Roof Insulation

RADIANT BARRIER / REFLECTIVE INSULATION

FOIL LAMINATE INDUSTRIES SDN BHD

Foil Laminate Industries Sdn Bhd

- Founded year **1999**, **24 years** experience in manufacturing Radiant Barrier and Reflective Insulation
- Factory located at **Bukit Minyak**, **Penang** and Sales Office at **Bandar Sunway**, **Selangor**
- Sold more then **100 million meter length**
- Member of Reflective Insulation Manufacturer of Malaysia (**RIMM**) under umbrella of FMM
- Award – **Asia Pacific Entrepreneurship Award 2016**

green building index · SIRIM ECO-LABEL · SIRIM MS 2095:2014 · MY HIJAU · BOMBA certified · TÜV SÜD PSB Singapore · CIDB MALAYSIA · malaysiaGBC · BUATAN MALAYSIA · REFLECTIVE INSULATION MANUFACTURERS OF MALAYSIA

Product Range

Roofing Insulation

Bubble Reflective Insulation	High Quality Kraft Paper Foil	Ppolymer Foil	Woven Foil	Eco-Green	Foam Foil
Air Tac Bubble - Foil	Tac- Foil	Brite - Foil	Matt - Foil	Ultra - Foil	Acoustic Thermal Foil

Reflective ~ Protective ~ Excellence

Product Range

Thermshield

Air Cond Ducting Insulation

Telecommunication

- **WARN-U Underground Warning Tape**

Thermal Insulation

- **Insulating Blanket & Pallet Cover**
- **Thermal Packaging**

Medical

- **Emergency Rescue Blanket (ERB)**

- **Medi Shield – Protect Wrap (Adult)**
- **Medi Shield – Baby Wrap**

Reflective ~ Protective ~ Excellence

Project Reference

High Technology & Semiconductor	Small Medium Industry	Commercial Lot	Government Building
Warehousing & Logistics	Transport Hub	Residential	Education
Health Care Centre	Community & Cultural	Sport & Recreation	Others

International Market

Reflective ~ Protective ~ Excellence

Benefits of insulated roof

- **Improve comfort**

  Through IR Reflective property
- **Energy savings**

  Reduce energy consumption

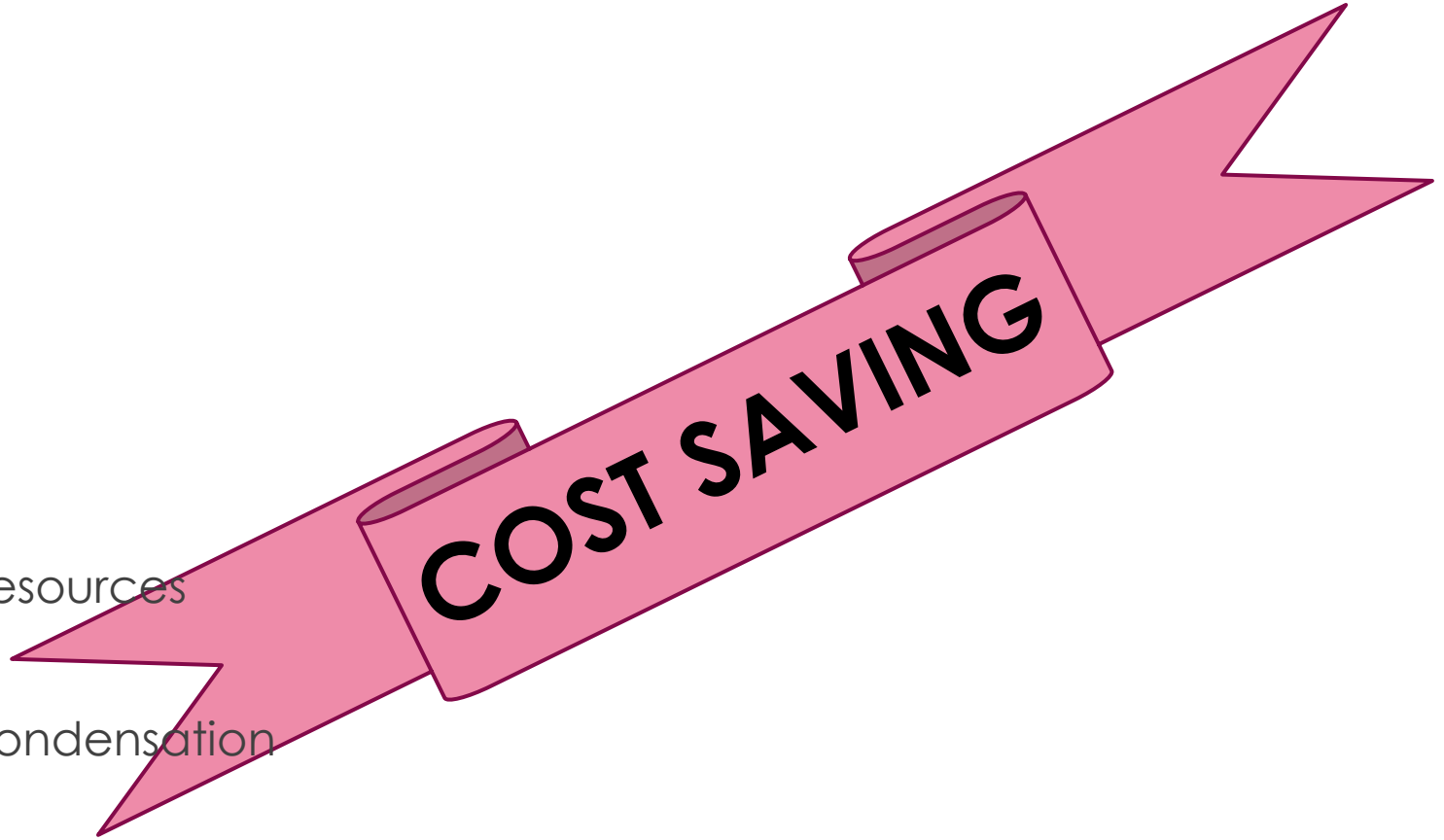
  Saves electricity cost
- **Sustainability**

  Noise Reduction Insulation

  Saves nation's limited energy resources
- **Healthier**

  Avoid dampness caused by condensation

  Prevent fungi growth



Roof Insulation

Aluminium Foil

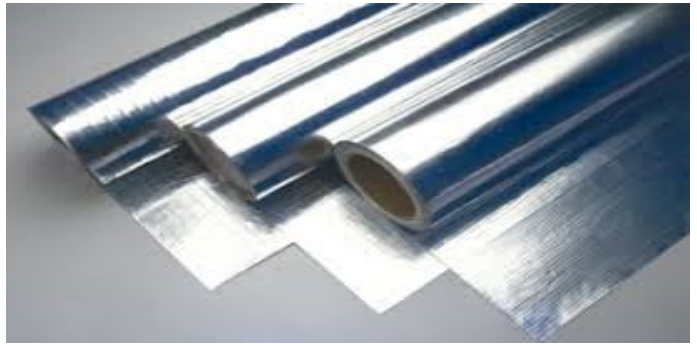
- Radiant Barrier
- Reflective Insulation

Reflective ~ Protective ~ Excellence

What is the different

Radiant Barrier

A material with a low emittance surface, when its facing an open space is defined as radiant barrier system.



