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AS/NZS 4859.1

Australian/New Zealand Standard™

Materials for the thermal insulation of buildings

Part 1: General criteria and technical provisions

Standards Australia

STANDARDS NEW ZEALAND

Paerewa Aotearoa

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee BD-058, Thermal Performance and Insulation of Dwellings. It was approved on behalf of the Council of Standards Australia on 28 August 2002 and on behalf of the Council of Standards New Zealand on 20 August 2002. It was published on 15 October 2002.

The following are represented on Committee BD-058:

Acceptable Standards of Construction Committee NSW
Aluminium Foil Insulation Association
Association of Consulting Engineers Australia
Australian Building Codes Board
Australian Cellulose Insulation Manufacturers Association
Australian Glass and Glazing Association
Australian Industry Group
Australian Institute of Refrigeration Air Conditioning and Heating
Australian Wool Testing Authority
Building Research Association of New Zealand
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Australian/New Zealand Standard™

Materials for the thermal insulation of buildings

Part 1: General criteria and technical provisions

Originated in Australia as part of AS 2352—1980, AS 2461—1981, AS 2462—1981, AS 2463—1981, AS 2464.1—1981, AS 2464.2—1981, AS 2464.3—1983, AS 2464.4—1981, AS 2464.5—1985, AS 2464.6—1983, AS 2464.7—1990 and AS 3742—1990
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AS 2352—1980, AS 2461—1981, AS 2462.—1981 AS 2463—1981, AS 2464.1—1981, AS 2464.2—1981, AS 2464.3—1983, AS 2464.4—1981, AS 2464.5—1985, AS 2464.6—1983, AS 2464.7—1990 and AS 3742—1990 and NZS 4222—1992 jointly revised, amalgamated and redesignated as AS/NZS 4859.1—2002.

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD-058, Thermal Performance and Insulation of Dwellings, to supersede the following standards:

AS

2352—1980	Glossary of terms for thermal insulation of buildings
2461—1981	Mineral wool thermal insulation—Loose fill
2462—1981	Cellulosic fibre thermal insulation
2463—1981	Sea grass bulk thermal insulation
2464.1—1981	Methods of testing thermal insulation, Part 1: Corrosiveness of thermal insulation
2464.2—1981	Methods of testing thermal insulation, Part 2: Bulk density of blown fibrous loose-fill thermal insulation
2464.3—1983	Methods of testing thermal insulation, Part 3: Thermal resistance of low-density fibrous loose-fill thermal insulation
2464.4—1981	Methods of testing thermal insulation, Part 4: Length, width and thickness of batt or blanket type thermal insulation
2464.5—1985	Methods of testing thermal insulation, Part 5: Steady-state thermal transmission properties by means of the heat flow meter
2464.6—1983	Methods of testing thermal insulation, Part 6: Steady-state thermal transmission properties by means of the guarded hotplate
2464.7—1990	Methods of testing thermal insulation, Part 7: Determination of the average thermal resistance of low-density mineral wool thermal insulation—Batt and blanket
3742—1990	Mineral wool thermal insulation—Batt and blanket

NZS

4222:1992	Materials for the thermal insulation of buildings

The objective of this Standard is to address the standardization and performance verification requirements of all thermal insulation materials that may be used in buildings. Insulation materials or assemblies are broadly classified into groups, having different testing requirements over a number of aspects of performance. These classifications may be applied to all unspecified products and materials according to definable characteristics. This Standard also provides specific requirements for individual types of insulation materials.

Particular 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 durability.

Standards Australia draws attention to the fact that this is not an installation Standard. Installation requirements can be obtained from other sources, including AS 3999. The sections of this Standard that relate to individual types of insulation materials may make some reference to installation matters where these are closely linked to the specification and performance requirements of the material or assembly.

This Standard does not deal with performance requirements for systems or materials that have some primary function other than providing thermal insulation. Where some other primary purpose is to be served by the material or system (e.g., sarking, structural panels etc.) compliance with this Standard alone shall not be seen as sufficient. In those cases reference to other appropriate Standards shall be made.

In this Standard, notes are for information and guidance only and compliance with them is not a requirement of the Standard.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

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.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Materials for the thermal insulation of buildings

Part 1: General criteria and technical provisions

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements and methods of test for materials that are added to, or incorporated in, opaque envelopes of buildings, to provide thermal insulation by moderating the flow of heat through these envelopes.

This Standard does not cover materials for the insulation of equipment, building facilities, windows or other glazings.

Specific requirements for individual materials or insulation types are given in Sections 5 to 9 of this Standard and in the following Standards:

(a) Rigid cellular polyurethane (RC/PUR) .... AS 1366.1.

(b) Rigid cellular polyisocyanurate (RC/PIR) .... AS 1366.2.

(c) Rigid cellular polystyrene Moulded (RC/PS-M) .... AS 1366.3.

(d) Rigid cellular polystyrene Extruded (RC/PS-E) .... AS 1366.4.

(e) Urea-formaldehyde foam thermal insulation—In situ set foam...................... AS 4073.

The scope of this Standard does not cover requirements for fire performance.

1.2 APPLICATION

This Standard is applicable to the full range of climatic and environmental conditions that exist under normal circumstances. It is intended for use by regulatory and specifying authorities, insulation manufacturers, developers, architects, builders, building engineers, property managers and commercial and residential building owners.

In order to comply with this Standard, a material or assembly that falls within the scope of AS 1366.1, AS 1366.2, AS 1366.3, AS 1366.4 or AS 4073 shall, apart from fire performance, comply with the requirements of that standard unless overridden by this Standard.

Materials or assemblies that do not fall within the scope of one of the above Standards or Sections 5 to 9 of this Standard, need only comply with Sections 1 to 4 of this Standard

NOTE: Alternative means for demonstrating compliance with this Standard are given in Appendix A.

1.3 UNSPECIFIED MATERIALS AND SYSTEMS

This Standard should not be interpreted as preventing the use of systems and materials that meet the performance criteria set out in this Standard, but are not specifically referred to in it.

NOTE: The inclusion of performance criteria in this Standard provides flexibility and allows for the use of alternative systems; however, the alternative system has to be verified as meeting the level of performance described in the performance criteria. Building regulations typically provide that acceptance of alternatives to the deemed-to-satisfy requirements is the prerogative of the relevant regulatory authority. Where performance criteria have not been included in this Standard, equivalence with the relevant deemed-to-satisfy requirement is to be achieved as a means of verifying the adequacy of an alternative system.

1.4 REFERENCED DOCUMENTS

The documents referred to in this Standard are listed in Appendix B.

1.5 DEFINITIONS

1.5.1 General

The definitions provided in ASTM C 168 shall be applicable this Standard.

NOTE: For additional information, see ISO 9229

1.5.2 Qualifications to definitions in ASTM C 168

The following additional qualifications shall apply to the definitions in ASTM C 168.

1.5.2.1 *Material thermal resistance, (R_m), m^2.K/W*

A resistance associated with a material, specified as a Material R. Excluding surface film resistances (see conductance, film and surface coefficient).

1.5.2.2 *System thermal resistance, (R_{sys}), m^2.K/W*

A resistance associated with a system or construction of different materials, specified as a System R. Excluding surface film resistances (see conductance, film and surface coefficient).

1.5.3 Additional definitions

1.5.3.1 *Pack*

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

1.5.3.2 *Pliable non-reflective insulation*

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

1.5.3.3 *Total thermal resistance, (R_t) m^2.K/W*

A total resistance associated with a material or a system or construction of materials, specified as a Total R, including surface film resistances (see conductance, film and surface coefficient).

1.5.3.4 *Stabilized*

The final value, representing the installed condition, allowing for settlement of loose fill materials and other installation related factors, when referring to thickness, density, thermal resistance and thermal conductivity.

1.5.3.5 *Solar*

The qualifying term applied to the reflectance and absorptance of surfaces for incident radiation with a spectral composition matching the solar spectrum.

1.5.3.6 *Wool*

Wool derived from the fleece of sheep.

NOTE: The term 'wool' may be used as a qualifying term to describe the fibrous nature of materials such as 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.

1.5.3.7 *Segmented foil insulation*

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 barrier.

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.

Except as specifically provided in this Standard, the characteristics of thermal insulation materials and systems, including integral covering, finishing or binding agents, shall be suitable for the purpose.

Characteristics to consider in determining suitability for purpose include—

(a) known safety issues; and

(b) freedom from objectionable odour; and

(c) the influence of aging.

NOTES:

1 The thermal properties and safety of insulation depend not only on the quality of the insulating materials, but also on their proper and workmanlike installation.

2 Where due care is not taken to comply with installation instructions, insulation may have reduced thermal effectiveness, cause fire hazards or other unsafe conditions and promote deterioration of the structure.

3 Some useful analysis of potential impact in terms of loss of thermal performance due to poor installation practice is given in BRANZ, *A Manual for Calculating R-values Using the Isothermal plane Method*, H.A. Trethowan, 1997.

4 Installation practice should take into account the deleterious effect of moisture ingress on thermal performance. Due care should be taken to prevent the insulation material from becoming wet.

5 Manufacturers should supply installation instructions.

6 For guidance on installation see AS 3999 and AS/NZS 4200.2.

2.2 VALIDITY OF TEST RESULTS

For materials that do not change in formulation or design, the test results shall be valid for a maximum period of 5 years from the date of measurement, computation or test.

Any changes made by the manufacturer to formulation or design, which may affect the performance, shall invalidate test results, and retesting shall be required.

2.3 THERMAL RESISTANCE

2.3.1 General

Thermal resistance of insulation materials may be highly dependant on boundary conditions and other environmental factors encountered in buildings and common insulation delivery systems. Thermal resistance (material, system or total) refers to the in situ or in-service condition. It is the intent of the methods and procedures contained in this Standard that the measured and/or declared thermal resistance shall reflect as accurately as possible the performance encountered within buildings.

NOTES:

1 Some materials may 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 reflective insulations, outgassing of blowing gasses in foam insulations and settlement of loose fill insulations. The declared thermal resistance should be the value achieved in the long term (see ISO 10456).

2 Some compression-packaged materials may take time to achieve their stabilized thickness and R-Value. When the declared R-value is not expected to be achieved until some time after installation, that time should be stated on the label.

3 For guidance on measurement of thermal resistance see, Appendix C.

4 The moisture content of materials will affect their thermal resistance.

2.3.2 Classification

Materials shall be classified as follows:

(a) Formed shapes Self-supporting shapes that do not have reflective external surfaces and which 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.

Formed shapes may be panels, complete building elements such as walls or roofs, or other assemblies of different materials, which may include or combine bulk and reflective components internally but satisfy the requirement of small-scale uniformity.

NOTE: For uniformity considerations, see Appendix C.

Formed shapes include all bulk insulation materials with solid, cellular, fibrous 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 that are not supplied compression packaged.

(b) Formed in situ Materials such as paints and other coatings, sprayed fibres, and foamed in situ plastics.

(c) Low-density fibrous Pre-formed insulation, including blanket, commonly compressible, that may be supplied cut into pieces and usually supplied compression packaged, e.g., rock wool, glass wool, polyester fibre, wool and like materials. Materials of this type are expected to exhibit substantial variation in density, thickness, resiliency, and thickness regain, after compressed packaging. Where materials have demonstrated, through previous testing, a level of uniformity high enough to give an uncertainty of less than ±5% in thermal resistance due to these factors, the material may alternatively be considered as being 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) Reflective Membranes, formed shapes and low density fibrous materials that incorporate one or more external 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. reflective foil insulation, reflective claddings and facings of buildings and foil-faced pieces and blankets, where used in applications that satisfy the requirement of small-scale uniformity.

