

Australian/New Zealand Standard™

Thermal insulation materials for buildings

Part 1: General criteria and technical provisions



AS/NZS 4859.1:2018

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Aluminium Foil Insulation Association
Australian Building Codes Board
Australian Cellulose Insulation Manufacturers Association
Australian Institute of Refrigeration Air Conditioning and Heating
Australian Professional Thermography Association
AWTA Product Testing
Building Research Association of New Zealand
Consumers Federation of Australia
CSIRO
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Thermal insulation materials for buildings

Part 1: General criteria and technical provisions

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD-058, Thermal Insulation, to supersede, AS/NZS 4859.1:2002, *Materials for the thermal insulation of buildings, Part 1: General criteria and technical provisions*.

The objective of this revision is to restructure the Standard as a material properties and test methods Standard and include latest thermal insulation products testing not previously covered by the Standard.

The significant changes in this edition are as follows:

- (a) The relocation of all thermal insulation system design to a separate Part of this series (i.e. AS/NZS 4859.2).
- (b) The deletion of the references to the AS 1366 suite of Standards.
- (c) The inclusion of a wider range of thermal insulation materials and, in particular, rigid foam products.

Emphasis has been given to the development of clear and concise requirements for determination and labelling of thermal performance, a primary performance requirement for these materials. Another consideration is the effect of ageing of materials where there is a significant change in the insulation properties of those materials over time.

In this Standard, notes to the main text are for information and guidance only.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

If alternative tests to those prescribed in this Standard are to be used, they would need to be considered as part of the development of a Performance Solution to demonstrate compliance with the relevant Performance Requirements of the National Construction Code (NCC) and be accepted by the relevant building authority.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard Thermal insulation materials for buildings

Part 1: General criteria and technical provisions

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard provides general criteria, technical provisions and methods of test for materials that are used for thermal insulation within buildings, including materials used for thermal insulation of ductwork and pipework.

Specific requirements for individual materials or insulation types are given in Sections 4 to 9.

This Standard does not address the following:

- (a) Materials for the insulation of windows or glazing.
- (b) Fire performance.
- (c) Installation requirements of thermal insulation.
- (d) Performance requirements of systems or materials that have some primary function other than providing thermal insulation.

1.2 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

1134 Wool—Determination of wool base and vegetable matter base of core samples of raw wool

1595 Cold-rolled unalloyed, steel sheet and strip

2001 Methods of test for textiles

2001.6.1 Method 6.1: Miscellaneous tests—Determination of the resistance of textiles to certain insect pests

2001.7 Method 7: Quantitative analysis of fibre mixtures

4200 Pliable building membranes and underlays

4200.2 Part 2: Installation

AS/NZS

4200 Pliable building membranes and underlays

4200.1 Part 1: Materials

4201 Pliable building membranes and underlays—Methods of test

4201.1 Method 1: Resistance to dry delamination

ISO	
8301	Thermal insulation—Determination of steady-state thermal resistance and related properties; heat flow meter apparatus
8302	Thermal insulation—Determination of steady-state thermal resistance and related properties; guarded hot plate apparatus
8990	Thermal insulation—Determination of steady-state thermal transmission properties—calibrated and guarded hot box
ASTM	
C167	Test methods for thickness and density of blanket or batt thermal insulations
C177	Test method for steady-state heat flux measurements and thermal transmission properties by means of the guarded-hot-plate apparatus
C335	Standard test method for steady-state heat transfer properties of horizontal pipe insulation
C518	Test method for steady-state heat flux measurements and thermal transmission properties by means of the heat flow meter apparatus
C687	Practice for the determination of thermal resistance of loose fill building insulations
C739	Standard Specification for cellulosic fibre (wood-base) loose-fill thermal insulation
C1363	Standard test method for the thermal performance of building assemblies by means of hot box apparatus
C1667	Standard test method for using heat flow meter apparatus to measure center-of-panel thermal transmission properties of vacuum insulated panels
EN	
12667	Thermal performance of building materials and products—Determination of thermal resistance by means of guarded hot plate and heat flow meter methods—Products of high and medium thermal resistance
12939	Thermal performance of building materials and products—Determination of thermal resistance by means of guarded hot plate and heat flow meter methods—Thick products of high and medium thermal resistance
13164:2012 +A1:2015	Thermal insulation products for buildings—Factory made extruded polystyrene foam (XPS) products—Specification
13165:2012 +A1:2016	Thermal insulation products for buildings—Factory made rigid polyurethane foam (PU) products—Specification
13166:2012 +A1:2016	Thermal insulation products for buildings—Factory made phenolic foam (PF) products—Specification

1.3 DEFINITIONS

For the purpose of this Standard the definitions below apply.

