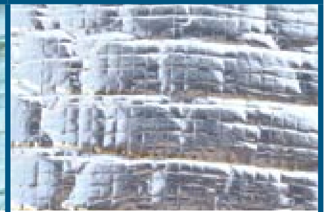
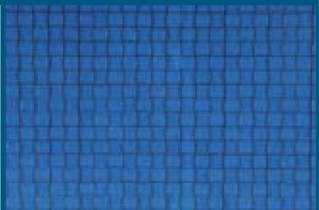
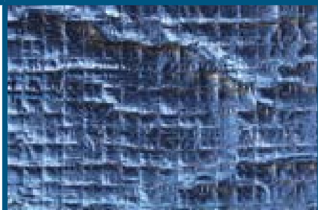
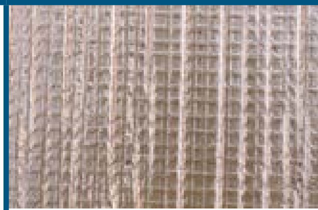
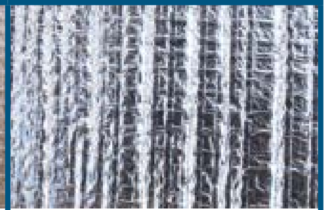
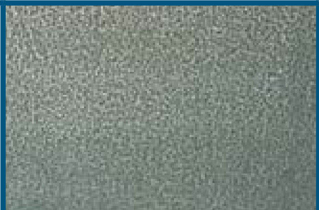
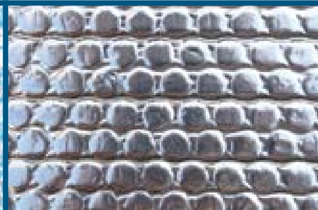
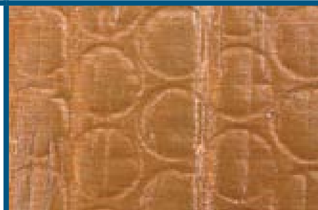
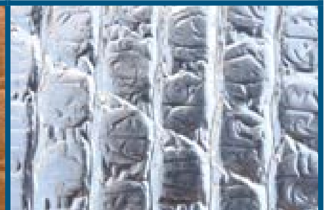
R_T = overall total thermal value of entire ceiling

R_1 = thermal value for insulation covering area A_1

R_2 = thermal value for insulation covering area A_2

R_x = thermal value for insulation covering area A_x

The emissivity values indicated below represent the average of at least four measurements undertaken using Normal Emittance Measurements According to ASTM E408 on the surface shown. Membrane samples were bought from builder's trade outlets. The images give an indication of the visual appearance of low emissivity; anti-glare and non-reflective surfaces. The images aim to highlight that emissivity cannot be determined by the visual appearance of the surface alone as it is a property that falls outside humans visual spectrum and can only be determined with the correct equipment

	Dull Side	Bright Side		Dull Side	Bright Side		Dull Side	Bright Side
(1) Single Side Foil	 e0.82	 e0.05	(6) Double Side Foil	 e0.15	 e0.04	(11) Bubble Foil	 e0.07	 e0.07
(2) Single Side Foil	 e0.5	 e0.07	(7) Double Side Foil	 e0.05	 e0.03	(12) Bubble Foil	 e0.13	 e0.17
(3) Single Side Foil	 e0.88	 e0.02	(8) Cellular Foam Foil	 e0.08	 e0.07	(13) Cellular Foam Foil	 e0.07	 e0.06
(4) Double Sided Foil	 e0.11	 e0.02	(9) Bubble Foil	 e0.16	 e0.06	(14) Bubble Foil	 e0.16	 e0.04
(5) Double Sided Foil	 e0.15	 e0.02	(10) Cellular Foam Foil	 e0.09	 e0.05	(15) Glasswool Faced	 e0.15	 e0.15

APPENDIX C MATERIAL PROPERTIES AND SURFACE EMISSIVITY

This appendix lists the material properties which were used in the ICANZ revision of this INSULATION HANDBOOK, Part 1: Thermal Performance Total R-value calculations for typical building applications.
Testing of 15 building membrane samples by R & D Services Inc. was used to determine the average emissivity of each membrane product type used in the calculations. There are generally 2 types of pliable building membranes used for thermal control in buildings, these are single side or double sided foils which have no material R-value and bubble foam products with an inner core material thickness and associated material R-value. From these membrane types; 4 surface emissivity types have been used in the total R-value calculations; additionally two parameters for foil faced expanded polystyrene (EPS) were tested and the reflective surface of polyisocyanurate (PIR) boards was assumed:

1. Single side or double sided foils - silver side
2. Double sided foils - anti-glare side
3. Bubble foams - silver side
4. Bubble foams - anti-glare side
5. EPS Board - silver side
6. EPS Board - anti-glare side
7. PIR Board - silver side

A total of 15 membrane samples purchased from trade retailers and were tested according to ASTM E408 using normal emissivity measurements and the values reported were the average of at least four measurements per sample.
All pliable building membranes and solid building materials for which no low emissivity surfaces are claimed were calculated with an emissivity of 0.9.
The numbers assigned to each product type low emissivity surface is listed in the table below.

Testing Results Averages		
	Tested Emissivity	
	Far IR Reflectance	Tested Emissivity
Average Bubble/Cellular Silver Side	0.94	0.06*
Average Bubble/Cellular AG Side	0.9	0.1
Average Laminate Silver Side	0.96	0.04
Average Laminate AG Side	0.92	0.08
Manufacturer Claimed EPS Board Silver Side	0.97	0.03
Average EPS AG Side	0.96	0.04
Average EPS AG Side	≥0.95	≤0.05

*For the purpose of calculating the value of bubble foam foils used as sarking under roof cladding with an attic space below, an emissivity of 0.05 is required to achieve a reflective attic space and improved summer R-values. An emissivity of 0.06 as calculated from the average test results for this type of material will not meet the 0.05 emissivity requirement and a non-reflective attic space will result. For the purposes of attic space calculations 0.05 emissivity for bubble foam foils has been used.

Generally glasswool is faced with a single side foil product. Therefore it has been assumed that all glasswool facings have emissivity values equivalent to single side foil products.

All products which will be used for calculations within this guide are outlined in the table on the opposite page.

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Material Thermal Properties	Thickness	R-value	Emissivity Internal	Emissivity External
	mm	m2.K/W	Downward	Upwards
Brickwork, up/extruded	110	0.18	0.90	0.90
AAC Wall Panel	75	0.51	0.90	0.90
AAC Floor Panel	75	0.51	0.90	0.90
AAC Blockwork	250	1.87	0.90	0.90
Concrete or terra cotta tiles	19	0.02	0.90	0.90
Gyprock 10mm	10	0.06	0.90	0.90
Concrete, 2400kg/m³	150	0.10	0.90	0.90
Bitumen - roofing membrane	10	0.06	0.90	0.90
Cement render, 1 cement : 4 sand	10	0.02	0.90	0.90
Concrete blocks - hollow, dense weight	190	0.20	0.90	0.90
Fibre Cement Cladding, 4.5mm	5	0.02	0.90	0.90
Fibre Cement Weatherboard 7.5mm	8	0.03	0.90	0.90
Plywood, 10mm	10	0.07	0.90	0.90
Steel sheeting, 0.42mm	0	0.00	0.90	0.90
Timber Tongue and Groove Flooring	19	0.12	0.90	0.90
Double Sided Refelctive Foil	n/a	n/a	0.04	0.08
Single Sided Reflective Foil	n/a	n/a	0.04	0.90
Non-Reflective Membrane	n/a	n/a	0.90	0.90
Bubble Foil, R_m0.2	7	0.20	0.05	0.10
Bubble Foil, R_m0.2	7	0.20	0.06	0.10
Thermo Cellular Foil R0.14	7	0.14	0.06	0.10
Thermo Cellular Foil R0.12	4	0.12	0.06	0.10
Thermo Cellular Foil R0.15	5.5	0.15	0.06	0.10
Thermo Cellular Foil R_m0.20	6.5	0.20	0.06	0.10
Thermo Cellular Foil R_m0.25	8	0.25	0.06	0.10
Glasswool Blanket R1.3	60	1.30	0.90	0.90
Glasswool Blanket R1.4	70	1.40	0.90	0.90
Glasswool Blanket R1.8	80	1.80	0.90	0.90
Glasswool Blanket R2.3	100	2.30	0.90	0.90
Glasswool Blanket R2.5	100	2.50	0.90	0.90
Glasswool Blanket R3.0	130	3.00	0.90	0.90
Glasswool Blanket R3.3	140	3.30	0.90	0.90
Glasswool Blanket R3.6	145	3.60	0.90	0.90
Foil Faced Glasswool Blanket R1.3	60	1.30	0.04	0.90
Foil Faced Glasswool Blanket R1.4	70	1.40	0.04	0.90
Foil Faced Glasswool Blanket R1.8	80	1.80	0.04	0.90
Foil Faced Glasswool Blanket R2.3	100	2.30	0.04	0.90
Foil Faced Glasswool Blanket R2.5	100	2.50	0.04	0.90
Foil Faced Glasswool Blanket R3.0	130	3.00	0.04	0.90
Foil Faced Glasswool Blanket R3.3	140	3.30	0.04	0.90
Foil Faced Glasswool Blanket R3.6	145	3.60	0.04	0.90
Cavity Wall Glasswool Blanket R0.45	15	0.45	0.90	0.08
Cavity Wall Glasswool Blanket R0.45	15	0.45	0.08	0.90