(f) Large-scale Insulation materials or assemblies that may fit the description of one of the above categories but have different requirements for determination of thermal resistance since, as incorporated in a building, they do not provide uniform thermal performance on a scale small enough to permit thermal resistance determination by physical measurement of heat flow through a representative area. Reflective products are often used in ways that place them in this category since, as installed, they do not satisfy the requirement of small-scale uniformity and so cannot be directly measured using available measurement methods.

2.3.3 Determination of R-value

2.3.3.1 *General*

Thermal resistance shall be determined in accordance with the test methods prescribed in Table 2.1.

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

TABLE 2.1

STANDARD METHODS FOR DETERMINATION OF THERMAL PROPERTIES

Classification	Test Methods
Formed shapes and Formed-in-situ	ASTM C 177, C 518, C 1363, ISO 8301, 8302, 8990
Low density fibrous	ASTM C 653 and Appendix D
Loose fills	ASTM C 687 and Appendix E
Reflective	ASTM C 177, C 518, C 1363, ISO 8301, 8302, 8990
Large-scale	Computations carried out in accordance with Clause 4.3 and able to provide equally reliable results as physical testing of the material or system

2.3.3.2 *Test protocol*

The test methods listed in Table 2.1 and calculations shall be performed for appropriate environmental and installation conditions. All factors that are known to affect the installed thermal resistance shall be taken into account and stated, including—

(a) temperatures that affect heat flow, including the hot and cold surfaces of the insulation material or assembly and other relevant temperatures;

(b) airflows around the insulation material or assembly that influence heat flow, including ventilation effects and convection within airspaces or within insulation materials;

(c) radiant energy level, including effects due to adjacent hot or cold surfaces and radiation penetration through insulation materials (or assemblies) that have some transparency to infra-red frequencies;

(d) dimensions and orientation of structures and materials;

(e) infra-red reflectance of surfaces; and

(f) moisture content in service.

2.3.3.3 *Mean temperatures*

For comparison of bulk products, thermal resistance shall be determined at a standard mean temperature of 23 ±1°C for products sold in Australia and 15 ±1°C for products sold in New Zealand. For accurate thermal design purposes, thermal resistance should be determined at the appropriate operating temperatures.

Where testing laboratories are, for technical reasons, unable to measure at the appropriate mean temperature, thermal resistance shall be determined by extrapolation of measurements performed at a minimum of two other mean temperatures.

NOTES:

1 ISO 10456 provides calculation methods, which may be used to correct measured conductivities to different temperatures for common insulants under limited conditions.

2 Figure 2.1 illustrates the importance of using appropriate temperatures when estimating heat flow from design data for bulk insulation materials.

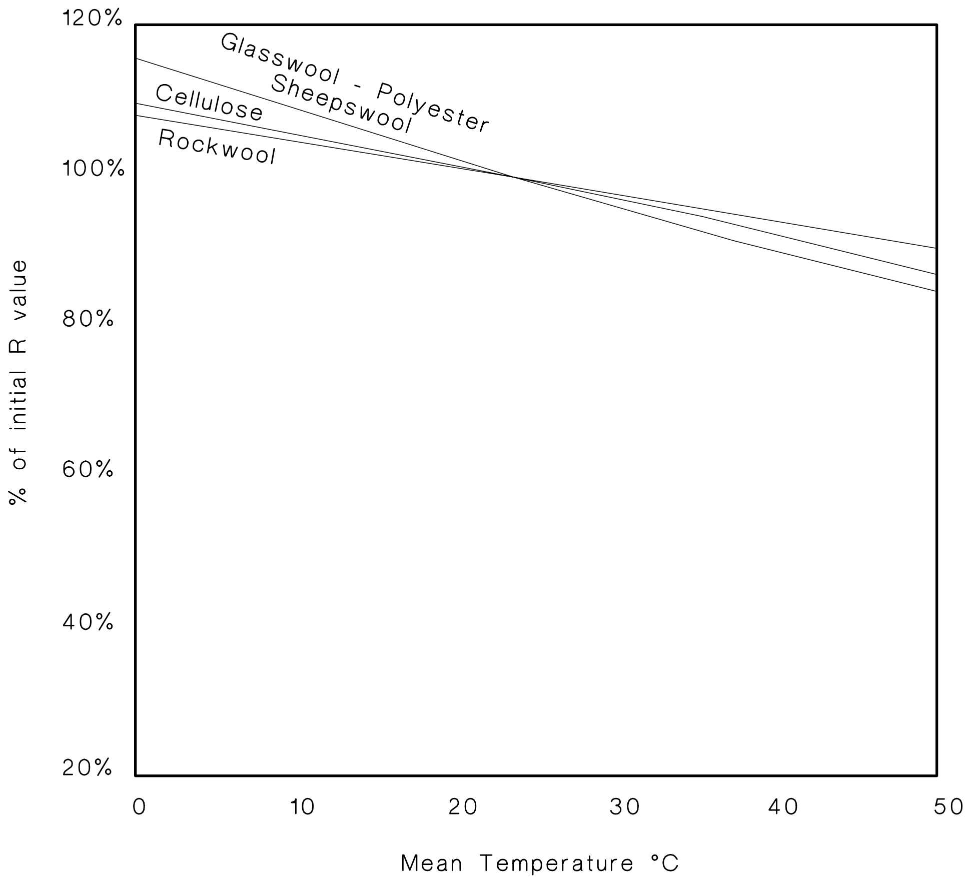


FIGURE 2.1 EFFECT OF MEAN TEMPERATURE ON R VALUE

2.3.3.4 *Temperature differences*

The thermal resistance of materials and systems that include any reflective airspaces shall be measured or computed for three standard values of air temperature difference between indoors and outdoors, in order to accommodate the likely dependence on this factor. These temperature differences shall be 18 ±1/2 K, 12 ±1/2 K and 6 ±1/2 K.

The actual temperature conditions around the material or assembly shall be consistent with the standard values of overall temperature difference between outdoors and indoors. Additionally, the overall temperature difference shall be consistent with actual indoor and outdoor temperatures that are appropriate for the climate, season and direction of heat flow.

NOTES:

1 For accurate thermal design purposes, thermal resistance should be determined at the appropriate temperature difference.

2 Figure 2.2 shows the effect of temperature difference on the R-value of a vertical reflective airspace, Based on Robinson and Powlich.

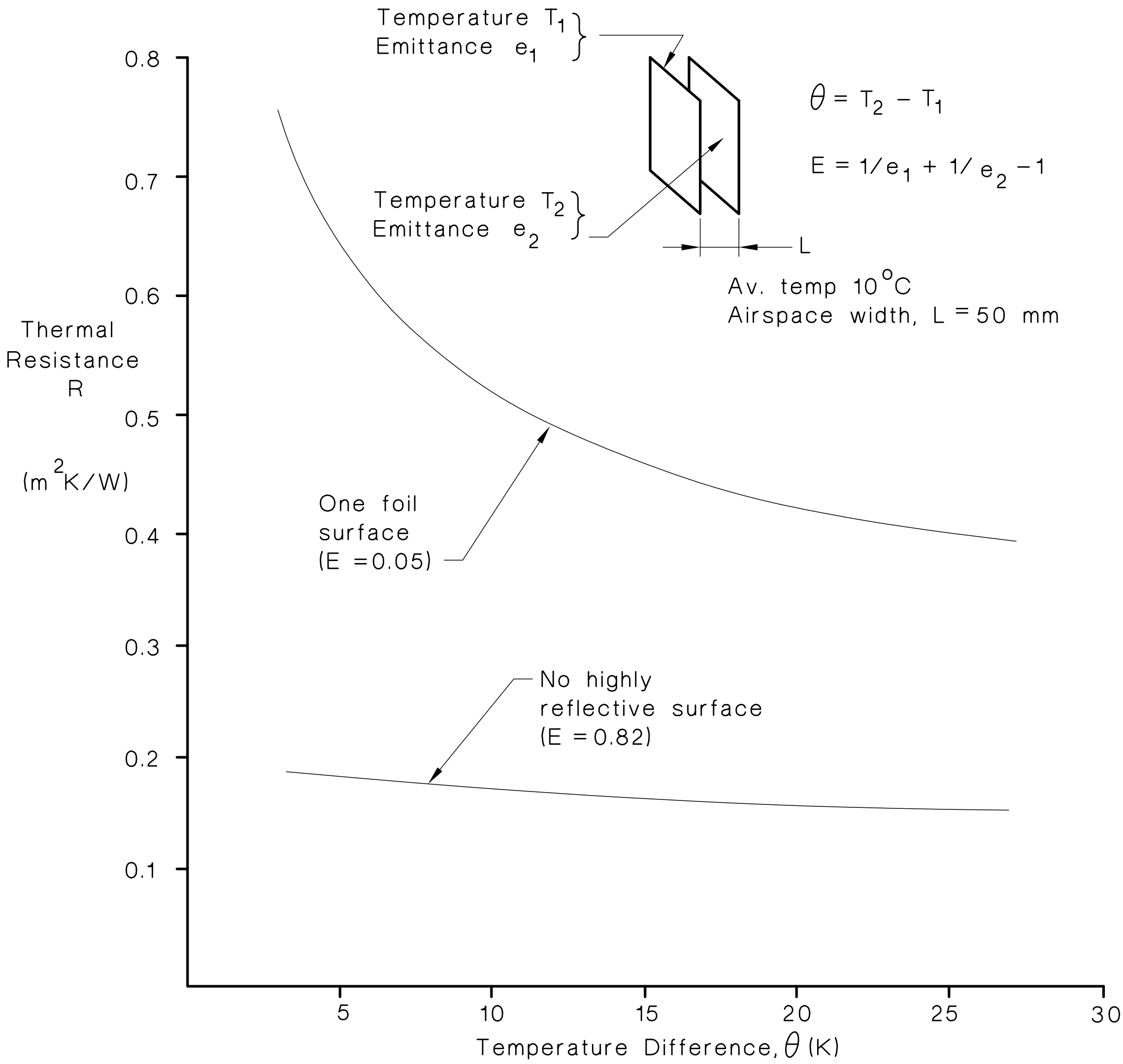


FIGURE 2.2 THERMAL RESISTANCE vs TEMPERATURE DIFFERENCE FOR VERTICAL REFLECTIVE AIRSPACE

2.3.3.5 *Material uniformity*

Where the structure of an insulation material or assembly is such that spatial variation in thermal resistance might exist, thermal resistance measurements shall be performed at two or more locations across the material or assembly, as required, to derive a statistically representative average.

2.3.3.6 *Reflective materials*

The thermal resistance of a reflective material or assembly shall be expressed as either system R-value (R_{sys}) or a total R-value (R_t) (see also Table 4.1), and shall be the combined thermal resistance arising from—

(a) contributions by any bulk material that is part of the material or assembly; and

(b) contributions by the adjacent spaces or airspaces that the material or assembly reflectively bounds.

NOTE: See *A Manual for Calculating R-values Using the Isothermal Plane Method.* for calculations relating to the effects of thermal bridging, convective bridging and workmanship errors that might affect system R-value

2.3.3.7 *Low density fibrous materials*

The declared thermal resistance (material R-value) of any lot (as described in ASTM C 653) of low-density fibrous insulation shall not be greater than the actual average thermal resistance of the lot as determined in accordance with Clause 2.2.

