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ALUMINIUM FOIL INSULATION ASSOCIATION INC.
Est. 1998

Standard Guidelines & Assumptions

**For the Calculation of the Thermal Resistance of Building Elements
and Assemblies incorporating Reflective Insulation Materials for
Compliance with AS/NZS 4859.1:2002**

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Published literature reviews are important and AFIA is committed to providing accurate and up to date developments in its literature publications. Since not all literature is openly available due to some international papers being published in a foreign language or being published in obscure conference proceedings AFIA makes no claim that it can access all world wide development research papers available. A review of this published document was undertaken in September - October 2004.

The review was undertaken in three parts.

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**Inserted amendment below
March 8th, 2005**

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AFIA Standard Guidelines and Assumptions – October 2004

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Standard Guidelines and Assumptions

For the Calculation of the Thermal Resistance of Building Elements and Assemblies incorporating Reflective Insulation Materials for Compliance with AS/NZS 4859.1:2002

Foreword

These Guidelines and Assumptions have been developed and prepared by the Aluminium Foil Insulation Association (AFIA) as a common ground reference for the preparation of reports compliant with AS/NZS 4859.1:2002 “Materials for the Thermal Insulation of Buildings – Part 1: General Criteria and Technical Provisions”.

The aim of the Guidelines and Assumptions is to provide a basis as to what environmental and installation factors to assume when calculating the Total Thermal Resistance (R_t) of building design elements and assemblies incorporating reflective insulation materials under in-service conditions as required by the Australian Standard AS/NZS 4859.1:2002.

The Guidelines and Assumptions also represent the consensus of opinions of AFIA member companies and AFIA technical consultants at the time of issue. AFIA reserves the right to revise these Guidelines and Assumptions as required. For the latest information, please refer to the AFIA website, www.afia.com.au.

The function of this document is to act as a guide only and all reference to measurements contained within this document are assumed to be indicative unless otherwise stated. It is the responsibility of the user of this document to ensure that the Guidelines and Assumptions used are aligned with manufacturers materials design installation drawings and specifications to ensure applicability of the thermal calculations.

Australian Standard, AS/NZS 4859.1:2002 has now been incorporated into the Australian Building Codes-1996 articles under its Amendments and the Energy Efficiency Provisions (EEP) of the Code. The implementation of this Standard into the BCA is designed to ensure that all insulation materials manufactured for use in buildings are conforming to both the testing protocols contained within the Standard and the regulatory specifications of the Building Codes.

AS/NZS 4859.1:2002 OVERVIEW

The *Materials for the Thermal Insulation of Buildings* Standard has many components. Of specific interest to this publication is Section 9-Reflective Insulation, and the following clauses that relate to Definitions and the thermal testing and calculation conformance measures for reflective insulation materials.

- Section 1, Clause 1.5, sets out the general definitions for;
 - a) Material thermal resistance
 - b) System thermal resistance
 - c) Total thermal resistance
 - d) Segmented foil insulation
- Section 2, Clause 2.3.3 – **Determination of R-values**: sets out the general terms for determination of R-value as shown in tables of Table – 2.1.
- Section 2, Clause 2.3.3.2 – **Test protocols**: sets out the conformance measures that must be adopted when either material testing or where indicative in-service thermal performance calculations are performed on insulation materials in-situ.
- Section 2, Clause 2.3.3.3 – **Mean temperature**: sets out the conformance measures that must be adopted by bulk insulation materials where they are adhered to reflective insulation membranes and where their material R-value is used in *Total* thermal performance computations.
- Section 2, Clause 2.3.3.4 – **Temperature difference**: sets out the standard seasonal temperature differences between indoor and outdoor conditions.
- Section 2, Clause 2.3.3.6, sets out the computation methods for the in-situ thermal performance assessment of reflective insulation materials and materials that incorporate reflective aluminium foil within their structure for use in-situ under computation. Refer also to Section 1, Clause 1.5 – Definitions.
- Section 2, Clause 2.4 – **Infra-Red Emittance**: specifies the test Standard and conformance condition for the measurement of reflective insulation surfaces.
- Section 3 – **Labeling**: sets out the compliance requirements for labeling of products.
- Section 4 – **Demonstration of Compliance**: sets out the acceptance of calculations and demonstration of compliance procedures required by this Standard.
- Section 9 – **Reflective Insulation**: sets out the main body of the reflective insulation component of the Standard.