Reflective Insulation

A thermal insulation system consisting of one or more low emittance surfaces, bounding one or more enclosed air spaces with measurable R-Value

MS 2095: 2022

Reflective ~ Protective ~ Excellence

How many types

- 2 types

1. Single sided

2. Double sided

Reflective ~ Protective ~ Excellence

CERTIFICATION

Domestic Authorities Certification

CIDB Certificate

BOMBA Certificate

SIRIM BS476 Part 6 & 7 Certificate

SIRIM MS2095:2014 Certificate

Green Certification

LESEN PENSIJILAN EKO-LABEL
Eco-Label Licence

No Lesen : EL000066
Licence No :

SIRIM QAS International Sdn. Bhd. dengan ini menganugerahkan kepada
SIRIM QAS International Sdn. Bhd. hereby grants to

FOIL LAMINATE INDUSTRIES SDN. BHD.
1139,LORONG PERINDUSTRIAN BUKIT MINYAK 11
TAMAN PERINDUSTRIAN BUKIT MINYAK
14100 SIMPANG AMPAT
PENANG, MALAYSIA

Lesen untuk menggunakan Tanda Eco-Label di atas barangan
a licence to use the Eco-Label Mark on
REFLECTIVE RADIANT BARRIER

Please refer to detail in the SCHEDULE

sebagai mematuhi keperluan
as complying with
KeTTHA/SIRIM-001 : 2015

Mohd Azanuddin bin Salleh
Ketua Pegawai Eksekutif
Chief Executive Officer
SIRIM QAS International Sdn. Bhd.

Tarikh Mula Pensijilan : 18 December 2015
Certified Since
Sah Sehingga : 18 December 2021
Valid Until

Tarikh Dikeluarkan : 21 October 2019
Issue Date
No Siri : 050160
Serial No

Lesen ini dianugerahkan tertakluk kepada syarat-syarat Perjanjian Pensijilan Barangan SIRIM QAS International Sdn. Bhd.
This Licence is granted subject to the provisions of the Product Certification Agreement of SIRIM QAS International Sdn. Bhd.

SIRIM ECO-LABEL Certificate

MyHIJAU · MARK

This is to certify that

FOIL LAMINATE INDUSTRIES SDN. BHD. (1435870)
1139
Lorong Perindustrian Bukit Minyak 11, Taman Perindustrian Bukit Minyak
14100 SIMPANG AMPAT
Pulau Pinang

has the rights to use the MyHIJAU Mark on the following item:

(Refer to Schedule Page for more details)

Compliance Category:
Green Label Certification (ISO 14024 Type I ECO-Labels)

Certification Scheme:
SIRIM Eco-Labelling Scheme

Certificate no.: MyHP00156/16
Issue Date: 31-12-2019
Expiry Date: 18-12-2021

This is a computer generated certificate hence no signature is required.

Malaysian Green Technology Corporation (462237-T)
No 2, Jalan 9/10, Persiaran Usahawan Seksyen 9, 43650 Bandar Baru Bangi Selangor Darul Ehsan Malaysia
T: 603-8921 0800
F: 603-8921 0801
www.myhijau.my
www.greentechmalaysia.my

This certificate is granted subject to the Terms and Condition of usage of MyHIJAU Mark certificate and label.

MyHijau Certificate

ARCHITECTURAL BUILDING MATERIALS

greenpages malaysia

MGBC

RADIANT BARRIER AND REFLECTIVE INSULATION

APPLICABLE GBI CREDITS

NRNC	EE1,, MR2, MR3
RNC	EE1, EE2, MR2, MR3
INC	EE1, MR2, MR3
NREB	EE1, MR2
IEB	EE1, MR2
INTERIORS	EE4, MR2, MR3

GREEN LABELS

ECO-LABEL

OTHER PRODUCT LABELS

CIDB

COMPANY DETAILS

FOIL LAMINATE INDUSTRIES SDN BHD

HEAD OFFICE
1139, Lorong Perindustrian Bukit Minyak 11,
Taman Perindustrian Bukit Minyak, 14100
Simpang Ampat, Pulau Pinang, Malaysia.

TEL +604 5011 999
FAX +604 5011 991
EMAIL marketing@foil-laminate.com
WEB www.foil-laminate.com

SALES OFFICE
No. 11 (Ground & 1st Floor)
Jalan PJS 9/5, Bandar Sunway, 46150 Petaling Jaya, Selangor, Malaysia.

TEL +603 5621 4068
FAX +603 5621 4878

WHY IS IT GREEN?
- Effective Radiant Barrier and Reflective Insulation with ≥ 95% of reflectivity.
  Radiant Barrier and Reflective Insulation as known as Aluminium Foil, which effectively reflects a substantial percentage of radiant heat, thus minimizes heat conduction and convection.
- Energy efficiency. Low radiant emissivity significantly improves the building energy efficiency.
- High recycled and non-toxic content.