The declared thermal resistance of the lot (material R-value) shall be a value such that not less than 95% of individual packs of low-density fibrous insulation shall have an average thermal resistance, as determined in accordance with Clause 2.2, that is not less than 90% of this declared thermal resistance.

The declared thermal resistance (material R-value) shall apply to the material—

(a) in an unrestrained state; and

(b) in a dry (ambient) state.

NOTE: Thickness reduction due to compression, or the presence of free water, will reduce the thermal resistance of the material.

2.3.3.8 *Reporting of test results*

The report on thermal resistance shall include the following:

(a) Values for all temperatures that affect heat flow including the hot and cold surfaces of an insulation material or assembly.

(b) Values for the effective temperature of the environment that faces both the hot and the cold surfaces of an insulation material or assembly, and which act as source and sink temperatures for heat transfer attributable to penetration of thermal radiation.

(c) A statement concerning relevant airflows, ventilation effects and convection around and within an insulation material or assembly

(d) Dimensions and orientation of structures and materials.

(e) The infrared emittance of relevant surfaces.

(f) A statement of compliance with the test method employed (as specified in Table 2.1).

(g) All of the reporting requirements of the relevant test method.

(h) A statement of the type(s) of accreditation held by the laboratory for the test method employed (see Section 4).

(i) A statement of compliance with this Standard.

(j) The conditions of validity as described in Section 2.2.3.8.

In the case of low density fibrous materials, the report shall include statements as to the adoption or otherwise of the variations set out in Appendix D.

For loose fill materials, the report shall state whether or not the variation set out in Appendix E (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.

2.4 INFRA-RED EMITTANCE

Where insulating materials or assemblies achieve some or all of their thermal resistance through the reflective nature of their external surfaces, and these surfaces are claimed to have an infrared emittance less than 0.9, the infrared emittance of these surfaces shall be determined. Measurement shall be in accordance with ASTM E 408, and shall be stated on the label and literature and in conjunction with measurements or calculations of thermal resistance (see Clause 2.2).

NOTES:

1 The definitions of reflectance and emittance are complex; however, in the case where total hemispherical properties over the full infra red spectrum are being considered:

$$\text{emittance} = 1 - \text{reflectance}$$

2 This Standard does not prescribe minimum or maximum requirements for infra-red emittance and does not include methods to determine the emittance of materials that are not claimed to be reflective.

3 See Appendix F for guidance on infra-red emittance

2.5 SOLAR REFLECTANCE

NOTE: See Appendix G for information on solar reflectance.

2.5.1 Classification

Materials and surface coatings shall be classified as follows:

(a) Solar-reflective Materials or coatings that may receive direct or indirect solar radiation from the sky and that are intended to influence the thermal performance of the building due to reflection or absorption of this radiation.

(b) Non-solar-reflective Materials or coatings that are not intended to influence the thermal performance of the building due to reflection or absorption of solar radiation.

2.5.2 Measurement

The method and apparatus used to determine solar reflectance shall be capable of measuring hemispherical total diffuse solar reflectance.

The solar reflectance of all solar-reflective materials and coatings shall be measured, and shall be stated in conjunction with measurements or calculations of the effect of the solar reflective material on the thermal performance of a building. Determination of the solar reflectance of non-solar-reflective materials is not required.

NOTES:

1 A method and apparatus suitable to determine solar reflectance is described in Integrating sphere for solar transmittance measurement of planar and non-planar samples, *Applied Optics*, 1982, Vol. 21, No. 15.

2 This Standard does not prescribe minimum or maximum requirements for solar reflectance and does not include requirements to determine the solar reflectance of materials that are not claimed to be solar-reflective.

2.5.3 Thermal resistance of solar reflective materials and coatings

Where a solar-reflective material or coating is claimed to have thermal resistance, it shall be measured in accordance with Clause 2.2.

2.6 CORROSIVENESS

When tested in accordance with Appendix H, materials and assemblies shall be non-corrosive.

Materials and assemblies are exempt from this test if they are composed entirely of mineral or plastic fibres (such as rock wool, glass wool, polyester fibre) with or without inert binders (such as phenyl formaldehyde resins), inert plastics (foamed or solid), or inert minerals that do not react with liquid water.

Cellulose fibre that contains certain formulations of fire-retardant chemicals as its sole additives shall be regarded as non-corrosive and exempt from the requirement for corrosion testing (see Section 5).

NOTE: This requirement addresses the possible tendency of some insulation materials, especially those incorporating water-soluble ionic additives (e.g., salts used as fire retardants) to increase the risk of corrosion damage to building structures and elements in contact with such agents. It does not, however, address the question of the resistance of the insulation itself to corrosion damage. This requires a test that is relevant primarily to foils and sarking (see Clause 9.3.3).

SECTION 3 PACKAGING AND LABELLING

3.1 GENERAL

The insulation material or assembly shall be packaged by the manufacturer or agent in such a way as to provide adequate protection during handling, transport and storage. Packaging shall be adequate to provide reasonable expectation that performance will be maintained through normal storage and handling, with particular regard to the possible effects of excessive compression.

NOTE: Figure 3.1 shows the loss of R-value with reduction in material thickness due to compression.

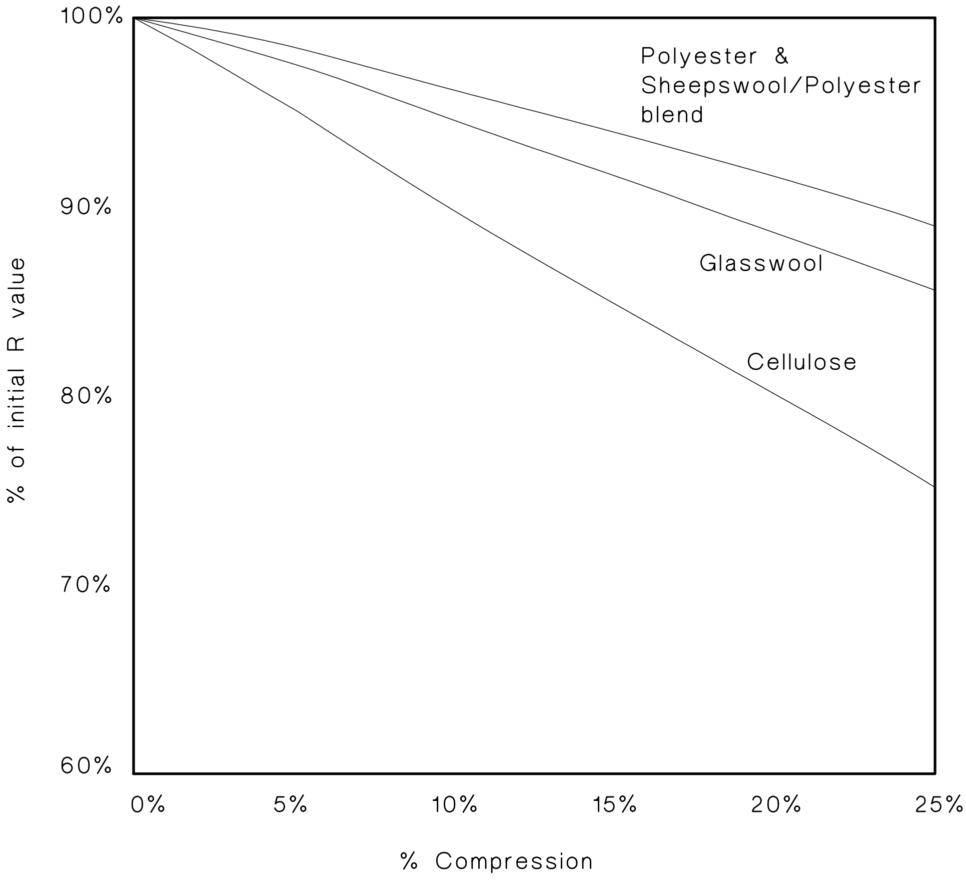


FIGURE 3.1 EFFECT OF COMPRESSION ON R-VALUE OF BULK INSULATION

Labelling shall include at least one of the terms; 'R', 'R-value', 'R-value' 'Thermal Resistance' to describe thermal resistance values. These terms shall be qualified with the term 'declared' together with one of the terms 'material', 'system' or 'total' (see Clauses 1.5.2.1, 1.5.2.2 and 1.5.3.3).

The declared R-value shall be the long-term value and shall take into account the derating that may arise through aging or environmental factors (see Clause 2.3.1 and ISO 10456).

Labelling shall comply with Table 3.1. Additional information may be provided by the manufacturer or agent. The required information shall be conspicuous.

Where the product is supplied for retail sale in packaged quantities, labelling in accordance with Table 3.1 shall be provided with each package.

Where the product is not supplied in packaged quantities with labelling in accordance with Table 3.1, the manufacturer shall supply documentation that conveys the same information as Table 3.1.

NOTE: Formed shapes and low-density fibrous materials may be used in situations where space is limited. In order to ascertain that the material will fit within an available space without being compressed, the product thickness, as stated on the label, should be noted. Loss of material R-value due to compression is less than the loss in thickness. Typically 5% loss of material R-value may occur for a 10% loss in thickness, depending on the initial density and the type of material (see *A Manual for Calculating R-values Using the Isothermal Plane Method*).

3.2 SAFETY INSTRUCTIONS

Where applicable, safety instructions shall include one of the following statements (see AS/NZS 3008.1.1):

CAUTION: ELECTRIC CABLES AND EQUIPMENT PARTIALLY OR COMPLETELY SURROUNDED WITH BULK THERMAL INSULATION MAY OVERHEAT AND FAIL. THIS APPLIES TO WIRING INSTALLED PRIOR TO 1989. READ THE INSTRUCTIONS ACCOMPANYING THIS PACK.

CAUTION: ELECTRIC CABLES AND EQUIPMENT PARTIALLY OR COMPLETELY SURROUNDED WITH BULK THERMAL INSULATION MAY OVERHEAT AND FAIL. THIS APPLIES TO WIRING INSTALLED PRIOR TO 1989. READ THE FOLLOWING INSTRUCTIONS.

TABLE 3.1

LABELLING REQUIREMENT

Type of material	Information required
All types	Product name Description of contents Name and address of manufacturer Batch identification or other traceability information Safety instructions A statement of compliance with this Standard, i.e., AS/NZS 4859.1 One or more declared R-values (m^2.K/W), accompanied by a clear statement as to the conditions under which it/they apply and preceded by one or more of the qualifiers 'Total', 'System' or 'Material' as appropriate. When 'heat flow up' or 'heat flow down' or 'Summer' and 'Winter' R-values are different, all values shall be quoted with equal emphasis
Reflective	A statement "the contribution of this product to total R value depends on installation and environmental conditions"
Loose fill and formed in situ	Nominal coverage (area per unit mass) and stabilized thickness (mm), for each declared R-value Nominal net weight of contents or supplied quantity (kg) A statement 'the total R value depends on installation and may be greater than or less than the R value of the product'
Formed shapes	Number of pieces Nominal total area (m^2) Nominal length, width and thickness of each piece Nominal net weight of contents or supplied quantity (kg) A statement 'the total R value depends on installation and may be greater than or less than the R value of the product'
Low-density fibrous	The statement 'This pack complies with AS/NZS 4859.1 for a net weight of xx kg, a total area of yy m^2 and a mean thickness of zz mm' where xx, yy and zz appear on a valid and current report of measurement of thermal resistance in accordance with this Standard Number of pieces Nominal total area (m^2) Nominal length and width of each piece Nominal stabilized thickness A statement of the time after installation to achieve nominal stabilized thickness and R-value A statement 'the performance of this product may be reduced if stored for too long in its compression packaging' A statement 'the total R value depends on installation and may be greater than or less than the R value of the product'

NOTE: The requirements of Table 3.1 are not to be construed as limiting the information that is to be provided or as indicating any particular emphasis to be given to the information provided.