Material Thermal Properties	Thickness	R-value	Emissivity Internal	Emissivity External
	mm	m2.K/W	Downward	Upwards
Ceiling Batts R2.0	115	2.00	0.90	0.90
Ceiling Batts R2.5	140	2.50	0.90	0.90
Ceiling Batts R3.0 (Cathedral)	120	3.00	0.90	0.90
Ceiling Batts R3.0	165	3.00	0.90	0.90
Ceiling Batts R3.5	185	3.50	0.90	0.90
Ceiling Batts R4.0	215	4.00	0.90	0.90
Ceiling Batts R5.0	240	5.00	0.90	0.90
Ceiling Batts R6.0	260	6.00	0.90	0.90
Ceiling Batts R7.0	290	7.00	0.90	0.90
Commercial Acoustic Ceiling Glasswool R1.2	50	1.20	0.90	0.90
Commercial Acoustic Ceiling Glasswool R1.7	75	1.70	0.90	0.90
Commercial Acoustic Ceiling Glasswool R2.5	110	2.50	0.90	0.90
Commercial Acoustic Ceiling Glasswool R2.0	75	2.00	0.90	0.90
Wall Batts R1.5	75	1.50	0.90	0.90
Wall Batts R2.0	70	2.00	0.90	0.90
Wall Batts R2.0	75	2.00	0.90	0.90
Wall Batts R2.0	90	2.00	0.90	0.90
Wall Batts R2.1	70	2.10	0.90	0.90
Wall Batts R2.2	75	2.20	0.90	0.90
Wall Batts R2.5	90	2.50	0.90	0.90
Wall Batts R2.7	90	2.70	0.90	0.90
Wall Batts R4.0	140	4.00	0.90	0.90
Masonry Wall Blanket R0.75 LD Faced In	25	0.75	0.04	0.90
Masonry Wall Blanket R1.1 LD Faced In	38	1.10	0.04	0.90
Masonry Wall Blanket R1.2 LD Faced In	40	1.20	0.04	0.90
Masonry Wall Blanket R1.5 LD Faced In	50	1.50	0.04	0.90
Masonry Wall Blanket R1.8 LD Faced In	63	1.80	0.04	0.90
EPS Board	10	0.25	0.03	0.04
EPS Board	15	0.37	0.03	0.04
EPS Board	20	0.49	0.03	0.04
EPS Board	30	0.74	0.03	0.04
EPS Board	60	1.47	0.03	0.04
PIR Foam R0.9	20	0.91	0.05	0.05
PIR Foam R1.4	30	1.36	0.05	0.05
PIR Foam R1.8	40	1.82	0.05	0.05
PIR Foam R2.3	50	2.27	0.05	0.05
PIR Foam R2.7	60	2.73	0.05	0.05
PIR Foam R3.2	70	3.18	0.05	0.05
PIR Foam R3.6	80	3.64	0.05	0.05
PIR Foam R5.5	120	5.45	0.05	0.05

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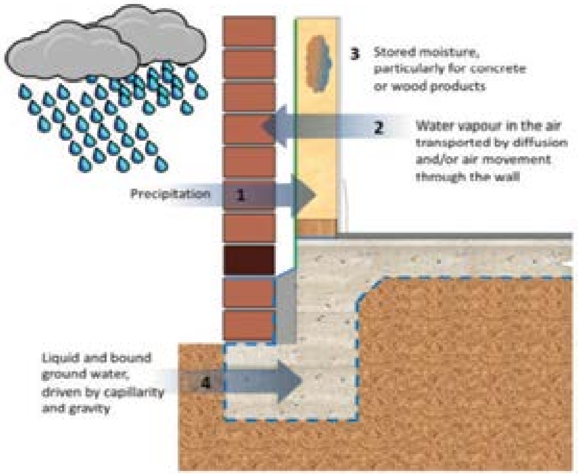