PRODUCT FEATURES
Pure Aluminium. Pure aluminium is used for its superior reflectivity properties. Such reflection reduces a tremendous amount of heat transmission into a building, which can provide substantial energy saving.
High Tensile Strength. Reinforcement and toughest thermal insulation materials are used giving it the high tensile strength and better performance especially during installation.
Non Thermal Conductor Material. Radiant barrier aluminium foil is produced by using non thermal conductor material (Paper, Woven, Bubble or Film) thus prevent heat-generating inside the building particularly from sunlight.
Light Weight and Flexible. Other Outstanding Features:
- **Fire retendent**
- **Self-support**
- **Puncture, tear and vapor resistance**
- **Prevention of insects, bacterial or fungus growth**
- **Bubble and foam range products with noise reduction feature by reducing sound transmission**

PRODUCT CERTIFICATION & COMPLIANCE
- BS 476 Part 6:1989 (Fire Propagation) & BS 476 Part 7:1997 (Surface Spread of Flame)
- Bomba Class 'O'
- MS 2095:2014 (Malaysia Standard on Radiant Barrier and Reflective Insulation Building Materials)
- CIDB Perakuan Pematuhan Standard (PPS)

14 GREENPAGESMALAYSIA 5TH EDITION

www.greenpagesmalaysia.com | www.mgbc.org.my

Green Pages Malaysia

International Certification

ZERTIFIKAT ◆ CERTIFICATE ◆ 合格证书 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

PSB Singapore

CERTIFICATE OF CONFORMITY

Product Listing Scheme* : Class 2

This Certificate is issued to

Foil Laminate Industries Sdn Bhd
1 & 3, Lorong Perda Utama 9,
Bandar Perda,
14000 Bukit Mertajam,
Penang, Malaysia

FOR

Product:	Thermal Insulation Material
Brand:	Whale
Model:	Ultra-Foil
Country of Origin:	Malaysia
Product Details:	Weight per unit area: 735 g/m² Thickness: 0.6mm Tested with the smooth face exposed to heat

which has complied with the requirements of the scheme and based on the following:

Standard(s)	Test Report(s)
British Standard 476 Part 6: 1989 British Standard 476 Part 7: 1997	PSB no. S09MEC02963/YWA & S09MEC02962/OKH (Rating: Class '0')

Vice-President (Certification Department)
TÜV SÜD PSB

Certificate No:	Date of Original Issue:	Date of Last Revision:	Date of Expiry:
012270	01/02/2010	-	28/02/2013

PSB TEST

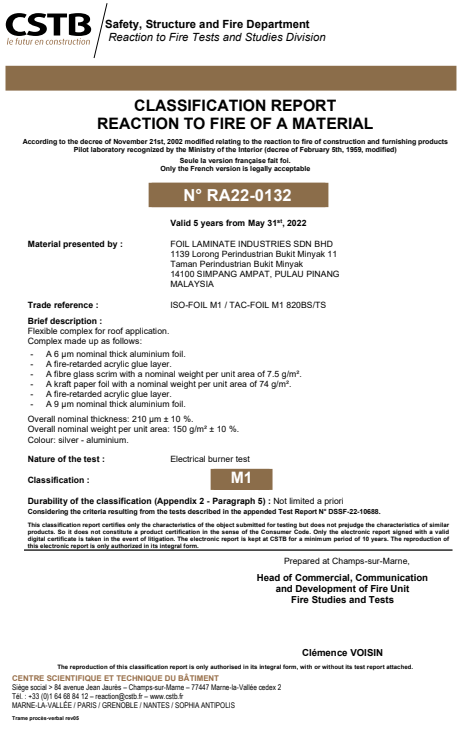
* All products listed under Class 1A/1B must have this mark affixed / printed on them. Failure to comply with this requirement may result in revocation of this certificate.

This Certificate is part of a full report and should be read in conjunction with it. This Certificate remains the property of TÜV SÜD PSB Pte Ltd and shall be returned upon request. The use of this Certificate is subjected to the terms and conditions of the Product Listing Scheme. The manufacturer is solely responsible for compliance of any product that has the same designation as the product type-tested. Persons relying on this Certificate should verify its validity by checking TÜV SÜD PSB's website at www.tuv-sud-psb.com.

TÜV SÜD PSB Pte Ltd • 1 Science Park Drive • Singapore 118221

TÜV

TUV Certificate



CSTB le futur en construction

Safety, Structure and Fire Department
Reaction to Fire Tests and Studies Division

CLASSIFICATION REPORT
REACTION TO FIRE OF A MATERIAL

According to the decree of November 21st, 2002 modified relating to the reaction to fire of construction and furnishing products
Pilot laboratory recognized by the Ministry of the Interior (decree of February 5th, 1959, modified)
Seule la version française fait foi.
Only the French version is legally acceptable

N° RA22-0132

Valid 5 years from May 31st, 2022

Material presented by : FOIL LAMINATE INDUSTRIES SDN BHD
1139 Lorong Perindustrian Bukit Minyak 11
Taman Perindustrian Bukit Minyak
14100 SIMPANG AMPAT, PULAU PINANG
MALAYSIA

Trade reference : ISO-FOIL M1 / TAC-FOIL M1 820BS/TS

Brief description :
Flexible complex for roof application.
Complex made up as follows:

- A 6 µm nominal thick aluminium foil.
- A fire-retarded acrylic glue layer.
- A fibre glass scrim with a nominal weight per unit area of 7.5 g/m².
- A kraft paper foil with a nominal weight per unit area of 74 g/m².
- A fire-retarded acrylic glue layer.
- A 9 µm nominal thick aluminium foil.

Overall nominal thickness: 210 µm ± 10 %.
Overall nominal weight per unit area: 150 g/m² ± 10 %.
Colour: silver - aluminium.

Nature of the test : Electrical burner test

Classification : **M1**

Durability of the classification (Appendix 2 - Paragraph 5) : Not limited a priori
Considering the criteria resulting from the tests described in the appended Test Report N° DSSF-22-10688.

This classification report certifies only the characteristics of the object submitted for testing but does not prejudge the characteristics of similar products. So it does not constitute a product certification in the sense of the Consumer Code. Only the electronic report signed with a valid digital certificate is taken in the event of litigation. The electronic report is kept at CSTB for a minimum period of 10 years. The reproduction of this electronic report is only authorized in its integral form.

Prepared at Champs-sur-Marne,

Head of Commercial, Communication and Development of Fire Unit
Fire Studies and Tests

Clémence VOISIN

The reproduction of this classification report is only authorised in its integral form, with or without its test report attached.