While the Guidelines and Assumptions also provide reliable and consistent information for use by BCA subscribers, Commonwealth Government Agencies, National Community Municipalities, Regulators, Builders, Manufacturers, Architects, Engineers and Energy Rating Assessors they also enable reflective insulation materials to attain certification in accordance with Australian Standard, AS/ANZ 4859.1:2002.

Use of these conformance provisions will additionally assist in the Energy Efficiency Provisions (EEP) of the Building Code of Australia whereby the contributions of reflective insulation correctly evaluated for in-situ or in-service performance will indicatively assist in the reduction of greenhouse gas emissions and improved energy efficiency of buildings.

Tools & Software

There are numerous tools and software programs available to industry that will provide realistic indicative thermal performance assessments of buildings or specific building elements. Among them is REFLECT-3, a software tool licensed to AFIA for calculating Total (R_t) or System R-values of parallel-sided air filled cavities of up to 100mm wide for surfaces of varying emittance (emissivity).

The software computes the R-values of cavities with non-reflective and reflective insulation materials or radiant barrier membranes such as sarkings or wall wraps in ceilings, roofs, floors and walls. The software caters for different air gaps, emittance and roof pitch orientation. REFLECT-3 has been tested and validated against physical measurements by the Oak Ridge National Laboratory (ORNL), USA for cavities up to 100mm wide. The algorithms of REFLECT-3 are based on REFLECT-2 by D. Yarbrough, "Assessment of Reflective Insulations for Residential and Commercial Applications" ORNL, 1983, (See reference in "About Reflect-3", page 16)

Input Controls for REFLECT-3

- Mean Temperature and temperature difference across the cavity
- Emittance (Emissivity) of each side of the cavity
- Width of air space between layers (accommodates up to three 100mm reflective cavities)

Outputs Assumptions from REFLECT-3

- R-values for vertical, 45 degrees and horizontal orientations, for upward, downward and horizontal heat flow.
- Temperature difference across each air space
- Mean temperature and temperature difference across the assembly

Note: Due to the nature and complexities of non-parallel surfaces in roof spaces, these cannot be determined using REFLECT-3 but can be estimated using ASTM C1340 developed by Oak Ridge National Laboratory (ORNL). For more information on this Standard users should contact their nearest reflective insulation AFIA association member via, www.afia.com.au.

Material Definitions

The following definitions frequently used in this document are relevant to various reflective insulation and moisture barrier materials commonly used in Australian building construction design.

1. **RIM** – refers to: ***Reflective Insulation Material***. These materials can either be made up of formed air cell structures, of layered batt type shape or continuous roll form or may be single structures of expandable concertina accordion shape.

A reflective insulation material can also be classified in this group if its overall thickness is greater than about 1mm since the material will have a measurable R value. Usually all these materials have reflective aluminium foil attached to all surfaces. Some materials may have antiglare inks applied to one surface.

2. **RBS** – refers to: Radiant Barrier Sarking. These materials are usually manufactured in continuous roll form and usually have one aluminium foil surface and one opaque, coloured non-foil surface. Some material is available with two faces of aluminium foil one of which may have an antiglare ink coating.
3. **HWW** – refers to: House Wall Wrap. This term is not commonly used today but nonetheless remains a reference in specifications. These materials are usually manufactured in continuous roll form and commonly have non-foil opaque, coloured surfaces. Some house wall wraps are available though with foil on one surface, usually the inner surface. The foil usefulness is then only considered if it is installed with an adjacent air space. It is worth noting also that perforated breather type house wall wrap materials are also available.

