NZS 4218:2009

New Zealand Standard

Thermal Insulation – Housing and Small Buildings

Superseding NZS 4218:2004

NZS 4218:2009

Single User PDF Terms & Conditions

COMMITTEE REPRESENTATION

This Standard was prepared under the supervision of the P 4218 Committee the Standards Council established under the Standards Act 1988.

The committee consisted of representatives of the following nominating organisations:

Association of Building Sustainability Assessors (ABSA)
Building Industry Federation
Centre for Building Performance Research, Victoria University Wellington
BRANZ Ltd
Cement and Concrete Association of New Zealand
Certified Builders' Association New Zealand
Claddings' Institute of New Zealand
Department of Building and Housing
Energy Efficiency and Conservation Authority (EECA)
Glass Association of New Zealand
Insulation Council of Australia and New Zealand
Local Government New Zealand
Ministry for the Environment
New Zealand Green Building Council
New Zealand Institute of Architects
New Zealand Pine Manufacturers' Association
Windows Association of New Zealand

ACKNOWLEDGEMENT

Standards New Zealand gratefully acknowledges the contribution of time and expertise from all those involved in developing this Standard.

Published by Standards New Zealand, the trading arm of the Standards Council, Private Bag 2439, Wellington 6140. Telephone: (04) 498 5990, Fax: (04) 498 5994, Website: http://www.standards.co.nz.

		AMENDMENTS	
No.	*Date of issue*	*Description*	*Entered by, and date*

NZS 4218:2009

New Zealand Standard

Thermal insulation – Housing and small buildings

Superseding NZS 4218:2004

ISBN 1-86975-121-3

NOTES

CONTENTS

Table (continued)

Figure

REFERENCED DOCUMENTS

Reference is made in this document to the following:

NEW ZEALAND STANDARDS

NZS 4214:2006	Methods of determining the total thermal resistance of parts of buildings
NZS 4303:1990	Ventilation for acceptable indoor air quality
NZS 4229:1999	Concrete masonry buildings not requiring specific engineering design

JOINT AUSTRALIAN/NEW ZEALAND STANDARDS AND HANDBOOKS

AS/NZS 4666:2000	Insulating glass units
AS/NZS 4668:2000	Glossary of terms used in the glass and glazing industry

AMERICAN STANDARD

ANSI/ASHRAE 140-2001	Standard method of test for the evaluation of building energy analysis computer programs (ANSI approved); 91 pp. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE), Atlanta, 2001. ISBN/ISSN 1041-2336
ASHRAE SPC 142	Standard method for determining and expressing fenestration heat transfer

ISO

ISO 15099:2003	Thermal performance of windows, doors and shading devices – Detailed calculations

NEW ZEALAND LEGISLATION

Building Act 2004

Compliance Document for New Zealand Building Code, Clause E3, Internal Moisture

Compliance Document for New Zealand Building Code, Clause H1, Energy Efficiency

New Zealand Building Code (NZBC)

OTHER PUBLICATIONS

BRANZ Ltd.	House insulation guide. Third Edition. 2007. ISBN 1-877330-29-9 and 2008 supplement.
BRANZ Ltd.	The LEVEL sustainable building series. Passive design, 2008. ISBN 978-1-879330-40-7.
Judkoff R. and Neymark J.	International Energy Agency building energy simulation test (BESTEST) and diagnostic method. 1995 NREL/TP-472-6231 Golden, Colorado, USA; National Renewable Energy Laboratory.
Energy Safety Service	New Zealand electrical code of practice for the installation of recessed luminaires and auxiliary equipment NZECP 54:2001. Ministry of Consumer Affairs, Wellington, New Zealand.

WEBSITES

http://www.branz.co.nz

http://www.ecbcs.org/

http://eeca.govt.nz

http://www.energysafety.govt.nz

http://www.iea-shc.org/

http://www.legislation.govt.nz

http://www.level.org.nz

http://www.ngdc.noaa.gov/geomag/magfield.shtml

REVIEW OF STANDARDS

Suggestions for improvement of this Standard will be welcomed. They should be sent to the Chief Executive, Standards New Zealand, Private Bag 2439, Wellington 6140.