CENTRE SCIENTIFIQUE ET TECHNIQUE DU BÂTIMENT
Siège social > 84 avenue Jean Jaurès – Champs-sur-Marne – 77447 Marne-la-Vallée cedex 2
Tél. : +33 (0)1 64 68 84 12 – reaction@cstb.fr – www.cstb.fr
MARNE-LA-VALLÉE / PARIS / GRENOBLE / NANTES / SOPHIA ANTIPOLIS

Trame procès-verbal rev05

CSTB-M1 Certificate

MyHijau

- In Tandem with Malaysia Government's agenda to drive the growth of Malaysia's green economy, an announcement of green technology tax incentives in the Budget 2014 has been introduced where **Malaysia Green Technology And Climate Change Corporation (MGTC)** has been mandated to commence and verify on the Green Technology Incentives been offered.
- The purpose of this incentive is to strengthen the development of green technology through **Green Investment Tax Allowances (GITA)** for the purchase of green technology equipment / assets and Green Income Tax Exemption (GITE) for green technology service providers.
- To apply and more information, refer to the guidelines below https://www.myhijau.my/wp-content/uploads/2022/05/REC-GTGT-007-GUIDELINES-FOR-GREEN-TECHNOLOGY-TAX-INCENTIVE-GITAGITE.pdf

JKR/SIRIM STANDARD

JKR/SIRIM 1:2017

ICS: 13.020.50; 91.100

Manual for Green Product Scoring System

sub-section including the cost required for the services p

6.5. The Contractor shall submit documentary evidence of compliance with this sub-section to the S.O. within one (1) month from the date of each delivery to the Site of such materials, plant, equipment, vehicles or other goods.

7. Sustainable Materials and Products

7.1. Notwithstanding the materials and products shown on the Drawings or specified herewith, the Contractor is encouraged to propose, at no additional cost, alternative equivalent materials or "Green" products to be used in the Works, subject to the approval of the S.O., such as:

7.1.1. Environmentally friendly materials or "Green" products that are certified under the SIRIM Eco-Label certification or any labels under the Global Eco-Label Network (GEN) certification.

7.1.2. Product registered under MyHijau Mark Scheme.

7.1.3. Products self-declared "Green" by the manufacturer with certification from recognised independent certifying bodies and not a member of GEN.

7.2. The contractor shall refer to SIRIM/JKR Standard on Manual for Green Product Scoring System (GPSS) for additional information on sustainable materials and products.

Roof Thermal Transmittance Value (RTTV) Calculation

RADIANT BARRIER (RB) / REFLECTIVE INSULATION (RI)

FOIL LAMINATE INDUSTRIES SDN BHD

UBBL Amendment 2021

By-law $38_{A.}$ Energy efficiency in buildings.

[Amendment 2012]

(1) A new or renovated non-residential building with air conditioned space exceeding 4,000 square metres --

(a) shall be designed to meet the requirements of MS 1525 with regards to the Overall Thermal Transfer Value (OTTV) and the Roof Thermal Transfer Value (RTTV); and

(b) shall be provided with an Energy Management System.

[Amendment 2012]
[Amendment 2021]

(2) The roof for all buildings (residential and non-residential) shall not have a thermal transmittance (U-value) greater than --

(a) 0.4 W/m^2K for a light weight roof (below 50 kg/m^2); and

(b) 0.6 W/m^2K for a heavy weight roof (above 50 kg/m^2),
unless provided with other shading or cooling means.

[Amendment 2012]
[Amendment 2021]

MS 1525 - Roof U-Value Major Changes

Y 2014 Roof Weight Group	Y 2019 Roof Type	Max. U-Value
Light (under 50kg/m²)	Light Weight (non concrete roof construction)	0.4
Heavy (above 50kg/m²)	Heavy Weight (concrete roof construction)	0.6

Clause 4.7 : Thermal Insulation

Summary

- Use of both Mass and Reflective technologies is encouraged;
- Simple explanation on the relationships between thermal conductivity (k), thermal transmittance (U-value) and thermal resistance (R-value);
- Description of the differences between Mass Insulation technology and Reflective Insulation technology;
- Air space required for Reflective Insulation as part of its overall system or assembly R-value which relies on the low thermal conductivity of air;
- Description of the Reflective Insulation technology's principles of reflecting and re-emitting radiant heat due to the properties of high reflectivity and low emissivity.

Clause 4.7 : Thermal Insulation

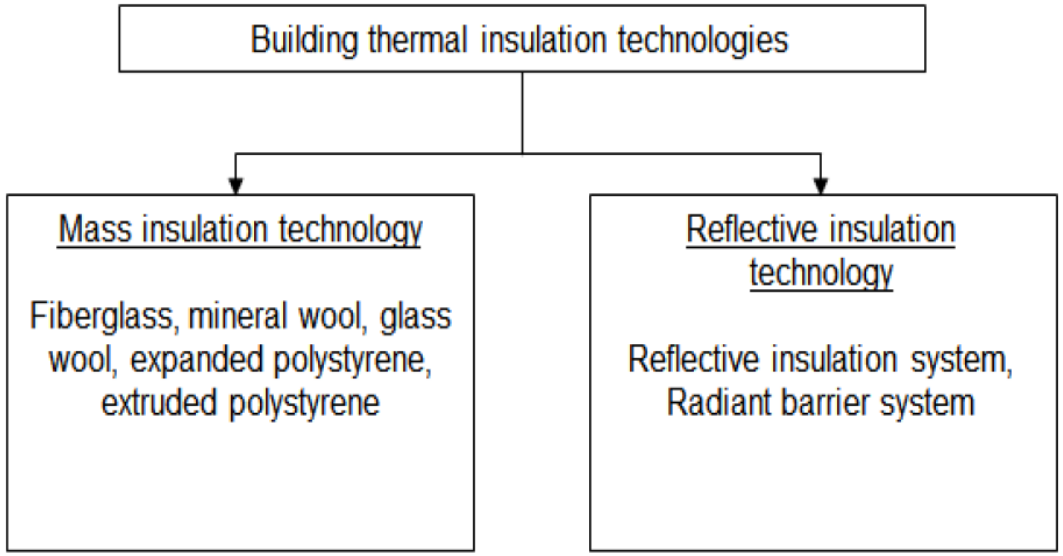


Figure 14

A combination of both technologies is recommended

Relationship between thermal conductivity (k), thermal resistance (R) and thermal transmittance (U).

k = Thermal Conductivity

$$R = \frac{\text{Material Thickness, d}}{k}$$

$$U = \frac{1}{R} = \frac{k}{d}$$

Clause 4.7 : Reflective Insulation Radiant Barriers

- Based on a composite system or assembly to derive R;
- Comprises of a low emissivity and high reflectance values;
- Reflective insulation relies on the low conductivity of air space bounded and adjacent to the low-e surfaces;
- Radiant barriers rely on large ventilated airspaces eg. attics;
- A combination of mass insulation and reflective insulation/radiant barrier is recommended.