Publications

Referenced in AS/NZS 4859:1:200, under Clause 2.3.1, is a note on the possible effects of dust on reflective insulation materials in-situ or in-service. International research has now concluded with findings that dust deposits are not a long term contributing factor to thermal performance failure of reflective insulation materials and that dust deposits depend on ventilation factors, installed orientation and building location. Refer to the publication which is titled “De-rating recommendations for aluminium foil radiant barrier membranes & reflective foil laminate as a result of dust accumulation” available from the Aluminium Foil Insulation Association website, www.afia.com.au.

Other publications that can be considered when determining the total thermal performance of building fabric are;

- ASTM C 1340 – 99 “*Standard Practice for Estimating of Heat Gain or Loss Through Ceilings Under Attics Containing Radiant Barriers by Use of a Computer Program*”.

- Publication: Ford, J K 1983. “*Deriving Radiation View Factors within a Triangular Cross-Section Residential Attic*”. ASHRAE Transactions V 89 Part 1A. publication No. 2751.
- **CSIRO Bulletin NSB 61 (September 1991) *Condensation in Houses***
 “It is suggested somewhat arbitrarily (though not necessarily conservatively) that the occurrence of condensation within the external walls of a house is likely to be acute at times in areas where the mean minimum winter temperature is 4°C or lower, or where provision is made for continuous high-efficiency heating because of the coldness of the winter seasons” (Clause 2.01)

 “Condensation in brick cavity walls of houses is not a major problem under Australian climatic conditions.” (Clause 4.01)
- **CSIRO Report 84/20 (1984) “*Thermal resistance measurements on brick veneer walls insulated with reflective foil*”** by: R.E. Clarke and L.F.O’Brien
 Note: The reflective airspace R-values shown in the “Brick Veneer” construction computation of this report represent R-values using plain double-sided foil with no antiglare coating. The R-values quoted do not mean that common radiant barrier sarkings (RBS) consisting of one side having plain foil and the other side having coloured poly weave meet the same thermal performance values if installed under the same building wall design.

Condensation

Since this document is intended to cover both Australia and New Zealand it needs to be recognised that the climates in these two countries are very different. Therefore the installed operating or in-service conditions and environmental factors will have an effect on the use of reflective foil insulations. New Zealand has more moisture problems in construction than Australia does. This produces condensation on insulation surfaces and can induce mould growth in bulk insulations. Measures should be taken to reduce accumulations of condensation on reflective foil surfaces even though the performance of the product recovers after the moisture evaporates.

Common Construction Design

AFIA recommends that tests and reports for AS/NZS 4859.1:2002 compliance incorporate the following assumptions and standard building construction profiles commonly used in Australia. All insulation materials must be installed in accordance with the manufacturers installation design drawings and specifications and regulations.

1.0 Roof and Ceiling Systems:

1.1. Tiled Roof

- a) Evaluation for the standard 22.5° pitch satisfactorily approximates the case for roof pitches between 18° and 28°.
- b) Where reflective insulation material (RIM) or radiant barrier sarking (RBS) is specified, the material is installed under 40mm tile battens.
- c) The antiglare foil surface or opaque surface of RBS faces upwards.
- d) The reflective surface of RIM or RBS faces downwards.
- e) The ceiling is horizontal 10mm plasterboard.
- f) With RIM or RBS present, the tiled roof attic cavity is considered non-ventilated unless it has fan ventilation or louvered openings for ventilation.
- g) Eaves are sealed.

1.2. Metal Roof

- a) Evaluation for the standard 22.5° pitch satisfactorily approximates the case for roof pitches between 18° and 28°.
- b) Evaluation for 0° pitch satisfactorily approximates the case of a “flat skillion type metal roof” having a pitch less than 12°.
- c) Where specified;
 - i. Reflective insulation material or radiant barrier sarking may be installed under or over 40mm battens, or;
 - ii. Foil-backed glass wool or polyester wool blanket material may be installed under or over 40mm battens.
- d) The antiglare foil surface or opaque surface of RBS faces upwards.
- e) The reflective surface of RIM, RBS, foil-backed glass wool or polyester wool blanket faces downwards.
- f) The ceiling is horizontal 10mm plasterboard.
- g) The roof attic cavity is considered non-ventilated unless it has fan ventilation or louvered openings for ventilation.
- h) Eaves are sealed.