1.3.1 Declared thermal resistance, (R_d)

Expected value of thermal resistance for a building material or product assessed from measured material thermal resistance data at reference conditions of temperature and humidity, for a stated fraction and confidence level, and corresponding to an expected service lifetime under normal conditions. [Unit: (m².K)/W]

1.3.2 Declared thermal conductivity, (λ_d)

Expected value of thermal conductivity for a building material or product assessed from measured material thermal conductivity data at reference conditions of temperature and humidity, for a stated fraction and confidence level, and corresponding to an expected service lifetime under normal conditions. [Unit: W/(m.K)]

1.3.3 Pack

A number of pieces or blankets contained as a unit, usually within plastic wrapping.

1.3.4 Pliable non-reflective insulation

A bulk insulating material that is able to be folded 180° back on itself without mechanical failure.

1.3.5 Segmented foil insulation

IR reflective insulation cut or formed into individual sections for use between or over building structural members.

NOTE: Segmented foil insulation is produced in packs, not rolls. Because it is not continuous, it cannot perform as a sarking membrane or vapour control membrane.

1.3.6 Stabilized

The value, representing the installed condition, allowing for variations of thermal insulation materials and other installation-related factors, when referring to thickness, density, thermal resistance and thermal conductivity.

1.3.7 Total thermal resistance (R_t)

A total resistance associated with a material, or a system or construction of materials, computed or measured over an area which is fully representative of the element of construction, and specified as a total-R value, including surface film resistances and thermal bridging. [Unit: (m².K)/W]

1.3.8 Wool

Wool derived from the fleece of sheep.

NOTE: The term 'wool' is used in this Standard as a qualifying term to describe the fibrous nature of materials such as mineral wool, rock wool, glass wool and steel wool. Where the term is used to describe a material (rather than a physical characteristic) it means wool derived from sheep.

SECTION 2 CRITERIA AND TECHNICAL PROVISIONS

2.1 GENERAL

This Section provides performance criteria and technical provisions for materials to be used in the thermal insulation of buildings and building services.

In addition to this Section the insulating material shall—

- (a) meet packaging and labelling requirements of Section 3;
- (b) where applicable, meet product specific requirement of Sections 4 to 9, and normative Appendices B, C, D and E.

2.2 VALIDITY OF TEST RESULTS

Insulation products shall be retested if any change is made to material formulation or design that affects the performance.

2.3 THERMAL RESISTANCE

2.3.1 General

Thermal resistance of insulation material is designated as its declared R-value, which is determined as specified in Clause 2.3.3.

NOTES:

- 1 Some materials achieve a thermal resistance that is lower in the long term than at the time of installation. Common causes include the settlement of dust on IR reflective insulations, changes in cell gas composition in foam insulations and settlement of loose fill insulations.
- 2 Some compression-packaged materials take time to achieve their stabilized thickness and R-value.
- 3 For guidance on measurement of thermal resistance, see Appendix A.
- 4 The moisture content of materials will affect their thermal resistance.
- 5 For guidance on determination of design R-value, refer to AS/NZS 4859.2.

2.3.2 Category

Materials shall be categorized as follows:

- (a) *Formed shapes* Self-supporting shapes that have uniform or regularly repeating geometry on a scale small enough to permit determination of thermal resistance by physical measurement of heat flow through a representative area.

NOTES:

- 1 Formed shapes include panels, complete building elements such as walls or roofs, or other assemblies of different materials, which could include or combine bulk and IR reflective components internally but satisfy the requirement of small-scale uniformity. Formed shapes include bulk insulation materials with solid, cellular or other regular structure, (e.g. foamed or cellular plastics, insulating concretes, rammed earth, mud brick, wood-based products and rigid cellulose-based products such as cardboard, aerogels, cast resins and plasters). They also include fibrous materials not meeting the definition of 'compressible'.
 - 2 For guidance on thermal resistance measurement, see Appendix A.
- (b) *Formed in situ* Materials such as paints and other coatings, sprayed fibres, and sprayed or injected foams.