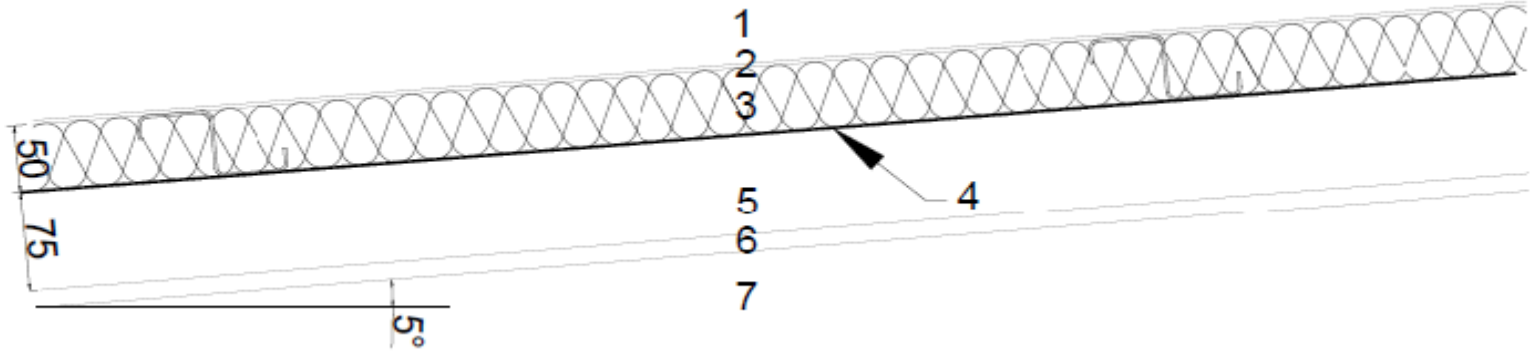
Thermal Resistance Value
Radiant Barrier

Eg.	Description	RSI (m^2K/W)
a	Radiant Barrier	Evaluated in terms of reduced heat flux (W/m^2)
b	Radiant Barrier	Value depends on selected product ε, roof angle and air gap depth
	Still Air Gap	
c	Still Air Gap	Value depends on selected product ε, roof angle and air gap depth
	Double sided Radiant Barrier	
	Still Air Gap	

Reflective ~ Protective ~ Excellence

Example

Radiant Barrier (b)



	Element	Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)
1	External Air Film	-	0.0400
2	Metal Deck	47.600	0.0000
3	Mass Insulation ***50mm x 40kg/m³***	0.036	1.3889
4	Radiant Barrier ***Single Sided (ε=0.05 Facing Down)***	-	**0.0000**
5	Rafter + Still Air Gap ***75mm***	-	**1.1360**
6	Plaster Board ***13mm Thick***	0.250	0.0480
7	Internal Air Film	-	0.1600
		Total R	**2.7729**
		U Value (1/R)	**0.3606**

Air Spaces & Attic Spaces RSI value

GUIDEBOOK ON

HOW TO CALCULATE ROOF U-VALUES

FOR LIGHTWEIGHT ROOF

(REQUIREMENT UNDER UBBL 38A)

This updated Guidebook is published by Working Committee of RIMM and GBI

14 April 2020 (Revision 1)

Reflective ~ Protective ~ Excellence

Table A2: RSI of enclosed air space for ε=0.05 (Reflectivity 95% : 5% Emissivity)

Angle (°)	RSI of Enclosed Air Space for Heat Flow Down at Tm=27.5°C, ε=0.05, ΔT=15°C (m^2K/W)																								
	Enclosed Air Space (m)																								
	0.005	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	0.050	0.055	0.060	0.065	0.070	0.075	0.080	0.085	0.090	0.095	0.100	0.105	0.110	0.115	0.120	0.125
0	0.180	0.341	0.484	0.607	0.712	0.804	0.885	0.956	1.019	1.075	1.125	1.171	1.212	1.249	1.283	1.313	1.340	1.364	1.386	1.406	1.424	1.440	1.454	1.468	1.480
5	0.180	0.341	0.483	0.602	0.700	0.781	0.847	0.901	0.947	0.988	1.025	1.057	1.086	1.112	1.136	1.158	1.177	1.194	1.210	1.225	1.238	1.250	1.262	1.272	1.282
10	0.180	0.341	0.482	0.597	0.688	0.759	0.812	0.852	0.885	0.915	0.940	0.963	0.984	1.003	1.020	1.035	1.049	1.062	1.074	1.085	1.095	1.105	1.114	1.123	1.131
15	0.180	0.341	0.481	0.592	0.677	0.738	0.779	0.807	0.831	0.851	0.869	0.885	0.899	0.912	0.925	0.936	0.946	0.956	0.965	0.974	0.982	0.990	0.997	1.005	1.012
20	0.180	0.341	0.480	0.588	0.666	0.718	0.749	0.768	0.783	0.796	0.808	0.818	0.828	0.837	0.846	0.854	0.862	0.869	0.876	0.883	0.890	0.897	0.903	0.909	0.915
25	0.180	0.341	0.480	0.583	0.655	0.700	0.722	0.732	0.740	0.747	0.754	0.761	0.767	0.773	0.780	0.785	0.791	0.797	0.803	0.808	0.814	0.819	0.825	0.830	0.835
30	0.180	0.341	0.479	0.579	0.645	0.682	0.696	0.699	0.702	0.705	0.708	0.711	0.715	0.719	0.723	0.727	0.731	0.736	0.740	0.745	0.749	0.754	0.759	0.764	0.769
35	0.180	0.341	0.478	0.575	0.635	0.665	0.672	0.669	0.667	0.666	0.666	0.667	0.669	0.671	0.674	0.677	0.680	0.683	0.687	0.691	0.695	0.699	0.703	0.707	0.712
40	0.180	0.341	0.477	0.570	0.625	0.649	0.650	0.641	0.636	0.632	0.630	0.629	0.629	0.630	0.631	0.633	0.635	0.638	0.641	0.644	0.647	0.651	0.655	0.658	0.662
45	0.180	0.341	0.476	0.566	0.616	0.634	0.629	0.616	0.607	0.601	0.597	0.594	0.593	0.593	0.593	0.594	0.596	0.598	0.600	0.603	0.606	0.609	0.612	0.616	0.620
50	0.180	0.341	0.475	0.559	0.599	0.612	0.606	0.594	0.586	0.580	0.577	0.574	0.573	0.573	0.574	0.575	0.577	0.579	0.581	0.584	0.587	0.590	0.593	0.597	0.600
55	0.180	0.341	0.474	0.553	0.584	0.591	0.584	0.573	0.566	0.561	0.557	0.556	0.555	0.555	0.556	0.557	0.559	0.561	0.563	0.566	0.569	0.572	0.575	0.579	0.582
60	0.180	0.341	0.473	0.546	0.569	0.572	0.564	0.554	0.547	0.542	0.540	0.538	0.537	0.538	0.539	0.540	0.542	0.544	0.546	0.549	0.552	0.555	0.558	0.562	0.565
65	0.180	0.341	0.471	0.540	0.555	0.554	0.545	0.536	0.530	0.525	0.523	0.522	0.521	0.522	0.523	0.524	0.526	0.528	0.530	0.533	0.536	0.539	0.542	0.546	0.549
70	0.180	0.341	0.470	0.534	0.541	0.537	0.528	0.519	0.513	0.509	0.507	0.506	0.506	0.506	0.507	0.509	0.511	0.513	0.515	0.518	0.521	0.524	0.527	0.530	0.534
75	0.180	0.341	0.469	0.528	0.529	0.521	0.511	0.503	0.498	0.494	0.492	0.491	0.491	0.492	0.493	0.495	0.497	0.499	0.501	0.504	0.507	0.510	0.513	0.516	0.519
80	0.180	0.341	0.468	0.522	0.517	0.506	0.496	0.488	0.483	0.480	0.478	0.478	0.478	0.478	0.480	0.481	0.483	0.485	0.488	0.491	0.493	0.496	0.499	0.502	0.506
85	0.180	0.341	0.467	0.516	0.505	0.491	0.481	0.474	0.470	0.467	0.465	0.465	0.465	0.466	0.467	0.468	0.470	0.473	0.475	0.478	0.481	0.483	0.486	0.490	0.493
90	0.180	0.341	0.466	0.510	0.494	0.478	0.468	0.461	0.457	0.454	0.453	0.452	0.453	0.453	0.455	0.456	0.458	0.461	0.463	0.466	0.468	0.471	0.474	0.477	0.481