SECTION 4 DEMONSTRATION OF COMPLIANCE

4.1 GENERAL

This Section sets out requirements for the demonstration of compliance with this Standard, of materials used in the thermal insulation of buildings.

4.2 ACCEPTANCE OF TESTING

Where a performance is measured by testing, it shall be performed by a recognized laboratory (see note 1).

NOTES:

1 A recognized laboratory should have accreditation or recognition for testing to the relevant standards and procedures, either to ISO 17025 or to the requirements of a recognized national laboratory accreditation scheme.

2 It is expected that the application and levels of all factors affecting the thermal resistance would be standardized by agreement between recognized laboratories

4.3 ACCEPTANCE OF CALCULATIONS

Where a performance is calculated, the calculations shall be performed by an appropriately qualified person/consultant and shall be accompanied by endorsement from a laboratory that has recognition in accordance with Section 4.2.

4.4 DEMONSTRATION OF COMPLIANCE

Where compliance with AS/NZS 4859 is claimed, the claimant shall provide the following.

(a) Details of the means of demonstrating compliance.

NOTE: Means for demonstrating compliance with this Standard are given in Appendix A.

(b) A list of the tests that have been performed

(c) For each listed test —

(i) the name of the testing laboratory;

(ii) the date(s) of test;

(iii) the designation of the test Standard(s) or procedure(s), including the level and application of performance-affecting factors in Clause 2.3.3.2;

(iv) the test report number(s); and

(v) the type of recognition held by the laboratory to perform the test.

(d) A list of the calculations that have been performed.

(e) For each calculation —

(i) the name of the person who performed the calculations;

(ii) the date(s) of calculation;

(iii) the temperature conditions and the level and application of performance-affecting factors in Clause 2.3.3.2;

(iv) the report number(s);

(v) the name of the testing laboratory that has endorsed the consultant's report;

(vi) a signed dated stamp of acceptance or recognition of the calculations by the testing laboratory; and

(vii) the type of accreditation held by the laboratory to perform the test.

(f) Copies of test and calculation reports to be made available upon request.

SECTION 5 CELLULOSE FIBRE INSULATION

5.1 GENERAL

This Section provides specific requirements for loose-fill insulation composed of cellulose fibre made from paper or paperboard stock derived from wood, in addition to fire retardant chemicals, with the total of these ingredients comprising more than 95% by weight of the product on a dry basis.

This Section shall be read in conjunction with Sections 1 to 4.

5.2 PERFORMANCE CRITERIA AND TECHNICAL PROVISIONS

5.2.1 Physical

The paper or paperboard stock used in the manufacture of cellulose fibre insulation may be used (recycled) or unused material.

The product shall have a stabilized density of between 20 kg/m^3 and 70 kg/m^3.

5.2.2 Corrosion

If the fire-retardant formulation is the sole additive and is a mixture of boric acid and borax, with the borax being between 15% and 35% of the mixture by weight and the total quantity of fire retardant being not less than 17% of the finished product by weight, then this product shall be regarded as non-corrosive and exempt from the requirement for corrosion testing.

All other formulations shall pass the requirements of Appendix H.

5.2.3 Moisture absorptance

Materials shall have a moisture absorption of less than 20% when tested in accordance with ASTM C739.

SECTION 6 INSULATION CONTAINING WOOL

6.1 GENERAL

This Section provides specific requirements for insulation containing wool comprising more than 5% by weight of the product, which includes fire retardants and insect protective agents applied during the manufacturing process.

This Section shall be read in conjunction with Sections 1 to 4.

6.2 PERFORMANCE CRITERIA AND TECHNICAL PROVISIONS

6.2.1 Thermal resistance

As wool can exhibit slow loft recovery after compression packaging, the product shall be conditioned at 45 ±1°C and 60 ±5% relative humidity for 24 h to accelerate relofting prior to thermal testing. The thermal resistance shall be determined at the lesser of the relofted thickness and the declared thickness.

NOTES:

1 If the artificially lofted thickness is less than the label declared thickness, the product may be tested for thermal resistance using ASTM C653 to determine the R-value of the pack at the artificially lofted thickness. If the thickness is less than the declared value, the thermal resistance will probably be lower. For example, a 10% shortfall in thickness is likely to result in a 5% lower thermal resistance.

2 Wool typically recovers to a stable thickness within a month after installation depending on the degree of packaging compression and the ambient environmental conditions. The label is required to carry a declaration of the time interval after installation that the product will achieve the declared thickness and, therefore, R-value. The conditioning requirements of this Standard are to expedite product thermal testing, and the ability of the product to naturally loft to its declared thickness has to be proven in addition to the thermal resistance measurement.

6.2.2 Physical

6.2.2.1 *General*

The wool used in the manufacture of wool insulation may be used (recycled) or unused material.

Raw wool shall be scoured (washed) to effectively remove wool wax (wool grease), suint and dirt present on the raw wool fibre.

If recycled wool is used, it shall be free of processing additives such as spinning oils or other blend fibres that will adversely affect its fire performance.

6.2.2.2 *Vegetable content*

When measured in accordance with AS 1134, vegetable content of scoured wool shall be a maximum of 3%.

NOTES:

1 Vegetable matter mainly affects appearance of the wool product, although under some circumstances it could act as a food source for silverfish or vermin.

2 In some locations, there may also be restrictions on transport of material containing viable seed matter.

6.2.3 Insect resistance

Wool insulation shall be treated to resist insect attack. When tested for insect resistance in accordance with AS 2001.6.1, wool insulation materials shall achieve a 'satisfactory' rating.

NOTE: Insulation containing untreated wool is liable to attack by certain insect species (clothes moths or carpet beetles) using the wool as a protein source. Whilst these insects are destroyed by prolonged exposure to temperatures above 50°C, these temperatures are rarely reached through the insulation mass in most parts of Australia. Because some insect-resistant agents act as anti-feedants, uniform coverage of the wool is required. Depending on the method of treatment, some loss of protective agent by dusting during installation is also possible. Sample for insect bioassay testing shall be representative of insulation as installed.

6.3 LABELLING

The wool fibre content shall be measured in accordance with AS 2001.7. If the wool fibre content is greater than 95%, the insulation content may be described as 'wool' on the label. Otherwise the actual fibre content shall be specified on the label

NOTES:

1 The mass of wool may change depending on the relative humidity of the atmosphere. Calculations of wool mass during manufacture and specification of wool content should be based on conditioned mass at 65% relative humidity, 20°C, as testing of fibre composition will also be corrected to these 'standard conditions'.

2 If water-soluble and solvent-soluble agents are present on the wool, these will be removed in the precleaning process under AS 2001.7 before wool content is determined. The mass of fire retardant and insect resist agents may be independently determined and included with the weight of wool fibre for the purposes of defining the material composition. Wool fibre contents should be measured using a sample mass of 10g rather than the 1g specified in AS 2001.7.

SECTION 7 LOW DENSITY POLYESTER FIBRE INSULATION

7.1 GENERAL

This Section provides specific requirements for low density fibrous insulation, which may be supplied as blankets or cut pieces and is composed of polyester fibre, with the possible addition of adhesive binders applied during the manufacturing process, with the total of these ingredients comprising more than 95% by weight of the product.

This Section shall be read in conjunction with Sections 1 to 4.

7.2 PERFORMANCE CRITERIA AND TECHNICAL PROVISIONS

7.2.1 Thermal resistance

As polyester can exhibit slow loft recovery after compression packaging, the product shall be conditioned at 45 ±1°C for 24 h to accelerate relofting prior to thermal testing. The thermal resistance shall be determined at the lesser of the relofted thickness and the declared thickness.

NOTES:

1 If the artificially lofted thickness is less than the label declared thickness, the product may be tested for thermal resistance using ASTM C653 to determine the R-value of the pack at the artificially lofted thickness. If the thickness is less than the declared value, the thermal resistance will probably also be lower. For example a 10% shortfall in thickness is likely to result in a 5% lower thermal resistance.

2 Polyester typically recovers to a stable thickness within a month after installation depending on the degree of packaging compression and the ambient environmental conditions. The label is required to carry a declaration of the time interval after installation that the product will achieve the declared thickness and, therefore, R-value. The conditioning requirements of this Standard are to expedite product thermal testing, and the ability of the product to naturally loft to its declared thickness has to be proven in addition to the thermal resistance measurement.

7.2.2 Physical

The polyester fibres shall be bonded into resilient cut pieces or blankets using either heat-bonding of low melt-temperature polyester fibres as a fraction of the fibre mix or using spray-adhesive bonding.

7.2.3 Dimensional tolerances

When any blanket or cut piece from any pack is measured in accordance with ASTM C167, the average length and width dimensions shall be the values nominated by the manufacturer on the product label, within the tolerances given in Table 7.1.

TABLE 7.1

DIMENSIONAL TOLERANCES

Form of insulation	Length	Width
Cut pieces	+50 mm −5 mm	+10 mm −5 mm
Blankets	+30 mm/m −5 mm/m	+15 mm −5 mm

SECTION 8 LOW DENSITY MINERAL WOOL INSULATION

8.1 GENERAL

This Section provides specific requirements for low density fibrous insulation that may be supplied as blankets or cut pieces, which is composed of mineral wool, in addition to binders applied during the manufacturing process, with the total of these ingredients comprising more than 95% by weight of the product.

This Section shall be read in conjunction with Sections 1 to 4.

8.2 PERFORMANCE CRITERIA AND TECHNICAL PROVISIONS

8.2.1 Physical

Mineral wool shall be manufactured from inorganic oxides or minerals, rock slag or glass. It shall be processed at high temperatures from the molten state into a non-crystalline, substantially fibrous glassy form. It shall be formed into flexible blankets or formed shapes, which may be cut into pieces of certain sizes, or supplied as rolls. Polymeric binders, usually of a thermosetting composition, may be used.

8.2.2 Dimensional tolerances

When material from any pack is measured in accordance with ASTM C167, the average length and width dimensions shall be the value nominated by the manufacturer on the product label (see Section 3), within the tolerances given in Table 8.1.

TABLE 8.1

TOLERANCES ON DIMENSIONS

Form of Insulation	Length	Width
Cut pieces	+30 mm −5 mm	+10 mm −5 mm
Blankets	+20 mm/m −5 mm/m	+15 mm −5 mm

8.3 LABELLING

Unless otherwise stated, labelling requirements shall be as described in Section 3.

SECTION 9 REFLECTIVE INSULATION

9.1 GENERAL

This Section provides specific requirements for insulation that incorporates a reflective metallic surface, in the form of either a rolled metallic foil or a metallic deposit.

This Section shall be read in conjunction with Sections 1 to 4. In addition, insulation materials or assemblies that include bulk insulation components shall comply with the requirements of Sections 5 to 8 and Clause 1.1, as applicable.