- (c) *Compressible* Materials that can be compressed by 20% or greater at 2 kPa applied pressure, including segments and blanket, and usually supplied compression packaged (e.g. rock wool, glass wool, polyester fibre, wool and like materials). If the material cannot be compressed by 20% at 2 kPa, it shall be treated as 'formed shapes'.
- (d) *Loose fills* Materials and mixtures of materials that are granular or loose and that could compact under load (e.g. cellulose fibre, exfoliated vermiculite, expanded perlite, wool, glass wool, granulated cork, mineral wool, rock wool, slag wool, and expanded plastic beads or chips, granular minerals and earths).
- (e) *IR reflective* Formed shapes and compressible materials that incorporate one or more external IR reflective surfaces and that have uniform or regularly repeating geometry on a scale small enough to permit determination of thermal resistance by physical measurement of heat flow through a representative area (e.g. IR reflective foil insulation, IR reflective claddings and facings of buildings and foil-faced pieces and blankets, where used in applications that satisfy the requirement of small-scale uniformity).
NOTE: Only the bulk insulation component R-value can be determined using the test methods detailed in this Standard. Any contribution from IR reflective airspaces external to the material should be calculated according to the methods detailed in AS/NZS 4859.2.
- (f) *Vacuum panels* Insulation systems whose gas phase thermal conductivity portion of the overall apparent thermal conductivity has been significantly reduced by reduction of the internal gas pressure.

2.3.3 Determination of thermal resistance R-value

2.3.3.1 General

Insulation properties for individual material specimens shall be measured in accordance with the test methods specified in Table 2.3.3.1.

NOTE: This Standard does not prescribe minimum or maximum requirements for thermal resistance.

TABLE 2.3.3.1
STANDARD METHODS FOR DETERMINATION
OF THERMAL PROPERTIES

Property	Test methods
Thermal resistance of all categories other than vacuum panels	Any of ASTM C177, ASTM C518, ASTM C1363, ISO 8301, ISO 8302, ISO 8990, EN 12667, EN 12939
Thermal resistance of pipe insulation	ASTM C335 or alternative calculation as per Clause 2.3.3.7 of this Standard
Thermal resistance of loose-fill	ASTM C687 and Appendix C
Thermal resistance of vacuum panels	ASTM C1667 (see Note)
Nominal thickness of compressible fibrous	ASTM C167 and Appendix B
Ageing factor and/or aged thermal resistance of PUR, PIR, PF and XPS rigid foams	Refer to Section 8

NOTE: ASTM C1667 only measures the centre-of-panel thermal resistance. Adjustments shall be made in order to determine the effective thermal resistance of the entire panel.

2.3.3.2 Sampling

The test specimens shall be representative of the product, in particular the mass per unit area and thickness.

NOTE: For guidance on sampling plans for factory-made products, see ISO 12576-1, and for site-made products such as loose fill, see ISO 12576-2.

2.3.3.3 Specimen conditioning

Test specimens shall be conditioned for at least 12 h at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity, unless otherwise specified in the test methods or in Sections 4 to 9.

2.3.3.4 Test thickness

Thermal conductivity and thermal resistance of compressible insulation materials shall be determined at the lesser of nominal thickness and actual measured thickness.

Thermal conductivity of samples that are greater than nominal thickness and cannot be compressed for thermal measurement shall be determined at actual thickness. Thermal resistance of specimens shall not be reported at thicknesses greater than nominal thickness.

2.3.3.5 Declared thermal performance

Thermal resistance shall be declared at a standard mean temperature of 23°C for products sold in Australia, and 15°C for products sold in New Zealand.

NOTE: Where required, declared thermal value should be supported by data summarized in accordance with Clause 2.3.3.9.

Thermal resistance and thermal conductivity may be measured at mean temperatures other than those at which they are declared, and then adjusted to the declared temperature, provided the accuracy of the relationship between temperature and thermal properties is well documented.

NOTE: Calculation methods for common insulants under limited conditions can be found in ISO 10456 and AS/NZS 4859.2.

For categories other than vacuum panels, the declared R-value, R_{declared} , and declared thermal conductivity, $\lambda_{\text{declared}}$, shall be derived from the statistically adjusted mean values $\lambda_{50/90}$ and $R_{50/90}$, representing a 50% fractile with 90% confidence, and a one-sided statistical tolerance interval (see Note 1 and Note 2), and which shall be based on thermal measurements on at least 10 individual specimens.