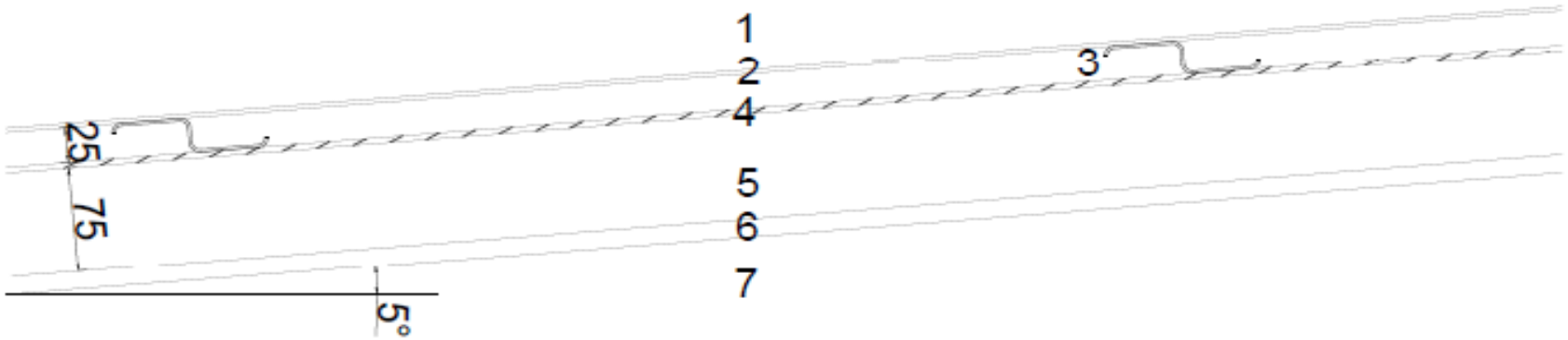
ε is surface emittance. Effective emittance, E is approximated as E=ε in most practical cases. (see Equation 6.2(3) in AS/NZ 4859.2:2018)

Thermal Resistance Value Reflective Insulation

Eg.	Description	RSI (m^2K/W)
a	Reflective Insulation	Value lies in the selected product itself
b	Reflective Insulation	Value lies in the selected product itself
	Still Air Gap	Value depends on the selected product ε, roof angle and air gap depth
c	Still Air Gap	Value depends on the selected product ε, roof angle and air gap depth
	Double Sided Reflective Insulation	Value lies in the selected product itself
	Still Air Gap	Value depends on the selected product ε, roof angle and air gap depth

Example

Reflective Insulation (c)



Element		Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)
1	External Air Film	-	0.0400
2	Metal Deck	47.600	0.0000
3	Purlin + Still Air Gap ***25mm**	-	**0.7660**
4	Reflective Insulation ***Double Sided (Both Surfaces ε=0.03)**	-	**0.3155**
5	Rafter + Still Air Gap ***75mm**	-	**1.3190**
6	Plaster Board ***13mm Thick**	0.250	0.0480
7	Internal Air Film	-	0.1600
		Total R	**2.6485**
		U Value (1/R)	**0.3776**

Table A1: RSI of enclosed air space for ε=0.03 (Reflectivity 97% : 3% Emissivity)