9.2 PRODUCT GROUPS

Reflective insulation falls into one of the following product groups:

(a) Group 1 Pliable building membranes that have at least one reflective surface. If the products within this group are installed facing an appropriate airspace, they may provide thermal insulation. If they are marketed for this property, the requirements of this Standard shall apply.

NOTE: These products are often intended to have a prime function as a sarking or vapour barrier. For this application, test methods, performance classifications and installation requirements are covered by AS/NZS 4200.1 and AS/NZS 4200.2.

(b) Group 2 Single sheet segmented reflective pliable membranes for installation between structural members (such as folded single sheet foil laminate).

(c) Group 3 Multiple layers of segmented reflective pliable membranes, formed and assembled to give multiple reflective airspaces for installation between and over structural members.

(d) Group 4 Reflective material bonded directly, or via a substrate, to a rigid insulation or support to provide a product in sheet form for application to structural members.

(e) Group 5 Reflective material bonded directly or via a substrate to a pliable non-reflective insulating material. For installation between or over structural members or in a continuous length.

(f) Group 6 Reflective material bonded directly or via a substrate to the inside of individual wall cladding sheets (metal or plastic), weatherboard type.

(g) Group 7 Reflective material bonded directly, or via a substrate, to the underside of a metal roof or wall sheet.

9.3 PERFORMANCE CRITERIA AND TECHNICAL PROVISIONS

9.3.1 Infra-red emittance

All reflective surfaces shall be tested for infra-red emittance in accordance with Clause 2.4.

9.3.2 Dry delamination

All products shall pass the requirements of AS/NZS 4201.1, with the following modifications:

(a) Group 3 Sample size, full product width +100 mm; number of samples, 4.

(b) Group 7 Test temperature 90 ±2.5°C.

A Group 1 product is exempt from this requirement if it passes the requirements of AS/NZS 4200.1.

9.3.3 Surface corrosion and wet delamination

When tested for resistance to surface corrosion and wet delamination in accordance with Appendix I, all products shall achieve a pass.

A Group 5 product is exempt from this requirement if it incorporates, as its reflective surface, a Group 1 material that meets the requirements of AS/NZS 4200.1.

A Group 1 product is exempt from this requirement if it passes the requirements of AS/NZS 4200.1.

9.4 LABELLING

Each pack of reflective insulation shall include the following:

(a) Infra-red emittance of external reflective surfaces and;

(b) Material declared R Value (for groups 4, 5, 6 and 7 only) and;

(c) System Declared R-value or Total Declared R-value at one standard temperature difference as described in Clause 2.3.3.4, and detailed description of application/system including all properties that may effect the R-value quoted or;

(d) A performance summary sheet separate from the main product identification label as in Table 3.1 but attached to the package in the same manner. For this option, the identification label shall show in place of Declared R Value, the following:

  (i) That the product is reflective insulation

  (ii) Refer to attached performance summary data sheet.

9.5 PACKAGING

Where water-based products are used in the manufacture of the reflective insulation, the manufacturer shall ensure that the product has been adequately dried before packaging.

APPENDIX A

MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD

(Informative)

A1 SCOPE

This Appendix sets out the following different means by which compliance with this Standard can be demonstrated by the manufacturer or supplier:

(a) Evaluation by means of statistical sampling.

(b) The use of a product certification scheme.

(c) Assurance using the acceptability of the supplier's quality system.

(d) Other such means proposed by the manufacturer or supplier and acceptable to the customer.

A2 STATISTICAL SAMPLING

Statistical sampling is a procedure which enables decisions to be made about the quality of batches of items after inspecting or testing only a portion of those items. This procedure will only be valid if the sampling plan has been determined on a statistical basis and the following requirements are met:

(a) The sample needs to be drawn randomly from a population of product of known history. The history needs to enable verification that the product was made from known materials at essentially the same time, by essentially the same processes and under essentially the same system of control.

(b) For each different situation, a suitable sampling plan needs to be defined. A sampling plan for one manufacturer of given capability and product throughput may not be relevant to another manufacturer producing the same items.

In order for statistical sampling to be meaningful to the customer, the manufacturer or supplier needs to demonstrate how the above conditions have been satisfied. Sampling and the establishment of a sampling plan should be carried out in accordance with AS 1199, guidance to which is given in AS 1399.

A3 PRODUCT CERTIFICATION

The purpose of product certification is to provide independent assurance of the claim by the manufacturer that products comply with the stated Standard.

The certification scheme should meet the criteria described in HB 18.28 in that, as well as full type testing from independently sampled production and subsequent verification of conformance, it requires the manufacturer to maintain effective quality planning to control production.

The certification scheme serves to indicate that the products consistently conform to the requirements of the Standard.

A4 SUPPLIER'S QUALITY MANAGEMENT SYSTEM

Where the manufacturer or supplier can demonstrate an audited and registered quality management system complying with the requirements of the appropriate or stipulated Australian or international Standard for a supplier's quality management system or systems, this may provide the necessary confidence that the specified requirements will be met. The quality assurance requirements need to be agreed between the customer and supplier and should include a quality or inspection and test plan to ensure product conformity.

Information on establishing a quality management system is set out in AS/NZS ISO 9001 and AS/NZS ISO 9004.

NOTES:

1 The quality assurance requirements need to be agreed between the customer and supplier and should include a quality or inspection and test plan to ensure product conformity.

2 If the above methods are considered inappropriate, determination of compliance with the requirements of this Standard may be assessed by being based on the results of testing coupled with the manufacturer's guarantee of product conformance. Irrespective of acceptable quality levels or test frequencies, the responsibility remains with the manufacturer or supplier to supply products that conform with the full requirements of the Standard.

APPENDIX B

REFERENCED DOCUMENTS

(Informative)

AS

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

1199 Sampling procedures and tables for inspection by attributes

1366 Rigid cellular plastics sheets for thermal insulation
1366.1 Part l: Rigid cellular polyurethane (RC/PUR)
1366.2 Part 2: Rigid cellular polyisocyanurate (RC/PIR)
1366.3 Part 3: Rigid cellular polystyrene—Moulded (RC/PS-M)
1366.4 Part 4: Rigid cellular polystyrene—Extruded (RC/PS-E)

1399 Guide to AS 1199 Sampling procedures and tables for inspection by attributes

1595 Cold-rolled unalloyed, steel sheet and strip

2001 Methods of test for textiles
2001.6 Part 6: Miscellaneous test
2001.6.1 Method 6.1: Determination of the resistance of textiles to certain insect pests
2001.7 Method 7: Quantitative analysis of fibre mixtures (Set)

3999 Thermal insulation of dwellings—Bulk insulation—Installation requirements

4073 Urea-formaldehyde foam thermal insulation—In situ set foam

AS/NZS

3008 Electrical installations — Selection of cables
3008.1.1 Part1.1: Cables for alternating voltages up to and including 0.1/1 kV—Typical Australian installation conditions

4200 Pliable building membranes and underlays
4200.1 Part 1: Materials
4200.2 Part 2: Installation requirements

4201 Pliable building membranes and underlays—Methods of test
4201.1 Method 1: Resistance to dry delamination
4201.2 Method 2: Resistance to wet delamination

ISO 9001 Quality management systems—Requirements

ISO 9004 Quality management systems—Guidelines for quality plans

NZS

4214 Methods of Determining the Total Thermal Resistances of Parts of Buildings

SAI

HB18 Guidelines for third-party certification and accreditation
HB18.28 Guide 28: General rules for a model third-party certification scheme for products

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

9229	Thermal insulation—Materials, products and systems—Vocabulary
10211	Thermal bridges in building construction—Heat flows and surface temperatures
10211.1	Part 1: General calculation methods
10456	Building materials and products—Determination of declared and design thermal values
ASTM	
C167	Test methods for thickness and density of blanket or batt thermal insulations
C168	Standard terminology relating to thermal insulating materials
C177	Test method for steady-state heat flux measurements and thermal transmission properties by means of the guarded-hot-plate apparatus
C518	Test method for steady-state heat flux measurements and thermal transmission properties by means of the heat flow meter apparatus
C653	Guide for determination of the thermal resistance of low-density blanket-type mineral fibre insulation
C687	Practice for the determination of thermal resistance of loose fill building insulations
C739	Specification for cellulosic fibre (wood-base) loose-fill thermal insulation
C871	Test methods for chemical analysis of thermal insulation materials for leachable chloride, fluoride, silicate and sodium ions
C1363	Standard test method for the thermal performance of building assemblies by means of hot box apparatus
E408	Test methods for total normal emittance of surfaces using inspection meter techniques
G1	Practice for preparing, cleaning, and evaluating corrosion test specimens
G31	Practice for laboratory immersion corrosion testing of metals
BRANZ	A Manual for Calculating R-values Using the Isothermal Plane Method, H.A. Trethowan, 26/01/1997

APPENDIX C

GUIDANCE ON THERMAL RESISTANCE MEASUREMENT

(Informative)

C1 SAMPLE SIZE AND METERING AREA

All thermal test apparatus incorporate a 'metering area' over which the heat flowing through a test sample is measured. The size of this area determines the suitability of the apparatus for testing materials with regular spatial variations in thermal resistance, which arise from spatial variations in composition. The metering area has to be large enough to 'average-out' such effects.

The nominal size of a test apparatus is generally substantially larger than its metering area, since the inner metering region is surrounded by a 'guard area', to ensure uniform heat flow and minimal 'edge effects'. With some apparatus, the metering area may be quite small, for example, it may be 150 mm^2 in a typical 300 mm^2 guarded hotplate apparatus.

On a larger 1000 mm^2 heat flow meter apparatus it would typically be about 500 mm^2, large enough to allow measurement of such things as hollow concrete blockwork walls, that are uniform on this scale. This metering area is not sufficiently large to accommodate the spatial irregularities, that may arise within many stud walls or extended areas of ceiling with long runs of joists at 460 mm spacing. Such measurements are generally performed in a guarded hot box apparatus, which would typically have a metering area of the order of 1000 mm^2. Even this metering area may be too small in circumstances where there are variations over the complete height of a wall or where a complete roof space is under investigation.

Although it may have limited precision and other difficulties, the calibrated hot box method offers the largest metering area, possibly exceeding 3 m^2, as it dispenses with the normal guard area. By definition, 'large scale' insulation materials or assemblies are those that are irregular on too large a scale to permit measurement using test apparatus in commercial operation within Australia and New Zealand.

Smaller test apparatus may offer higher accuracy for thinner test samples but are more limited in accuracy for thick samples, due to edge effects. These effects typically introduce unacceptable errors for samples thicker than about one quarter of the plate dimension (i.e., a 250 mm thick sample in a 1000 mm^2 apparatus).

C2 THERMAL RESISTANCE DETERMINATION BY CALCULATION

Thermal performance of some reflective insulation systems may be very difficult to measure in situ where airspaces are involved, but it may be amenable to calculation; therefore, this option is made available. The thermal resistance of standard simple airspace configurations can be estimated with reasonable accuracy, provided that boundary conditions are well defined. Ventilation, orientation and temperature difference may influence the thermal properties of airspaces in ways that make calculation complex or difficult, so that measurement may be a preferable option in more complex cases. Determination of an appropriate approach may require expert advice.

For building elements that may include ventilation paths or convection cells extending over a wide area, there may not be small-scale spatial uniformity in heat flow.