FOREWORD

Energy efficient design of housing and small buildings should consider solar gain from glazing, thermal insulation, and thermal mass. In the New Zealand climate, good passive solar design incorporating appropriate areas of glazing and thermal mass, combined with a well-insulated thermal envelope, can significantly reduce the energy requirements to heat and cool buildings.

This revision of NZS 4218 aims to align the Standard with the New Zealand Building Code (NZBC) Clause H1, and to improve the Standard's usability and robustness.

Some of the most significant changes are:

(a) Increased R-values to align with NZBC Clause H1;

(b) Changes to the calculation method to ensure adequate thermal performance is not compromised by large glazing areas;

(c) A revised modelling method to take account of recent research, and to make it easier to use with recent computer modelling packages;

(d) New requirements for high thermal mass construction to ensure that the thermal mass is adequate and effective;

(e) A revised appendix (now Appendix C) on windows and glazing;

(f) A new informative Appendix D provides guidance on alterations;

(g) More worked examples in informative Appendix F; and

(h) The new term 'construction R-value' has been introduced to distinguish the performance values in this Standard from insulation material R-values.

The construction R-values in this Standard result in a low life cycle cost, based on current knowledge of insulation costs, energy costs, and heating behaviour. Applying these construction R-values does not necessarily achieve good passive solar design. Better thermal performance can often be achieved by applying good passive solar design principles.

Glazing area beyond 30% of total wall area may create underheating and/or overheating problems in some buildings. Designers should take this into account and it is recommended they consider using the modelling method where the glazing area is over 30% of the total wall area.

OUTCOME STATEMENT

This Standard guides the achievement of both comfort and energy efficiency for New Zealand homes and small buildings. Minimum thermal resistance can be achieved through balancing the solar gains from glazing, insulation, and thermal mass and aims to reduce heating and cooling costs.

NOTES

New Zealand Standard

Thermal insulation – Housing and small buildings

1 GENERAL

1.1 Scope

1.1.1

This Standard specifies thermal insulation requirements for housing and small buildings.

> ***C1.1.1***
> *For buildings other than housing where two or more buildings are joined to form a larger building (greater than 300 m²), the joined building may be treated as a large building. For further guidance refer to NZS 4243.1* Energy efficiency – Large buildings – Building thermal envelope.

1.1.2

This Standard provides three methods of demonstrating compliance:

Schedule method	Select from the set of minimum construction R-values requirements (see 4.1).
Calculation method	Use a calculation to compare the proposed building with the reference building and ensure that the proposed building has no more heat loss than the reference building (see 4.2).
Modelling method	Use a modelling technique to compare the proposed building with the reference building and ensure that the proposed building consumes no more energy than the reference building (see 4.3).

Figure 1 provides a flowchart for guidance on which method to use.

1.2 Exclusions

1.2.1

Methods to determine the thermal resistance of building elements, and a listing of thermal resistances of common building materials, are covered in NZS 4214.

1.2.2

This Standard does not address minimum R-values that may be required for other purposes such as controlling internal moisture and achieving comfort conditions. R-value requirements for controlling internal moisture may exceed those required by this Standard.