Figure A - Wetting Mechanisms for a Wall

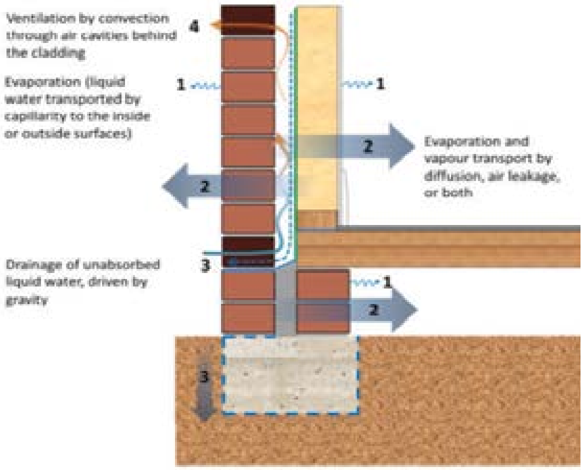


Figure B - Drying Mechanisms for a Wall

Climate

The climate in which the building resides is critical to understanding how much moisture is naturally occurring in the air. Understandably tropical climates have large amount of moisture in the air which presents a high risk of condensation if the air comes into contact with cooler surfaces. In cool climates the ability of the air to hold moisture is reduced but the likelihood of humid air coming in contact with low temperature surfaces is increased which also presents a high risk. It is essential that the climate in which the building resides is well understood before choosing the construction type and material properties.

There are various methods to calculate interstitial condensation risk for walling systems including ISO 13788 or alternatively specialist consultant opinions can be sought. This risk is strongly dependant on the external climate conditions and the vapour permeability of the construction elements. The risk can be eliminated with appropriate drying paths, vapour permeable membranes and/or reconfiguration of the system materials and insulation layers. Refer to the Australian Building Codes Board (ABCB) Condensation Handbook Version 2 for more information.

Heat, Air and Moisture Control

Water vapour in the air can be transported via air movement or vapour diffusion through building materials and can manifest itself as chronic mould or structural rot issues in buildings. Mould and fungi growth, including wood rotting fungi can result at relative humidity above 70%; water logging of porous building materials can result when water vapour comes into contact with cool surfaces which are cold enough to produce surface condensation or interstitial condensation within the construction system. The temperature at which condensation occurs is known as the dew point temperature and is always changing depending on the air temperature and the relative humidity.

System design and installation levels are critical in controlling the critical surface temperature in which condensation might occur. It is essential that the insulation selected has appropriate dimensions for the application, is not compressed, thermal bridges are minimised, the insulation has sufficient integrity and the insulation is suitably fixed in position. Insulation integrity ensures the insulation does not slump in wall cavities, cathedral roofs or compress over time under its own weight. The installation methodology set out in AS3999 should be followed.

To limit the amount of air transported water vapour ingress into construction systems and therefore reduce the risk of interstitial condensation it is essential that air control measures are taken such as lapping, sealing and taping of sarking and wall wraps and potentially even sealing at bottom plate and wall ceiling junctions. Please contact an ICANZ member for further information.

ICANZ System Type

Your construction system chosen from this guide will affect the ability of structure to control heat, control air and control moisture transfer through the structure. The ability of the materials to allow water vapour to transfer through the materials can provide a suitable mechanism for any accumulation of moisture to exit the building structure. These are known as permeable building products and vary widely in the range of water vapour transfer. As water trapped in the construction evaporates into water vapour during periods of warm weather permeable building products allow the water vapour to escape through the product.

As a general rule, the design of construction systems should always allow for at least one drying path. A drying path is considered as a mechanism to evaporate and shed the build-up of moisture within porous building products or surface condensation on impermeable products. This is achieved by having a series of high permeability products on at least one side of the insulation layer to allow water vapour to either diffuse inwards into the habitable spaces or outwards into a cavity or the external environment.

Traditionally drying has been achieved through the use of ventilated cavities. However this only works effectively if water vapour is allowed to enter the cavity from within the construction system and is best achieved with permeable building wraps. The use of ventilated cavities can also increase energy losses if air flow in structural cavities is not controlled with well-sealed air barrier membranes. The best performing membranes are vapour permeable air barriers, allowing construction systems maintain the ability to control the air flow in the construction systems while allowing moisture to escape. This means they can appropriately control moisture and not degrade the long term operational energy performance and long term durability of structure, cladding and internal linings. Please contact an ICANZ member for further information.