1.3. Reflective Insulation Material (RIM) Retrofit over a Horizontal Ceiling

- a) A retrofit RIM is not installed immediately beneath a tiled roof unless it is a cathedral ceiling.
- b) A retrofit RIM is installed over or between 90mm ceiling joists.

- c) Because it is a retrofit, it is permitted that the RIM be highly reflective on both the upward surface and the downward surface.
- d) The ceiling is horizontal 10mm plasterboard.
- e) For a metal roof, there is no ventilation in the roof space unless there is fan ventilation or louvered ventilation openings.
- f) Where insulation is already present adjacent the roof surface, there is no ventilation in the roof space unless there is fan ventilation or louvered ventilation openings.
- g) Where insulation is not already present beneath a tiled roof, the roof space is to be considered ventilated.
- h) Eaves are sealed.

1.4 Warehouse/Arena Metal Clad Roof without ceiling

- a) Common roof pitch elevations are 5° for metal roof cover or as design specified.
- b) Foil-backed glasswool or polyester wool blanket installed under flat metal roof to create a reflective air space beneath, or
- c) Reflective insulation material (RIM) installed under flat metal roof to create an adjacent upper antiglare cavity and a reflective air space beneath.
- d) The reflective surface of blanket or RIM faces downwards.
- e) Use support mesh where specified for all products.

1.5 Low Pitch Metal Roof with Ceiling

- a) Common roof pitch elevations are 5° for metal roof cover.
- b) Foil-backed glasswool or polyester wool blanket installed under flat metal roof to create a reflective air space beneath, or
- c) Reflective insulation material (RIM) installed under flat metal roof to create an upper adjacent antiglare cavity and a reflective air space beneath.
- d) The reflective surface of blanket or RIM faces downwards
- e) Use support mesh where specified for all products.
- f) A flat suspended ceiling (10mm plasterboard panels or acoustic tiles) is installed.
- g) >600mm ceiling cavity.
- h) The ceiling cavity is considered non-ventilated unless it has fan ventilation, louvered external openings for ventilation, or is a return-air path for air-conditioning.

2.0 Wall Systems

2.1 Brick Veneer Walls

- a) Standard 110mm face brick.
- b) 40mm to 50mm unventilated brick cavity unless brick vents are installed above ground level.

- c) The outward facing RIM, RBS or house wall wrap (HWW) surface is antiglare or opaque.
- d) That wall wrap, RBS or RIM is installed on the outer surface of a 70mm to 90mm metal or timber wall frame.
- e) The reflective face of RIM, RBS or wall wrap (if foil faced) faces plasterboard.
- f) The internal wall lining is 10mm plasterboard.

2.2 Weatherboard or Fibre Cement Walls

- a) Weatherboard or fibre cement is applied directly onto antiglare surface of RIM or opaque surface of house wall wrap applied to external face of 70mm or 90mm timber or metal frame or,
- b) Weatherboard or fibre cement is applied onto battens fixed directly over antiglare surface of RIM or opaque surface of house wall wrap applied to external face of 70mm or 90mm metal frame.
- c) Where an outer reflective airspace is required for RIM, a 20mm counter batten or spacing procedure shall apply. This may be the thermal bridging device method.
- d) The reflective face of the RIM or house wall wrap (if foil faced) faces plasterboard.
- e) The internal wall lining is 10mm plasterboard.

2.3 Double Brick Cavity Walls

- a) Standard 110mm face brickwork.
- b) 40mm to 50mm brick cavity.
- c) Optional – RIM or RBS is installed within the cavity either,
 - Centrally positioned using a wall tie system, or
 - Positioned against outer brick cavity surface using a wall tie system.
- d) Antiglare foil or opaque surface faces inwards as face brickwork is always constructed first.
- e) Reflective face of RIM or RBS faces outwards.
- f) Cavity is unventilated unless brick vents are installed above ground level.
- g) Standard 90mm internal render brick.
- h) 20mm plaster and set finish.