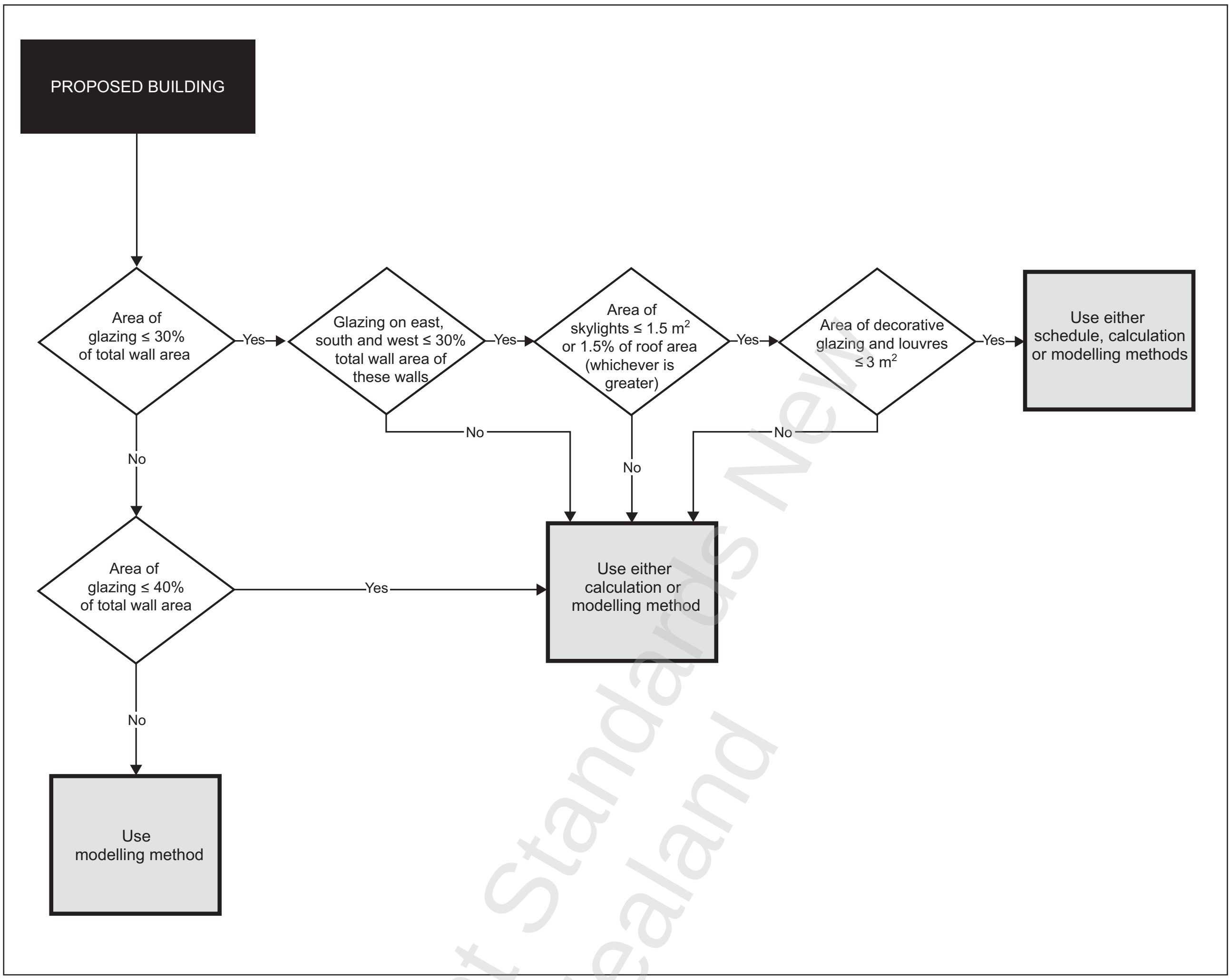

Figure 1 – Decision flowchart

1.3 Interpretation

For the purposes of this Standard, the word 'shall' refers to requirements that are essential for compliance with the Standard, while the word 'should' refers to practices that are advised or recommended.

Notes in tables are mandatory, or indispensable for the use of the Standard.

Clauses prefixed '*C*' and printed in italic type are intended as comments on the corresponding clauses. They are not to be taken as the only or complete interpretation. The Standard can be complied with if the comment is ignored.

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 while an 'informative' appendix is only for information and guidance.