In such cases, measurement of a full-scale representative building element would be required for acceptable results. Where a facility with this capability is not in commercial operation, calculation is the only available approach. Such calculations may draw on previous experimental results from other related insulation configurations but, as stated above, resulting estimates of thermal performance may nevertheless have considerable uncertainty attached to them.

C3 SIGNIFICANCE OF ASTM C653

ASTM C653 accommodates the wide production variability expected of low density fibrous materials by specifying procedures for sampling, measuring and averaging over defined sample lots of packaged production material; however, testing by this method is more complex, requires large amounts of material and is more expensive to undertake (than, e.g., ASTM C518). For this reason, materials, that have previously demonstrated that they have acceptably high uniformity, may be considered as of formed shape classification.

ASTM C653 is intended to apply only to mineral fibres over a density range of approximately 6.4 to 48 kg/m^3. Its applicability has been extended within this Standard to cover a wider range of densities and to cover all fibrous insulations. Appendix D includes procedures and the variations required to ASTM C653 to allow this wider usage. Significantly, these variations extend application of ASTM C653 to very low densities (below 6.4 kg/m^3) with no specific minimum. Experience with a variety of very low density products has shown that they may be predicably measured by this test method; however, convection and radiation effects in thin bulk insulation materials below 5 kg/m^3 may be unpredictable, and may lead to inferior in-situ performance.

Nine measurements of heat flow at three thicknesses are required by ASTM C653, as well as averaging out variations in apparent conductivity from point to point. This allows determination of non-linear relationships (if any) between thermal resistance and thickness which may occur in samples having low densities (less than 8–10 kg/m^3) and small thicknesses (<50 mm). This technique compensates for the so called ‘thickness effect’ phenomenon, which is thought to arise as a result of some radiation transfer through bulk insulations at very low density and thickness. It underscores the need to test samples at the applicable (declared) thickness and density. (See also ISO 10456.)

These thickness effects are not derating factors in themselves, but merely express the non-linearity of the relationship between the R-value and thickness of such materials. Nevertheless, they may provide some indication of the likelihood or otherwise of finding some significant radiation or convective transfer at very high radiant loads, such as may occur under unsarked roofs in hot climates, that is, bulk insulation is used to insulate attic spaces. Some derating of the (mean-temperature) performance of the bulk insulation might be appropriate, especially for bulk insulation that is thin or very low in density; however, scientific investigation of this (suspected) phenomenon needs to be carried out before any practical advice can be offered regarding magnitude of possible derating factors.

C4 IN SITU EFFECTS

With reflective materials, the application (i.e. the method, location and environmental conditions of use) strongly affects thermal resistance, so that a single material may achieve many different thermal resistance values depending on the situation. Therefore, it is inappropriate to directly associate a single thermal resistance value with such a product. In contrast, thermal performance of formed shapes, low density fibrous materials and loose fill materials are generally less dependent upon application or environmental conditions so that it is common practice to ascribe a material thermal resistance value to the product without reference to the application. Confusion or errors may arise in estimating in situ performance from material R-values only. The variability of total R-values with application and situation may be considerable. In addition, the presence of other components may affect overall performance. In particular, the presence of ceiling joists, which act as heat bridges will mean that the system or total thermal resistance may be lower than the material R-value of insulation if it is installed between these joists (see ISO 10211.1, NZS 4214 and *A Manual for Calculating R-values Using the Isothermal Plane Method*. H.A. Trethowan, BRANZ, 1997.

C5 THERMAL PROPERTIES OF SURFACE COATINGS

Surface coatings such as paints may be reflective (in the infra-red) if they are metallized, i.e., contain metal particles. If they are not metallized and are thin (less than 1 mm thick), then they have a thermal resistance that is very low (below 0.02 m^2.K/W) and they should not be described as 'insulating'. Such coatings may contribute to the thermal performance of a building through their solar reflectance. Where such coatings replace surfaces with high infrared reflectance, such as bright unpainted galvanized iron, they may additionally contribute to keeping a building cool in hot climates by their low infra-red reflectance, which assists with radiation cooling to cold skies. In this case, it is not their insulation but rather their lack of it, relative to a roof that is reflective in the infra-red, which is utilized to enable a hot building to be better cooled by the cold sky. Infra-red reflectance should be determined in accordance with Clause 2.3.

APPENDIX D

DETERMINATION OF THE THERMAL RESISTANCE OF LOW-DENSITY FIBROUS INSULATION USING ASTM C653 WITH VARIATIONS

(Normative)

D1 SCOPE

Low density fibrous insulation is defined, for the purposes of this Standard, as material with a density below 50 kg/m^3, supplied in compression packaging. Common materials of this type include rockwool, glass wool, polyester fibre and wool. Also included are combinations of these materials and any other fibres with similar properties, which may be bonded so as to produce a flexible, compressible formed shape or blanket.

A production pack of fibrous insulation may contain material with variability in density and thickness as an installed product. This is due both to variabilities in the material itself, as well as the duration and degree of compressive packaging, which affects thickness recovery. ASTM C653 sets out procedures for deriving representative thermal resistance values which account for these variabilities. It is used in conjunction with ASTM C167. These Standards are suitable for a wider range of material types (other than mineral fibre) and for the different standard sizes used in Australia and New Zealand when the variations that are set out in Paragraph D2 are incorporated.

D2 REQUIREMENTS

D2.1 Variation number 1—Applicability

The applicability of ASTM C653 shall be extended to cover all low-density fibrous material used as thermal insulation.

D2.2 Variation number 2—Dimensions

Where ASTM C653 and ASTM C167 refer to imperial dimensions for product and lot sizes, the closest corresponding metric dimensions shall be used. The thickness measurement locations on Australian and New Zealand low density fibrous insulations shall have the same proportion and general form as the locations specified within ASTM C167 for imperial products.

D2.3 Variation number 3—Test specimen

Where ASTM C653 recommends a 'lot sample size of 75 to 150ft2, to determine the lot average density (D_{av}), the following shall be used:

(a) 15 + 2.25 m^2 of whole pieces.

(b) 27 + 9 m^2 of whole blanket rolls shall be selected at random.

This sample shall be deemed to be 'the lot sample' for purposes of applying the statistical averaging procedures used in ASTM C653, in order to determine lot average density (D_{av}).

D2.4 Variation number 4—Number of thickness measurements

In order to accommodate a wide range of materials, some of which may have poor thickness uniformity, the number of thickness measuring points described in ASTM C167 shall be doubled by the addition of a mirror-image set of locations for all materials. This shall result in 10 thickness measurements per piece or section of blanket. One of these measurements, at the centre of the piece, is a mirror-image of itself and shall be simply repeated to maintain an appropriate weighting of locations.

D2.5 Variation number 5—Thickness depth gauge

The 75 mm diameter depth gauge described in ASTM C167 shall not be used where the surface of the material has height irregularities greater than 5% of the nominal thickness over the area of the gauge disk at any measuring point. In such cases, an alternative disk of 10 mm diameter, as shown in Appendix J, may be used. The 10 mm diameter disk may optionally be used for all thickness measurements.

D2.6 Variation number 6—Materials with low compression stiffness

For materials with low compression stiffness, which would undergo significant compression (more than 1% of nominal thickness) under the specified pressure (20 Pa) of the disk of a thickness gauge, the alternative procedure within ASTM C167, which allows this pressure on the sample, shall not be used.

D2.7 Variation number 7—Reduced number of thermal measurements

ASTM C653 provides three alternative measurement procedures. All of these procedures incorporate a series of nine thermal measurements, which are used to determine the apparent thermal conductivity of the material as a function of density and to subsequently calculate the thermal resistance of the lot.

In order to determine the density-conductivity relationship, each alternative procedure spreads the nine measurements over a range of densities, including various degrees of compression of samples. The number of measurements may be reduced to three, provided that each measurement, assumed to have been performed 3 times, satisfies all of the requirements for the analysis and computation described in ASTM C653.

NOTE: The nine measurements prescribed in ASTM C653 are used for calculation and statistical averaging, to derive the apparent thermal conductivity (λ_{av}) from the basic equation,

$$\lambda_s = a + b\,D_{av} + c_s / D_{av} \qquad \ldots \text{ D2.7(1)}$$

at the lot average density (D_{av})

where λ_s is sample conductivity and a, b and c are product curve parameters derived from measurements of conductivity at three thicknesses.

The apparent thermal resistance at the lot average thickness L_{av} is then:

$$R_{av} = L_{av} / \lambda_{av} \qquad \ldots \text{ D2.7(2)}$$

This is taken to be the (material) thermal resistance of the lot.

APPENDIX E

DETERMINATION OF THE THERMAL RESISTANCE OF LOOSE FILL INSULATION USING ASTM C687 WITH VARIATIONS

(Normative)

E1 SCOPE

Loose fill materials, where used as building insulation, range from mineral granules and pellets with densities above 1000 kg/m^3 to very low density fibrous materials with densities below 5 kg/m^3. They may or may not be compressible. The density and thickness may be dependent on sample preparation and installation procedures. Settlement may occur over time.

ASTM C687 is designed to take account of these factors; however, ASTM C687 includes requirements for pneumatically blown materials, which involve transportation of the blowing equipment to the site of the test. This is generally impractical within Australia and New Zealand because of large distances and the small number of testing laboratories. An alternative procedure for preparing pneumatically blown insulations is described in Paragraph E2. When incorporating this variation, ASTM C687 is suitable for all loose fill materials.

E2 VARIATION TO SPECIMEN PREPARATION PROVISIONS FOR REMOTELY BLOWN, PNEUMATICALLY APPLIED MATERIALS

Loose fill material that is normally installed pneumatically (by blower or similar technique) may be blown remotely (away from the testing laboratory) and prepared as follows:

(a) The supplier of the material shall blow the material into a rigid container (such as a cardboard box) using the technique and equipment that is normally employed to blow this material into place in a building. The container, containing a small excess of material, shall then be delivered to the testing laboratory by normal transportation methods. The supplier of the blown material shall specify the coverage and stabilized thickness at which testing is to be performed, for the case where ceiling joists and other coverage-extending objects are assumed not to exist. This information shall be as follows:

    (i) Coverage, in one of the following alternative units:

        (A) Area per unit mass (m^2/kg or m^2/g).

        (B) Area per bag (m^2/bag) for bags of stated weight (kg).

        (C) Mass per unit area (kg/m^2 or g/m^2).

    (ii) Stabilized thickness (mm).

    The test thickness shall be considered to be the stabilized thickness and the test density to be the value calculated from the coverage and stabilized thickness nominated by the supplier.

(b) At the testing laboratory, the material shall be agitated to reverse the effects of excess settlement due to transportation. The material shall be placed in an open shallow container and conditioned for sufficient time to reach constant weight, shown to be within 1% weight change in 24 h.

(c) Specimen preparation shall proceed in accordance with Clause 7.3.6 and subsequent clauses of ASTM C687, using a selected amount of the re-agitated conditioned material.

NOTE: Depending on the material, a number of alternative techniques may be used to agitate blown loose fill materials to restore them to the original density. With cellulose fibre, an impeller or propeller on the end of an electric drill may be employed. A 220 mm model aircraft propeller on a 500 mm long shaft operating in a variable speed electric drill with a maximum speed of approximately 3000 rpm has been found to be satisfactory. Wool and other materials with long fibres usually tangle with this technique. For such materials, an effective technique is agitation by a hand-held whisk with a single flexible tine of 5 mm aluminium tubing or similar material about 700 mm long.