2.4 Warehouse/Arena Metal Clad Walls

- a) Foil-backed glasswool or polyester wool blanket installed adjacent metal wall surface with foil facing inwards, or;
- b) Reflective insulation material (RIM) installed adjacent, or battened to vertical metal wall surface to create an air space cavity.
- c) Antiglare foil surface faces outward.
- d) The reflective surface of blanket or RIM faces inwards.
- e) Use support mesh where specified for all products.

3.0 Floors

3.1 Timber Floors

- a) 19mm T&G flooring or compressed treated particle board flooring.
- b) >100mm x 45mm timber floor joists.
- c) >100mm x 75mm timber floor bearers.
- d) RIM installed in accordance with manufacturers design details.
- e) Enclosed sub-floor spaces are considered non-ventilated unless breeze-way path ventilation systems are installed

Standard Reflective Insulation Material Calculation Assumptions

1.0 Calculation Methods

- 1.1 Where appropriate, the thermal resistance or R-values for reflective and semi-reflective parallel air spaces shall be calculated using REFLECT-3 software which models Robinson & Powlitch physical data, incorporates corrected algorithms by Yarbrough and is validated by Oak Ridge National Laboratory, Tennessee, USA. The calculated results depend on the temperature difference across the air space which in turn depends on the thermal resistance of all the elements in the design.
- 1.2 Thermal bridging computation is not a requirement of AS/NZS 4859.1:2002. Unless otherwise instructed, assessments to AS/NZS 4859.1:2002 shall be for the insulation path only without consideration of thermal bridging.
- 1.3 Directional Total R-values calculated and published shall report to one decimal point only, and be reported as “Declared R_t ”. The declared R_t must be accompanied with a statement verifying that the value is subject to change under the environmental in-situ or in-service conditions and therefore must be declared also as Indicative R_t .
- 1.4 In accordance with AS/NZS 4859.1:2002, Clause 2.3.3.4, all thermal assessments for RIM, RBS and foil-backed glasswool or polyester wool blanket materials shall be computed for the three standard values of air temperature difference of 6, 12 and 18K. Only for specific design purposes shall consideration be given to sunlit surface temperatures which are dependent on solar angle, cloud cover, etc. See also Clause 2.3.3.2 Test Protocol.

2.0 Emittance

- 2.1 The infra-red emittance of all reflective surfaces of all insulation materials claimed within thermal performance computations shall be certified in accordance with the test procedures of AS/NZS 4859.1:2002, Section 2, Clause 2.4.
- 2.2 Where an antiglare coated reflective insulation surface is claimed, the infra-red emittance shall also be tested in accordance with the requirements of AS/NZS 4859.1:2002, Section 2, Clause 2.4.

- 2.3 The effect of dust on upward facing horizontal and inclined surfaces shall be calculated in accordance with the references published in “*De-rating Recommendations for Aluminium Foil Radiant Barrier Membranes and Reflective Foil Laminates as a Result of Dust Accumulation* (AFIA, 28th January 2003) available from www.afia.com.au. In summary, dust is most unlikely to affect any reflective cavity insulation value significantly apart from ventilated tiled roof attics with upward facing bright foil. The latter is also dependent on the environmental conditions.
- 2.4 The calculations incorporate the AFIA assumptions that dust is not present on the top surfaces of reflective foil insulation installed in unventilated sub-floor airspaces.
- 2.5 On RIM or RBS where emittance is less than 0.2 and labelling ink comprises more than 5% of surface area, labelling must be considered for its de-rating affect. This shall be done on an area-weighted isothermal planes calculation basis.

3.0 Temperatures

- 3.1 R_T shall be reported for air-to-air temperature differences of 6, 12 and 18K across the entire system, in accordance with AS/NZS4859.1 Clause 2.3.3.4 for indoor air temperature of 18°C (winter) or 24°C (summer). The 6K result is to be highlighted.
- 3.2 The test temperature for bulk insulation components shall be 21.0°C - 24.5°C (mean 23.0°C) per AS/NZS4859.1:2002, clause 2.3.3.3 unless otherwise specified as a requirement of in-situ or in-service conditions.