2 DEFINITIONS

> ***C2***
> *See Appendix A for measurement details.*

For the purposes of this Standard the following definitions shall apply:

Building element A distinct part of a building, such as a wall, floor, roof or window. A building element consists of one or more components such as a concrete floor slab, or an assembly of several components, including cladding, cavity, timber frame, insulation material, and lining

Building envelope The exterior surfaces of the whole building enclosing all conditioned and unconditioned spaces. See figure A1

Climate zones Climate zone boundaries are shown in Appendix B

Conditioned space Space within the building envelope that is expected to be conditioned. This includes all habitable spaces and for housing includes kitchen, lounge, dining room, bedrooms, hallways, and bathrooms. Conditioned space shall be separated from unconditioned space by building elements (walls, glazing, skylights, doors, roof, and floor), to limit uncontrolled airflow and heat loss

Construction R-value The R-value of a typical area of a building element (for further information see 3.2)

- **For walls and roofs** The R-value of a typical area of the building element excluding the effects of openings and corners
- **For framed walls** This includes studs, dwangs, top plates, and bottom plates, but excludes lintels, additional studs that support lintels, and additional studs at corners and junctions
- **For walls without frames** This excludes any attachment requirements for glazing and doors
- **For slab floors** The R-value from the inside air to the outside air
- **For suspended floors** The R-value of a typical area of the floor excluding the effects of openings and corners
- **For windows and glazing** See R_{Window} as specified in Appendix C
- **For doors** The R-value of the door excluding the frame, opening tolerances, and glazing

Cooling load The amount of heat removed from the building to maintain it below the required maximum design temperature (not the amount of energy required to remove it)

Default values — Values used for thermal modelling, unless the designer can demonstrate that other values better characterise the building's use over its expected life

Door — Openings in walls designed for people to move through

Door area (A_{Door}) — The total area of doors in the thermal envelope, including frames and opening tolerances, but excluding all glazing, decorative glazing, and louvres

Floor area — The area of floor within the external walls. See also Thermal envelope floor area (A_{Floor})

Thermal envelope floor area (A_{Floor}) — The area of the floor that forms part of the thermal envelope

Glazing — A transparent or translucent area in the thermal envelope

Decorative glazing and louvres — Vertical fenestration that forms part of the thermal envelope that either has an unknown R-value, or does not achieve a window or construction R-value of 0.26. This includes decorative glazing, traditional leadlight glazing, and louvres of any type (such as glass, wood, and aluminium)

Glazing area ($A_{Glazing}$) — The total area of glazing in the thermal envelope, including frames and opening tolerances, glazing in doors, and decorative glazing and louvres, but excluding skylights

Insulating glass unit (IGU) — Two or more panes of glass spaced apart and factory sealed with dry air or special gases in the unit cavity. (Often abbreviated to IGU or referred to as the unit or double glazing)

Shading coefficient — The ratio of the total solar heat gain coefficient (SHGC) through a particular glass compared to the total solar heat gain coefficient through 3 mm clear float glass

Solar heat gain coefficient (SHGC) — The total solar energy entering a building through the glazing, that is, the direct transmission of energy from the sun plus the inwards re-radiation of heat from solar radiation that is absorbed in the glass. The SHGC is also known as the solar factor (SF) or g (glazing factor)

Surfaces (of glass) — The glass surfaces of single glazing and double glazing are numbered from the outside to the inside. The outside face of the outer pane is surface one, the inside face of the outer pane is surface two. In single glazing there are only two surfaces. With double glazing the outer surface of the inner pane is surface three, and the inner surface of the inner pane is surface four

Heated ceilings, walls or floors — Any ceiling, wall or floor incorporating embedded pipes, electrical cables, or similar means of raising the temperature of the ceiling, wall, or floor for room heating

High thermal mass construction Wall construction where the thermal mass material has a wall surface density of at least 215 kg/m^2 of wall area. The thermal mass layer shall be inside the insulation plane and be exposed to the interior

Wall surface density Wall surface density is calculated using the following formula:

$$\text{Wall surface density} = \frac{\text{Wall mass (kg)}}{\text{Wall area (m}^2\text{)}}$$

where wall mass does not include material in a low mass layer or material in any other layer exterior to a low mass layer. A low mass layer is any material with a volumetric density less than 250 kg/m^3