Wall Systems

Figure A indicates the wetting mechanisms for a wall assembly which occurs during wet and humid conditions. Figure B indicates the drying mechanisms which can occur in appropriately designed wall systems. Please contact an ICANZ member for further information.

Roof Systems

Roof systems are very complex and the wetting and drying cycles occurring seasonally and diurnally can be of concern for the health of the home and the structural integrity. A drive for reduced costs of housing in Australia over recent decades has seen many situations where membrane products are not specified to manage liquid water and water vapour transfer in roof spaces.

There are several design errors which have become increasingly common with cost reductions and these may have long term implications for the building longevity. These include tile roofs without sarking, metal roofs without insulation treatment on the underside, roof spaces without ventilation, sarking under metal roofs installed over the battens, the use of ventilated down lights and excessive ceiling penetrations. Figure C shows the correct method of installing sarking in roofs for appropriate moisture control.

Figure C - Correct Method For Installing Membranes under roof cladding

In order to design for long term durability the wetting and drying mechanisms for the roof need to be well understood. Figure D indicates the wetting mechanisms for tiled and metal roofs. Drying mechanisms such as vapour permeable products and ventilation need to be designed into the constructions for increased longevity. Please contact an ICANZ member for further information.

Liquid Water Ingress

Little can be done when liquid water penetrates due to faulty workmanship; the designer can only be prudent and design in drying paths to counteract this possibility. However, the effect of even the most effective drying paths cannot counteract problems associated with serious liquid water ingress issues. Detailing of roof and wall flashing junctions is of primary importance. Please contact an ICANZ member for further information.

Occupancy Patterns

There is always an ongoing exchange of air between outdoors and indoors. The water vapour content of the outdoor atmosphere will in turn affect the indoor humidity conditions. Household activities potentially add water vapour to the indoor air, including common events such as washing, cooking, bathing and even breathing.

For dwellings, daily average water vapour levels indoors will depend, at a minimum on what mixes with incoming outdoor air from ventilation or air infiltration, what is added from sources indoors, how much can be diverted directly outside and the rate of removal by ongoing ventilation. All this water vapour will need to be removed from the building to avoid excessively high humidity and pertential mould growth, rot or condensation issues. In cold climates with well-sealed vapour barriers the amount of internal moisture being released from a building can be limited and the use of vapour permeable membranes should be considered.

Commonly water vapour enters the roof space and construction cavities via gaps in the internal linings and recessed fittings such as power points, down lights, HVAC grilles, exhaust fans, radiant heat lamps. This can manifest itself as condensation related issues; decreased thermal performance; decreased structural integrity and associated fungal and mould outbreaks. Please contact an ICANZ memb er for further information.

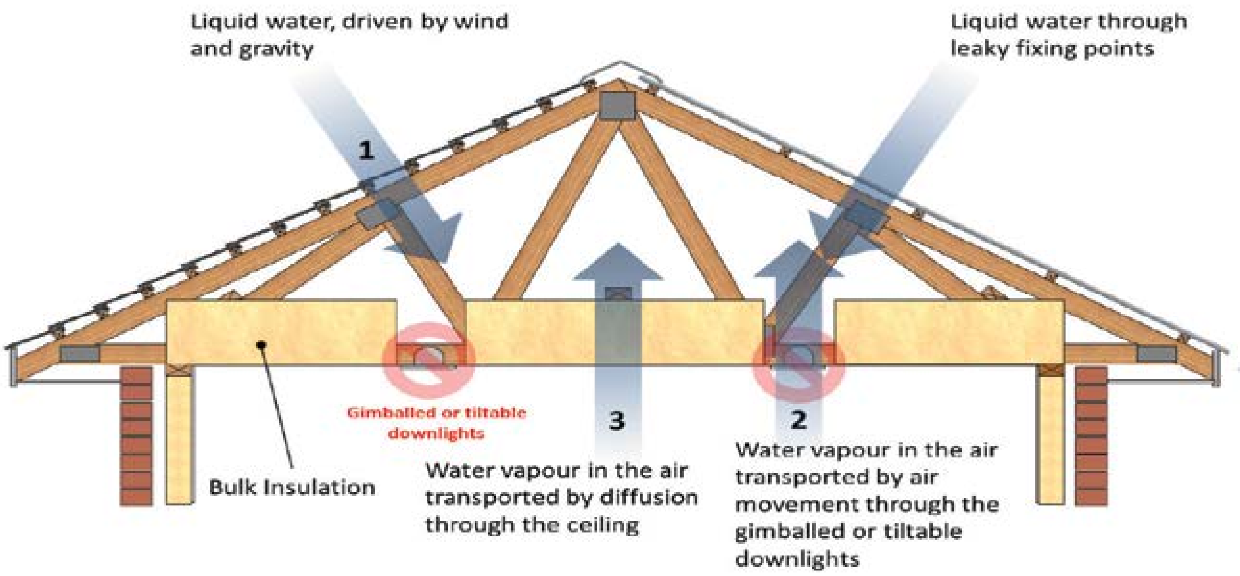
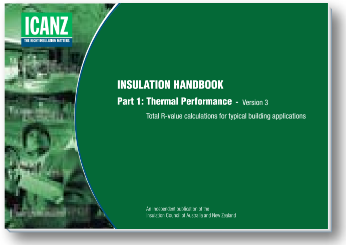
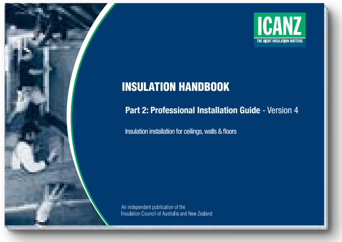