$R_{50/90}$ and $\lambda_{50/90}$ shall be calculated using the following equations:

$$R_{50/90} = R_{\text{mean}} - k_2 \cdot s \quad \dots 2.3.3.5(1)$$

$$\lambda_{50/90} = \lambda_{\text{mean}} + k_2 \cdot s \quad \dots 2.3.3.5(2)$$

where

k_2 = coefficient used when the standard deviation is estimated for one-sided tolerance interval (see Note 2)

s = sample standard deviation for the 10 or more measured values used to determine the declared value

NOTES:

- 1 For example calculation, see Annex B of ISO 10456:2007.
- 2 On the basis of an assumed Gaussian distribution, the adjustment coefficient $k_2(n;50\%;90\%)$ used in Equation B.1 of Annex B of ISO 10456:2007 is in column 4, Table C.1, Annex C, ISO 10456:2007.
- 3 For the particular case of $n = 10$, the value of k_2 in Table C.1, Annex C, ISO 10456:2007 is 0.44.

If thermal measurements have been performed on specimens at greater than nominal thickness, as permitted by Clause 2.3.3.4, $R_{50/90}$ shall be calculated at nominal thickness from the following equation instead of Equation 2.3.3.5(1):

$$R_{\text{declared}} = d_N / \lambda_{50/90} \quad \dots 2.3.3.5(3)$$

where

d_N = nominal thickness, in metres

During calculations, no value shall be rounded to less than three significant figures.

The declared thermal resistance shall not be greater than $R_{50/90}$, and shall be rounded downwards to the nearest $0.05 \text{ (m}^2\cdot\text{K)/W}$ for R-values of $1.0 \text{ (m}^2\cdot\text{K)/W}$ or more, and downwards to the nearest $0.01 \text{ (m}^2\cdot\text{K)/W}$ for R-values of less than $1.0 \text{ (m}^2\cdot\text{K)/W}$.

The declared thermal conductivity shall not be less than $\lambda_{50/90}$, and shall be rounded upwards to the nearest $0.001 \text{ W/(m}\cdot\text{K)}$.

Where thermal resistance could be lower in the long term (see Clause 2.3.1), the declared values shall take this into account, through the application of the accelerated ageing methods listed in Table 2.3.3.1. The determination of aged thermal performance shall also use at least 10 representative test specimens.

2.3.3.6 *Assessment of similar materials of differing nominal thickness*

Where a group of homogenous bulk insulation products of similar chemical and physical composition and differing only in thickness are expected to have the same thermal conductivity, only the thickest and thinnest products within the group need to be tested as a minimum requirement. Declared thermal conductivity for each tested thickness shall be determined from a minimum of 10 specimens in accordance with Clause 2.3.3.5. The highest declared thermal conductivity shall be taken to apply to the whole group and used to calculate the declared R-value for each product thickness within the group. Extrapolation shall not exceed 20 mm, to a maximum of 20% of the thickness tested, outside the tested thickness range.

Where aged thermal conductivity values are influenced by facings applied to the products (e.g. some rigid foams), separate product groups shall be established for products without facing, for products with diffusion open facing, and for products with diffusion tight facing.

2.3.3.7 *Alternative method for calculation of R-value for pipe insulation*

As an alternative to test method ASTM C335, as specified in Table 2.3.3.1, it is permitted to calculate the material R-value of pre-formed pipe insulation by measuring the thermal conductivity as a formed shape in accordance with Clause 2.3.3 on a planar section of insulation of the same specification as that of the pre-formed pipe section. The following formula shall then be applied to determine the material R-value of the pre-formed dimensions:

$$R = (r_2 \log_e(r_2/r_1))/k \quad \dots 2.3.3.7$$

where

R = material R-value of the pre-formed pipe insulation section

r_1 = inner radius of the pipe insulation, in metres

r_2 = outer radius of the pipe insulation, in metres

k = thermal conductivity of the insulation in planar form, in watts per metre kelvin

2.3.3.8 *Reporting of test results*

Test reports shall satisfy the reporting requirements of the relevant test method.

For loose fill materials, the report shall state whether or not the variation set out in Appendix C (for remotely blown pneumatically applied materials) has been adopted and, if so, the density of the material, as nominated by the supplier, and the method of agitation used to restore the sample to the blown density.