Housing Buildings or use where there is self-care and service (internal management). There are three types:

Detached dwelling Applies to a building or use where a group of people live as a single household or family. Examples: a holiday cottage, boarding house accommodating fewer than six people, dwelling or hut

Group dwelling Applies to a building or use where groups of people live as one large extended family. Examples: a commune or marae

Multi-unit dwelling Applies to a building or use which contains more than one separate household or family. Examples: an attached dwelling, flat or multi-unit apartment

Insulation plane The layer within a building envelope element where the predominant R-value is achieved

Proposed building The design of a building as it is proposed to be built

Plug load The load drawn by appliances connected to the building's electrical reticulation system by general purpose socket outlets

R-value (total thermal resistance) The value of thermal resistance of a building element (for example, wall, floor or roof) which is the sum of the surface resistances on each side of a building element and the thermal resistances of each component of the building element including any cavities in the element. It is determined by calculation or by measuring the temperature difference between the internal air on one side and the external air on the other side of a building element, when there is unit heat flow in unit time through unit area using internal and external conditions considered as typical for buildings. The units are m^2·°C/W or m^2·K/W

Reference building — A building design, with the same dimensions as the proposed building, that is compliant with the requirements of the calculation or modelling methods.

Roof — Any roof/ceiling combination where the exterior surface of the building is at an angle of 60° or less to the horizontal and has its upper surface exposed to the outside

Roof area (A_{Roof}) — The area of the roof that is part of the thermal envelope, excluding the skylight area (see Appendix A)

Skylight — Translucent or transparent parts of the roof

Skylight area ($A_{Skylight}$) — The area of skylights that are part of the roof thermal envelope, including frames and opening tolerances (see Appendix A)

Small building — A building other than housing with a floor area less than or equal to 300 m^2

Thermal envelope — The roof, wall, glazing, skylights, doors, and floor construction between unconditioned spaces and conditioned spaces

Thermal mass — The heat capacity of the materials of the building affecting building energy loads by storing and releasing heat as the interior and/or exterior temperature and radiant conditions fluctuate

Thermal resistance — A measure of resistance to the flow of heat. It can be determined by measuring the temperature difference which is maintained between surfaces or planes when there is constant heat flow between them in unit time through unit area. The units are $m^2·°C/W$ or $m^2·K/W$

Total roof area — The roof area (A_{Roof}) plus the skylight area ($A_{Skylight}$)

Total wall area — The wall area plus the door area, plus the glazing area

U-value (for glass) — A measure of air-to-air heat transmission (loss or gain) due to the thermal conductance of the glazing and the difference between indoor and outdoor temperatures. It is calculated as (U-value) U = 1/R (thermal resistance). Refer to AS/NZS 4668 and AS/NZS 4666 for further information. The units are $W/(m^2·°C)$ or $W/(m^2·K)$

Unconditioned space	Space within the building envelope that is not conditioned space (for example, this may include a garage, conservatory, atrium, attic, subfloor, and so on). However, where a garage, conservatory or atrium is expected to be heated or cooled these spaces shall be included in the conditioned space
Wall	Any vertical or near vertical part of the building that is not part of the glazing area or door area and is at an angle from the horizontal greater than 60°
Wall area (A_{Wall})	The area of walls in the thermal envelope, excluding the door area and the glazing area

3 GENERAL REQUIREMENTS

3.1 Integrity of thermal insulation

3.1.1

Insulation shall be installed to achieve and maintain its intended R-value. Gaps and over-compaction of insulation material shall be avoided.

C3.1.1
NZS 4246: 2006 Energy efficiency – Installing insulation in residential buildings *provides guidance to ensure that insulation is installed correctly and will perform as intended.*

3.1.2

Where recessed light fittings form part of the building thermal envelope, either:

(a) CA rated (closed abutted) light fittings shall be used, with no gaps in the insulation material to the sides of the light fitting; or

(b) The effect of any gap in the insulation material around the light fitting on the construction R-value of the building element shall be taken into account.