Figure D - Wetting Mechanisms for a Roof

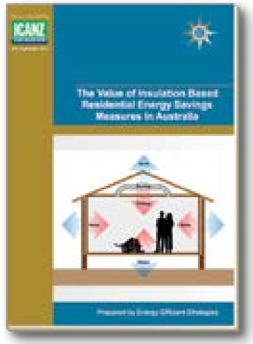
FURTHER REFERENCE STUDIES



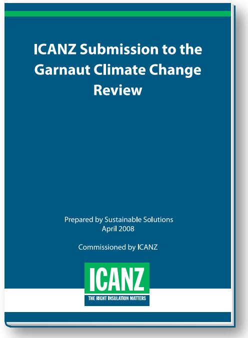
Insulation Handbook - Part 1: Version 3
Thermal Performance
Prepared by ICANZ: May 2016



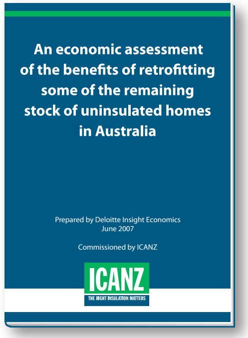
Insulation Handbook - Part 2: Version 4
Professional Installation Guide
Prepared by ICANZ: May 2016



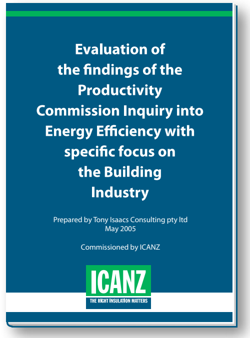
The Value of Residential Ceiling Insulation In Australia
Prepared by Energy Efficient Strategies: September 2011



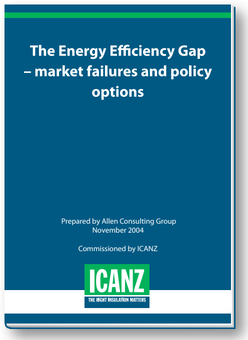
ICANZ Submission to the Garnaut Climate Change Review
Prepared by Sustainable Solutions: April 2008



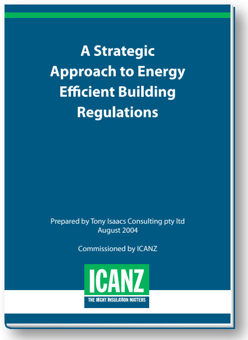
An economic assessment of the benefits of retrofitting some of the remaining stock of uninsulated homes in Australia
Prepared by Deloitte Insight Economics: June 2007



Evaluation of the findings of the Productivity Commission Inquiry into Energy Efficiency with specific focus on the Building Industry
Prepared by Tony Isaacs Consulting Pty. Ltd: May 2005



The Energy Efficiency Gap – market failures and policy options
Prepared by Allen Consulting Group: November 2004



A Strategic Approach to Energy Efficient Building Regulations
Prepared by Tony Isaacs Consulting Pty. Ltd.: August 2004

Reports available on ICANZ website:

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