Angle (°)	RSI of Enclosed Air Space for Heat Flow Down at Tm=27.5°C, ε=0.03, ΔT=15°C (m^2K/W)																								
	Enclosed Air Space (m)																								
	0.005	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	0.050	0.055	0.060	0.065	0.070	0.075	0.080	0.085	0.090	0.095	0.100	0.105	0.110	0.115	0.120	0.125
0	0.184	0.356	0.514	0.655	0.780	0.892	0.992	1.082	1.164	1.238	1.305	1.366	1.422	1.474	1.521	1.564	1.602	1.637	1.669	1.698	1.724	1.747	1.769	1.788	1.806
5	0.184	0.356	0.513	0.650	0.766	0.863	0.944	1.012	1.072	1.124	1.171	1.214	1.252	1.287	1.319	1.348	1.374	1.398	1.420	1.440	1.459	1.476	1.492	1.506	1.520
10	0.184	0.356	0.512	0.644	0.752	0.837	0.901	0.950	0.993	1.030	1.062	1.092	1.118	1.142	1.165	1.185	1.203	1.220	1.236	1.251	1.265	1.277	1.290	1.301	1.312
15	0.184	0.356	0.511	0.639	0.738	0.811	0.861	0.896	0.925	0.950	0.972	0.992	1.010	1.027	1.042	1.057	1.070	1.082	1.094	1.105	1.116	1.126	1.136	1.145	1.154
20	0.184	0.356	0.510	0.633	0.725	0.788	0.825	0.847	0.866	0.882	0.896	0.909	0.921	0.933	0.943	0.954	0.963	0.973	0.981	0.990	0.999	1.007	1.015	1.023	1.030
25	0.184	0.356	0.509	0.628	0.712	0.765	0.792	0.804	0.814	0.823	0.831	0.839	0.847	0.854	0.862	0.869	0.876	0.883	0.890	0.897	0.904	0.910	0.917	0.924	0.930
30	0.184	0.356	0.508	0.623	0.700	0.744	0.761	0.764	0.767	0.771	0.775	0.779	0.783	0.788	0.793	0.798	0.803	0.808	0.814	0.819	0.825	0.831	0.837	0.842	0.848
35	0.184	0.356	0.507	0.618	0.688	0.724	0.732	0.729	0.726	0.725	0.726	0.727	0.729	0.731	0.734	0.738	0.741	0.746	0.750	0.754	0.759	0.764	0.769	0.774	0.779
40	0.184	0.356	0.506	0.613	0.677	0.705	0.706	0.696	0.689	0.685	0.682	0.681	0.681	0.682	0.684	0.686	0.689	0.692	0.695	0.699	0.703	0.707	0.712	0.716	0.721
45	0.184	0.356	0.505	0.608	0.666	0.687	0.681	0.666	0.656	0.649	0.644	0.641	0.639	0.639	0.640	0.641	0.643	0.645	0.648	0.651	0.654	0.658	0.662	0.666	0.670
50	0.184	0.356	0.504	0.600	0.646	0.661	0.654	0.640	0.631	0.624	0.620	0.618	0.617	0.616	0.617	0.619	0.620	0.623	0.626	0.629	0.632	0.636	0.640	0.644	0.648
55	0.184	0.356	0.503	0.593	0.628	0.637	0.629	0.616	0.608	0.602	0.598	0.596	0.595	0.595	0.596	0.598	0.600	0.602	0.605	0.608	0.611	0.615	0.619	0.623	0.627
60	0.184	0.356	0.501	0.585	0.611	0.615	0.606	0.594	0.586	0.581	0.578	0.576	0.575	0.576	0.577	0.578	0.580	0.583	0.585	0.589	0.592	0.595	0.599	0.603	0.607
65	0.184	0.356	0.500	0.578	0.595	0.594	0.584	0.574	0.566	0.561	0.559	0.557	0.557	0.557	0.558	0.560	0.562	0.564	0.567	0.570	0.574	0.577	0.581	0.585	0.588
70	0.184	0.356	0.499	0.571	0.580	0.574	0.564	0.554	0.548	0.543	0.541	0.539	0.539	0.540	0.541	0.543	0.545	0.547	0.550	0.553	0.556	0.560	0.563	0.567	0.571
75	0.184	0.356	0.498	0.564	0.565	0.556	0.546	0.536	0.530	0.526	0.524	0.523	0.523	0.523	0.525	0.527	0.529	0.531	0.534	0.537	0.540	0.544	0.547	0.551	0.555
80	0.184	0.356	0.496	0.557	0.551	0.539	0.528	0.519	0.514	0.510	0.508	0.507	0.507	0.508	0.509	0.511	0.513	0.516	0.519	0.522	0.525	0.528	0.532	0.535	0.539
85	0.184	0.356	0.495	0.551	0.538	0.523	0.512	0.503	0.498	0.495	0.493	0.493	0.493	0.494	0.495	0.497	0.499	0.502	0.504	0.507	0.511	0.514	0.517	0.521	0.524
90	0.184	0.356	0.494	0.544	0.526	0.508	0.496	0.489	0.484	0.481	0.479	0.479	0.479	0.480	0.481	0.483	0.486	0.488	0.491	0.494	0.497	0.500	0.503	0.507	0.510

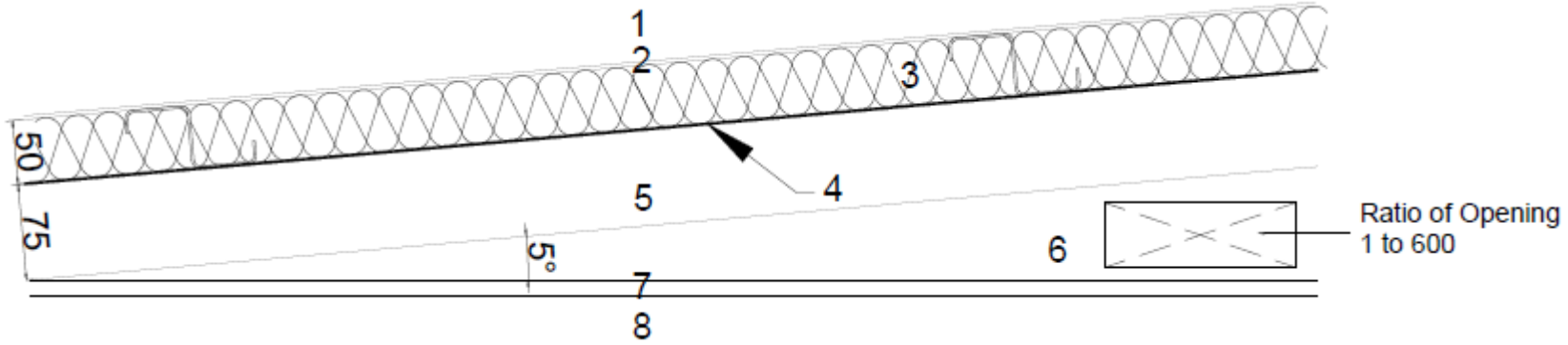
ε is surface emittance. Effective emittance, E is approximated as E=ε in most practical cases. (see Equation 6.2(3) in AS/NZ 4859.2:2018)