4.0 Large Air Spaces

- 4.1 Thermal resistances of air films and pitched roof spaces of page 609, AIRAH 2000 Handbook. Where there is a semi reflective attic, the following R values for the attic may be assumed:
 - a. Tiled roof, ventilated attic, heat flow up $R=0.32 \text{ m}^2.\text{K}/\text{W}$
 - b. Tiled roof, ventilated attic, heat flow down $R=0.83 \text{ m}^2.\text{K}/\text{W}$
 - c. Metal roof, unventilated attic, heat flow up $R=0.49 \text{ m}^2.\text{K}/\text{W}$
 - d. Metal roof, unventilated attic, heat flow down $R=0.85 \text{ m}^2.\text{K}/\text{W}$

(Values determined by James M Fricker Pty Ltd by non-linear interpolation of AIRAH 2000 Handbook and other data)

5.0 Ventilation & Air Movement

- 5.1 Outdoor air movement:
 - a) Summer - 3.0 metre/sec (*AIRAH Handbook 2000*)
 - b) Winter - 6.0 metre/sec (*AIRAH Handbook 2000*)
- 5.2 Indoor air movement: Still air in most applications.
- 5.3 A sub-floor with “minimum ventilation to BCA” is to be considered unventilated.
- 5.4 Residential metal roof attic spaces with RIM or RBS under the roof fabric are assumed to be non-vented unless otherwise stated.
- 5.5 Residential tiled roof attic spaces with RIM or RBS under the roof fabric are assumed to be non-vented unless otherwise stated. AS/NZS 4859.1:2002 requires that relevant conditions be stated on the label or the computation.
- 5.6 Residential tiled roof attic spaces without reflective insulation material under the roof fabric are assumed to be naturally ventilated, unless the tile profile significantly restricts ventilation.
- 5.7 Drain holes in sub-floor foil insulation have negligible effect on ventilation, and hence the R-value does not need to be de-rated due to the presence of drain holes in RIM.
- 5.8 Where face brickwork construction incorporates brick ventilation panels of either one course or two course high installed at nominal intervals to the perimeter of the building envelope the wall cavity shall be considered ventilated at 0.06m/s which will attract a 10% de-rating of the wall cavity R-value. The ventilation rate derives from CSIRO Report 84/20 (refer page 8).
- 5.9 Where face brickwork construction incorporates moisture relief weep holes located at the base of the brickwork, the wall cavity shall be considered unventilated for computation of R-value.

6.0 Materials

- 6.1 Installation of foil-backed glasswool or polyester wool blanket materials adjacent to support mesh causes compression and R-value reduction in-service to the following extents in both vertical and horizontal applications*.

Nominal Blanket Thickness	Compression	Reduction in R	
		Glass Wool	Polyester Wool
55mm	20%	11%	9%
75mm	25%	14%	11%
100mm	30%	17%	13%

*AS/NZS 4859.1:2002, Clause 3.1 and Table 3.1 require these environmental factors to be accounted for. (See also Clause 2.3.1 and ISO 10456).

- 6.2 Unless otherwise specified, brickwork is either
- 90mm with $R=0.15 \text{ m}^2\cdot\text{K}/\text{W}$ or
 - 110mm brickwork is $R=0.18 \text{ m}^2\cdot\text{K}/\text{W}$ (per AIRAH 2000 Handbook).
- 6.3 In Brick Veneer construction the common fabric measurements are;
- Face brick – 110mm
 - Cavity – 40mm or 50mm
 - Timber or metal frame – 70mm or 90mm
 - Wall lining – 10mm plasterboard
- 6.4 In Double Brick Cavity construction the common fabric measurements are;
- Face brick – 110mm
 - Cavity – 40mm or 50mm
 - Internal brick – 90mm
 - Plaster render and set – 20mm

Recognized Laboratories

AFIA recognizes the following testing laboratories as providing services for testing the behavior of insulation materials under specific tests as prescribed in AS/NZS 4859.1:2002 “Materials for the Thermal Insulation of Buildings” – Part 1: General Criteria and Technical Provisions.