APPENDIX F

GUIDANCE ON INFRA-RED EMITTANCE

(Informative)

Whilst non-reflective insulating materials achieve thermal resistance within their structure, the thermal performance of reflective materials is intended to be at least partly due to the thermal resistance of the adjacent spaces or airspaces that they reflectively bound. The thermal resistance of these airspaces is dependent upon the emittance of the surfaces that bound them. Thermal resistance (see Clause 2.3) may have been initially determined either by measurement or computation. In either case, it applies only for the specified emittance values, which have to be determined.

Exposed metal surfaces that are clean and shiny, such as aluminium foil, have a very low emittance, typically below 0.05. Where a metal layer is not directly exposed, but rather exists behind another material that is visibly transparent, such as clear plastic film or glass, the surface may look shiny but the emittance may actually be much higher. The emittance of most non-metallic surfaces is approximately 0.9 or higher. Metal surfaces that are dull through oxidation or that have antiglare coatings may have a range of intermediate emittance values.

If a foil surface acquires an accumulation of dust or debris, its emittance will be increased. This is prone to occur with upward facing foil surfaces in well-ventilated spaces, such as would be the case with foil laid horizontally across ceiling joists within a roof space with a tiled roof. Even if sarking is present and especially if ridge caps remain exposed, then sufficient ventilation within tiled roof spaces may occur, to allow significant rates of dust accumulation, thus rendering upward facing surfaces ineffective in terms of low emittance. A complete covering of dust would result in a emittance of approximately 0.9 or higher.

APPENDIX G

INFORMATION ON SOLAR REFLECTANCE

(Informative)

The solar reflectance of a surface that faces the sky provides a measure of the fraction of solar radiation, which it reflects away rather than absorbs it. More reflective surfaces absorb less solar energy and stay cooler, reducing heat flow from these surfaces into the building and helping minimize internal overheating in hot conditions. In the same way, high solar reflectance may lessen the extent to which a building in a cooler climate is able to warm up by absorbing the sun.

The solar reflectance of internal surfaces that are not sunlit is of negligible thermal consequence and, in a well-insulated building, even the solar reflectance of external surfaces may be relatively unimportant.

Surfaces with high solar reflectance (above 0.8) generally appear quite close to white, if painted, or bright and shiny, if metallic. Apparent lightness of colour is a reasonable indicator of solar reflectance over the range from near-white (above 0.7) to black (below 0.1).

The effect of solar reflectance on building thermal performance is relatively complex, although thermal calculation methods allow it to be assessed in a straightforward manner. For a particular set of circumstances, similar thermal benefits may be derived by adding a certain thermal insulation or by changing solar reflectance by a certain amount. As a consequence, it is not possible to say that the surface has an insulation value, and it should be remembered that the comparison depends on conditions. For example, solar reflectance offers no thermal benefit at times when the sun is not shining.

Some materials, such as aluminium foil, have high solar reflectance but are not intended to be used in ways that make use of their solar-reflective properties. They should generally be classified as non solar-reflective. (See to CSIRO information sheet, *Do Insulating paints Work*.)

APPENDIX H

DETERMINATION OF CORROSIVENESS

(Normative)

H1 GENERAL

Determination of corrosiveness shall be in accordance with the test procedures set out in this Appendix. As the pre- and post-cleaning procedures may be hazardous, these tests should only be carried out by, or under the supervision of, a qualified chemist.

H2 APPARATUS

The following apparatus is required:

(a) A forced-air humidity chamber capable of maintaining 50 ±1°C and not less than 95% relative humidity.

(b) A balance capable of determining mass to an accuracy of 0.0001 g.

(c) Stainless steel wire mesh (type 304, 24 mesh, 0.355 mm wire diameter, 0.71 mm aperture size), cut into strips measuring 112.5 mm long by 7.5 mm wide.

(d) A water bath.

(e) No. 12 rubber bands, not more than 12 months old.

(f) A stiff nylon bristle brush.

(g) Hair dryer.

(h) Various size beakers, watch glasses and tweezers.

H3 REAGENTS AND MATERIALS

All reagents shall be analytical grade unless specified. The following reagents and materials are required:

(a) 1,1,1-trichloroethane (TCE).

(b) Sodium hydroxide.

(c) Sulphuric acid (specific gravity 1.84).

(d) 1,3-di-o-tolyl-2-thiourea.

(e) Ethanol.

(f) Acetone.

(g) Roll of surgical grade cotton wool wadding.

H4 TEST COUPONS—STEEL

Coupons are prepared from steel equivalent to BHP CA2, cold rolled, conforming to AS 1595, matt finish, oiled, 0.6 mm thick, temper approx. 5. Each metal coupon shall measure 100 mm long and 25 mm wide, and shall be free from crimps, punctures and tears.

H5 INSULATION SPECIMENS

Samples of the thermal insulation material submitted for testing shall be materials representative of the insulation manufactured on an industrial scale.

H6 PRE-CLEANING PROCEDURES

The following applies:

(a) For handling and cleaning all metal coupons, the following shall be observed:

(i) At no stage during the fabrication, cleaning or testing shall the metal coupons be touched by ungloved hands.

(ii) Gloves either plastic disposable or acetone-extracted cotton shall be clean and in good condition.

(iii) All chemicals shall be of analytical reagent grade or better, free from oily residues and other contaminants.

(iv) Water shall be distilled or deionized.

(v) Clean coupons shall be handled only with clean forceps, wherever possible at the edges of the coupon.

(vi) All coupons shall be cleaned until they are completely free of waterbreaks. A waterbreak is a break, separation, beading or retraction of the water film, as the coupon is held vertically after wetting. As the coupons are cleaned, the water film should become gradually thinner at the top and heavier at the bottom. Cleaning procedure shall be repeated as necessary.

(vii) In order to avoid exposing laboratory personnel to toxic fumes, all cleaning procedures shall be performed in a fume hood.

(b) For cleaning steel coupons, the procedure shall be as follows:

(i) Immerse the coupons in room temperature TCE for 15 min with occasional agitation. Rinse coupons twice by dipping into fresh TCE.

(ii) Air-dry.

(iii) Immerse the coupons in 5% by weight aqueous sodium hydroxide at 60 °C for 15 min, with occasional agitation;

(iv) Rinse the coupon with water to remove residual alkali.

(v) Immerse the coupons in refluxing or boiling ethanol for 5 min.

(vi) Rinse the coupons twice by dipping in fresh, room temperature ethanol.

(vii) Rinse the coupons with water and inspect for a waterbreak-free surface.

(viii) Immerse the coupons in fresh ethanol and dry in a hot airstream.

NOTE: The pre-cleaning and post-cleaning procedures described in this Standard are based on the methods outlined in the ASTM Gl, ASTM G31, and ASTM C739.

H7 Specimen preparation

Two specimens of insulation shall be used, each measuring 37.5mm × 112.5mm by approximately 12.5mm thick when compressed between the stainless steel mesh strips.

Sterile cotton wool wadding shall act as the control material for the corrosion test. The cotton wool shall be solvent extracted with acetone by placing the cotton wool into a suitable beaker filled with analytical grade acetone and soaked for 48 h, with occasional agitation. After 48 h, the cotton wool is allowed to drain and then rinsed for a further hour with fresh acetone and re-drained.

The cotton wool is then placed in a vacuum oven at 35°C and vacuum-dried (approx. 5 h) until no residual acetone odour can be detected. Alternatively, it can be air-dried and then thoroughly oven-dried (80°C).

Two specimens of solvent-extracted cotton wool shall be used for the test, each approximately 6 mm thick when compressed between the stainless steel mesh strips.

NOTE: The corrosiveness of loose fill cellulose insulation material may be tested using this test procedure. Due to the high compressibility of the loose fill material, care should be exercised to ensure that only the minimum quantity of sample shall be used to produce a stable composite structure of thickness 25 ±3mm. High packing density of loose fill material in the composite structure may bias the results.

H8 TEST PROCEDURE

The procedure shall be as follows:

(a) Weigh 4 steel coupons and record the mass to nearest 0.1 mg.

(b) Place one coupon of steel between two pieces of insulation material that measure 112.5 mm × 37.5 mm.

(c) Compress the assembly between two pieces of stainless steel wire mesh (112.5 mm × 37.5 mm) to form a composite structure.

(d) At each end, constrain the structure by a No 12 rubber band. The rubber band should be placed at a distance between 20 mm and 30 mm from each end of the composite. The compressed thickness of the composite structure shall be 25 ±3 mm.

(e) Construct a cotton wool control specimen by placing a steel coupon between two pieces of solvent-extracted cotton wool wadding measuring 112.5 mm × 37.5 mm. When compressed between the steel mesh, the wadding shall measure approximately 12 ±2 mm in thickness.

(f) Construct duplicate composite structures of each test insulation material and cotton wool controls.

(g) Suspend each test specimen composite and the cotton wool composites vertically (long axis) in an atmosphere free from contaminants and having a relative humidity not less than 95% at a temperature of 50 ±1°C for 168 ±2 h. Monitor the chamber atmosphere periodically to ensure that the conditions are within specifications. If dripping occurs in the chamber, position a drip guard in the chamber to direct condensation to the chamber floor.

NOTE: The composites should be suspended in such a manner as to be electrically isolated from the chamber. The composites may be suspended from the shelving within a humidity chamber using plastic clips, glass clips or electrically-isolated steel clips (e.g.. plastic-coated clips), thread, and the like.

(h) At the conclusion of the test period, remove the coupons from the chamber and visually inspect for corrosion.

H9 ASSESSMENT AND POST-CLEANING PROCEDURES

The procedure shall be as follows:

(a) Upon completion of the test, disassemble the composite specimens and assess the coupons visually for extent of corrosion compared with the cotton wool controls.

(b) After a visual assessment has been made, thoroughly wash the metal coupons using water and lightly brush them using a nylon bristle brush or equivalent to remove loose corrosion products.

(c) Remove the remaining corrosion products from the metal coupons by cleaning them in accordance with the following practices (see Note 1).

    (i) Add 100 mL of sulphuric acid (specific gravity 1.84) slowly to 500 mL of deionized water, followed by 2 mL organic inhibitor solution (0.5 g/L 1,3 di-o-tolyl-2-thiourea). Swirl the solution and add water to make a 1 L solution (see Note 2).

(ii) Warm the solution to 50 ±1°C. Dip the coupons in this solution for 30 s. Rinse in deionized water, and dry in a hot airstream. If corrosion products remain on the coupon surface, repeat the cleaning process and note that two cleaning cycles are required. Replenish the cleaning solution as the solution becomes dirty.

(d) Rinse and dry in hot airstream.

NOTES:

1 These practices are based on the recommended practices in ASTM G1.

2 The organic inhibitor solution should be prepared by initially dissolving 0.005 g organic inhibitor in ethanol (10 mL) and then adding 2 mL to the sulphuric acid solution before making up to the 1 L mark on the volumetric flask.

H10 EXAMINATION AFTER POST-CLEANING

All metal coupons shall be equilibrated to room temperature by placing them in a desiccator for at least 30 min after drying with a hot airstream. The coupons shall be weighed and the mass loss (mg) determined relative to the coupons exposed to the cotton wool controls. All coupons shall be examined for surface etching and pitting.

H11 NON-CORROSIVENESS

After cleaning, there shall be no mass gain caused by build up of corrosion products. Mass loss from test coupons shall be no greater than the mass loss from the coupons exposed to cotton wool.