Thermal Resistance Value
Attic Space

Eg.	Description	RSI (m^2K/W)
a	Reflective Insulation / Radiant Barrier	Value lies in the selected product itself
	Attic Space	Value depends on reflective / non reflective and ventilation / non ventilated
b	Still Air Gap	Value depends on the selected product ε, roof angle and air gap depth
	Double Sided Reflective Insulation / Radiant Barrier	Value lies in the selected product itself
	Attic Space	Value depends on reflective / non reflective and ventilation / non ventilated

Example

Radiant Barrier + Attic Space



Element		Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)
1	External Air Film	-	0.0400
2	Metal Deck	47.600	0.0000
3	Mass Insulation ***50mm x 40kg/m³***	0.036	1.3889
4	Radiant Barrier ***Single Sided (ε=0.05 Facing Down)***	-	**0.0000**
5	Rafter ***75mm***	-	**0.0000**
6	Attic Space (IR Reflective) ***Ventilated***	-	**1.3600**
7	Plaster Board ***13mm Thick***	0.250	0.0480
8	Internal Air Film	-	0.1600
		Total R	**2.9969**
		U Value (1/R)	**0.3337**

Table B: RSI of attic space with reflective or non-reflective surface

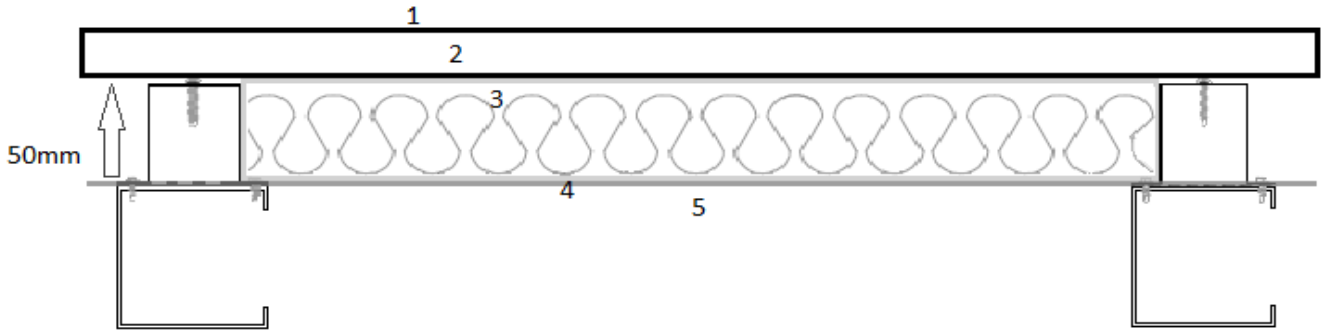
Source: AS/NZS 4859.2:2018 Table 14, Heat Flow Down.

Airspace Type	RSI (m^2K/W)	
	IR Non-Reflective	IR Reflective
Non-Ventilated	0.28	1.09
Natural Ventilation	0.46	1.36

- An Air space that has non-parallel bounding (irregular) surfaces.
- Reflective surface has an ε not greater than 0.05; Non reflective surface has an ε greater than 0.05
- Natural ventilation requires min. opening ratio 1:600 vented space; Non Ventilated refers no opening and / or opening ratio less than 1:600

Example

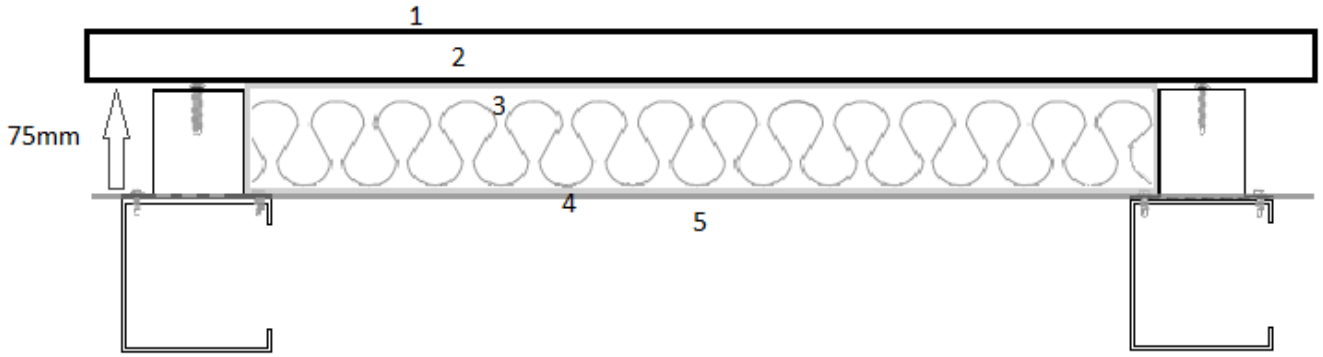
Commercial Warehouse
Reflective Insulation



	Element	Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)
1	External Air Film	-	0.040
2	Metal Deck	47.600	0.000
3	Mass Insulation ***50mm x 40kg/m³***	0.036	1.3889
4	BBS2FR-25 Big Bubble Foil	-	**0.3155**
5	Internal Air Film	-	**0.8000**
		Total R	**2.5455**
		U Value (1/R)	**0.3929**

Example

Commercial Warehouse
Radiant Barrier



	Element	Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)
1	External Air Film	-	0.040
2	Metal Deck	47.600	0.000
3	Mass Insulation ***50mm x 40kg/m³***	0.036	2.083
4	MF2-FR double sided reflective alu. foil	-	**0.000**
5	Internal Air Film	-	**0.800**
		Total R	**2.923**
		U Value (1/R)	**0.342**

Reflective ~ Protective ~ Excellence

RSI of Air Films

8 AIR FILMS

The following applies:

(a) The thermal resistance of air films on outdoor surfaces shall be assumed to be 0.04 (m^2·K)/W.

NOTE: This assumes a wind speed of 3.0 m/s.

(b) The thermal resistance value of air films other than on outdoor surfaces shall be as given in Table 15 as appropriate.

NOTE: Still air values are reproduced with permission from AIRAH Handbook 2013, page 46.

TABLE 15

THERMAL RESISTANCE OF AIR FILMS

Surface orientation	Direction of heat flow	Resistance (m^2.K)/W	
		IR non-reflective	IR reflective
Horizontal	Up Down	0.11 0.16	0.23 0.80

Source: AS/NZS 4859.2:2018

Thank You

Joey Boo 012-432 6377
Darren Wang 012-706 8377