1. Building Research Association of New Zealand (BRANZ)
2. University of Western Australia (UWA)
3. Commonwealth Scientific & Industrial Research Organization (CSIRO)
4. Australian Wool Testing Authority (AWTA)
5. Oak Ridge National Laboratory, (ORNL) USA
6. R & D Services, Tennessee, USA (www.rdservices.com)

Recognized Thermal Engineers

AFIA recognizes James M Fricker Pty Ltd of Australia as a suitably qualified practicing thermal engineer for the purposes of calculating the behaviour and thermal resistance of Australian designed building elements and assemblies incorporating Reflective Insulation Materials for Compliance with AS/NZS 4859.1:2002 “Materials for the Thermal Insulation of Buildings – Part 1: General Criteria and Technical Provisions”.

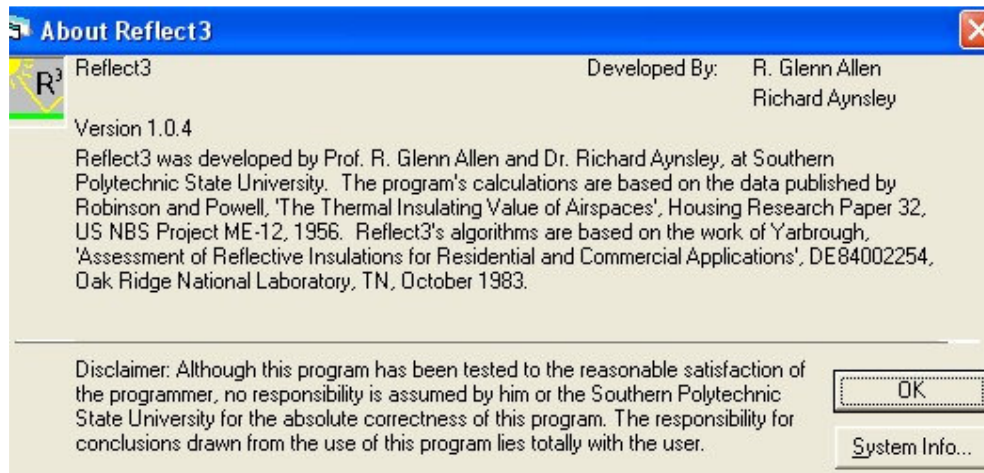
References

- Australian Standard, AS/NZS 4859.1:2002 “Materials for the Thermal Insulation of Buildings – Part 1: General Criteria and Technical Provisions”.
- Building Code of Australia-1996, Amendment-13:2003, Clause V2.6.2.
- REFLECT-3 computer software (Version 1.0.5-May 23rd, 2003) developed by; R. Glenn Allen and Dr Richard Aynsley, Southern Polytechnic State University, Georgia, USA.
- Aluminium Foil Insulation Association Inc, “De-rating Recommendations for Aluminium Foil Radiant Barrier Membranes and Reflective Foil Laminates as a Result of Dust Accumulation”, (Publication-28th January 2003).
- AIRAH Handbook 2000: R-values in preference to ASHRAE and other R-values, for Australian assessment (for proprietary materials – use accredited laboratory test certificate R-value).

- ASTM C 1340 – 99 “Standard Practice for Estimating of Heat Gain or Loss Through Ceilings Under Attics Containing Radiant Barriers by Use of a Computer Program”.
- Publication: Ford, J K 1983. “*Deriving Radiation View Factors within a Triangular Cross-Section Residential Attic*”. ASHRAE Transactions V 89 Part 1A. publication No. 2751.
- BRANZ: “A Manual for Calculating R-Values using the Isothermal Planes Method” by H.A. Trethowen 1997.

Notes:

- Reference to H.E. Robinson and F.J. Powlitch has from time to time been quoted in publications as Robinson H.E. and Powell F.J. or Robinson H.E. and Powlitch F.J. These are equivalent. The reference to the publication quoted in the REFLECT–3 code development is the one bearing his name, “Powell”.



Document End