H12 REPORTING

The following shall be reported:

(a) Pass, if the coupons meet the requirements of Paragraph H11.

(b) Fail, if the coupons do not meet the requirements of Paragraph H11.

APPENDIX I

RESISTANCE TO SURFACE CORROSION AND WET DELAMINATION AT ELEVATED AMBIENT TEMPERATURES (REFLECTIVE INSULATIONS)

(Normative)

I1 GENERAL

This Appendix provides a test to determine the ability of reflective foil laminate and insulation products that include or comprise reflective materials to resist corrosion and delamination in hot, humid atmospheric conditions liable to be encountered in roofs over a prolonged period.

When reflective foil insulation is installed in any situation where there is a possibility of electrochemical corrosion, appropriate measures shall be taken to ensure that, throughout the life of the building, there will never be —

(a) any contact between the reflective foil insulation and metals likely to cause electrochemical corrosion; and

(b) any electrolytic conductor between the reflective foil insulation and such metals.

NOTES:

1 Significant electrochemical corrosion may occur when there is contact in the presence of moisture, either direct or by conductor, between reflective foil insulation and components made of copper, tin, lead, steel and other metals of similar composition.

2 Significant electrochemical corrosion is not likely to occur in most circumstances where there is contact, either by conductor or direct, between reflective foil insulation and components made of aluminium, cadmium, zinc, cadmium-coated or zinc-coated steels or other metals of similar composition.

I2 APPARATUS

The following is required:

(a) Sealed glass vessel (e.g., a desiccator) of sufficient volume to hold the required number of test pieces, and of sufficient depth to hold a quantity of water and to allow the test pieces to be suspended vertically above water level.

(b) A suitable frame, of material that does not react with the foil surfaces, shall be provided to carry the test pieces.

(c) Oven of sufficient size to hold the container and capable of being maintained at a temperature of 60 +2.5°C for not less than 28 d.

I3 CONDITIONING

The test pieces shall be conditioned for at least 6 h prior to testing, at 23 +2°C and 50 +5% relative humidity.

I4 TEST PIECES AND CONTROL SPECIMEN

I4.1 Test Pieces

Ten test pieces, each 100 mm long and 100 mm wide, shall be cut from each sample piece and conditioned in accordance with Paragraph I3. Care shall be taken to ensure that the edges of the test pieces do not coincide with any fibre reinforcement.

The test pieces shall be selected from various positions across and along the sample piece so that each section of the sample piece is tested.

The test pieces shall be so taken from the sample piece so as to ensure that the characteristics of the sample piece can be measured in the longitudinal direction as well as the transverse or lateral directions, as applicable.

I4.2 Control specimen

The control specimen shall be a piece of unlaminated aluminium foil 100 mm long and 100 mm wide, of the same thickness and the same physical characteristics as the foil surfaces of the test pieces.

I5 CORROSION TESTING

Deionized water shall be used for corrosion testing.

The procedure shall be as follows:

(a) Place foil control and sample in separate containers.

(b) Suspend test pieces from frame.

(c) Seal containers.

(d) Place in oven at 60 ±2.5°C, maintain oven and contents for 28 d.

(e) At the end of this time, visually examine the test pieces and the control specimen for corrosion, and the test pieces for delamination.

(f) If corrosion of the control specimen has occurred, repeat the test after eliminating the cause(s) of the corossion.

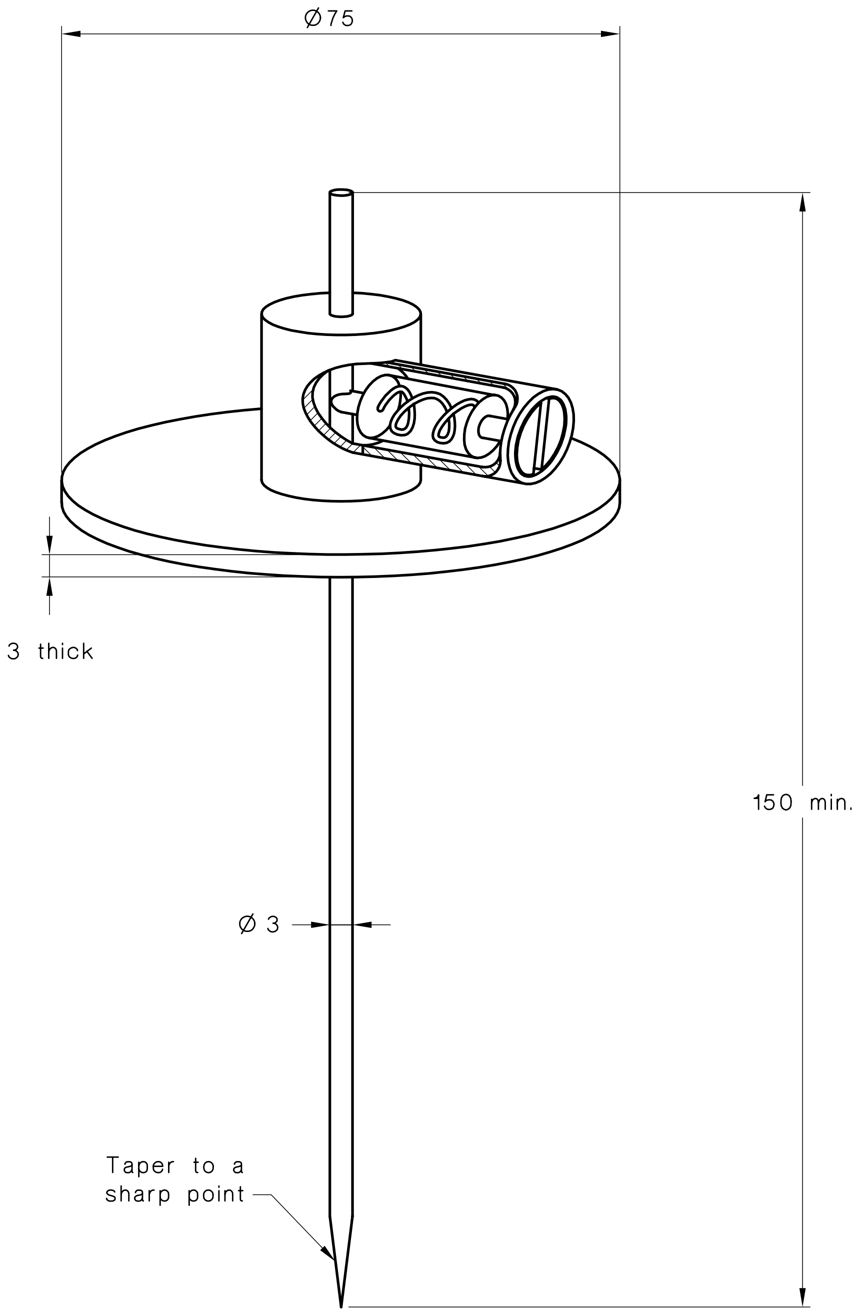
I6 REPORTING

The following results shall be reported:

(a) Wet delamination, report pass or failure of test to AS/NZS 4201.1

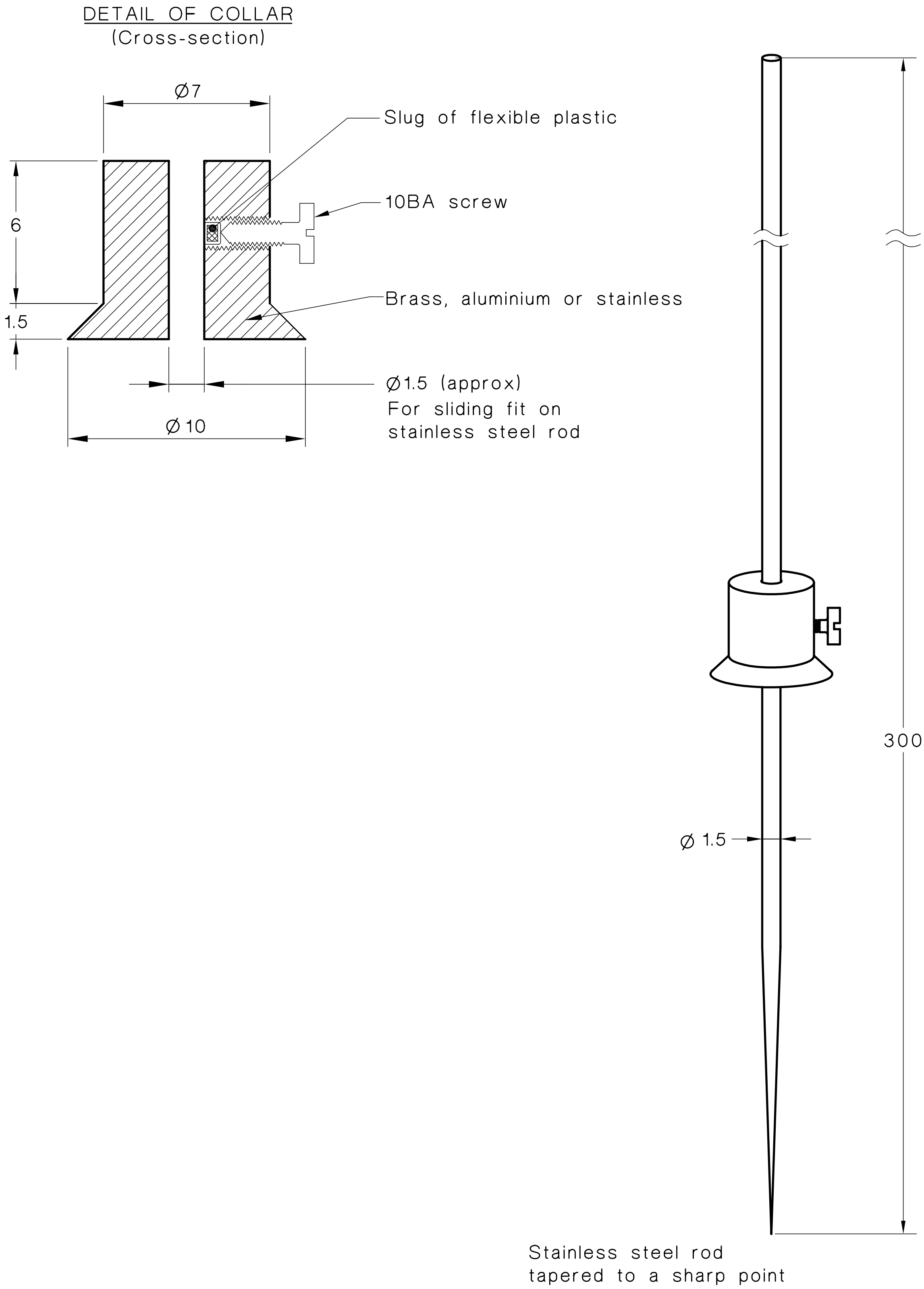
(b) Surface corrosion; pass, if corrosion is no worse than the control sample (surface staining of test samples is allowed; fail, if corrosion of sample is worse than the control or if the sample is perforated

APPENDIX J
DEPTH GAUGES FOR THICKNESS MEASUREMENTS
(Informative)



DIMENSIONS IN MILIMETRES

FIGURE J 1 DEPTH GAUGE



DIMENSIONS IN MILMETRES

FIGURE J 2 DEPTH GAUGE

NOTES

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