C3.1.2
NZS 4246:2006 and the BRANZ 'House insulation guide' provide guidance on the reduction in thermal resistance from insulation clearances around recessed light fittings.

CA (closed abutted) light fittings are described in the 'New Zealand electrical code of practice 54:2001' http://www.energysafety.govt.nz.

Ceiling access hatches often form part of the thermal envelope and therefore should be insulated.

3.2 Construction R-value

The construction R-values of building elements shall be calculated using the typical area described in the definitions.

The construction R-value for walls, roofs, floors, and doors may instead be calculated including the effect of openings and corners, lintels, sills, additional studs, and so on.

The R-value of an unconditioned air-space between the thermal envelope and the building envelope may be included in the construction R-value. Examples are the subfloor, roof space, garage, or conservatory.

When determining the construction R-values for floors that include reflective air-spaces (such as draped foil) or ventilated unconditioned air-spaces (such as subfloor space), the effects of ventilation shall be taken into account.

When determining the floor construction R-value, the effect of floor coverings (including carpets) shall be ignored.

C3.2
The BRANZ 'House insulation guide' gives construction R-values for common constructions, and accounts for the effects of ventilation on floor and subfloor R-values.

3.3 Embedded heating systems

Where building elements form part of the thermal envelope and include embedded heating systems, those building elements shall have construction R-values no less than those in table 1.

C3.3
Floor coverings, for example carpet or cork will reduce the efficiency of the heated floor.

Table 1 – Heated ceilings, walls or floors – Construction R-values

Building element	Construction R-values for climate zones 1, 2, and 3 ($m^2 \cdot °C/W$)
Heated ceiling	R 3.5
Heated wall	R 2.6
Heated floor	R 1.9

where

R_{IN}/R-value < 0.1

and

R_{IN} is the thermal resistance between the heated plane and the inside air.

NOTE – The construction R-values in this table shall not be reduced by applying the calculation or modelling methods and therefore apply whenever building elements that are part of the thermal envelope include heating systems.

4 COMPLIANCE METHODS

The construction R-value requirements shall be determined by either the schedule, calculation or modelling method. Figure 1 provides guidance on which method is most appropriate in particular circumstances. Appendix D provides guidance on how to apply this Standard to alterations.

4.1 Schedule method

4.1.1

The schedule method shall only be used where:

(a) The glazing area is 30% or less of the total wall area;

(b) The combined area of glazing on the east, south, and west facing walls (see Appendix E) is 30% or less of the combined total area of these walls;

(c) The skylight area is no more than 1.5 m^2 or 1.5% of the total roof area (whichever is greater);

(d) The total area of decorative glazing and louvres is 3 m^2 or less.

C4.1.1
The size and orientation of windows within a building affects the amount of heating and/or cooling required. North-facing windows provide a positive heating benefit. Excessive glazing on the east or west (particularly the west) can lead to overheating. Excessive glazing on the south can make buildings difficult to heat.

The results of thermal modelling can be used to maximise the energy efficiency of a building. For more information on passive solar design refer to www.level.org.nz or the BRANZ publication 'Passive design'.

4.1.2

Building elements that are part of the thermal envelope shall have construction R-values no less than those in table 2 except where 4.1.3, 4.1.4, or 4.1.5 apply.

4.1.3

A building where all the walls in the thermal envelope are of solid timber construction may instead have building elements that form part of the thermal envelope with construction R-values no less than those in table 3.

4.1.4

A building where all the walls in the thermal envelope are of high thermal mass construction, may instead have building elements that form part of the thermal envelope with construction R-values no less than those in table 4.

C4.1.4

Thermal mass used in conjunction with good passive design can increase comfort and reduce energy use. The R-values in table 3 and table 4 assume that good passive solar design principles have been applied.

For more information on good passive design refer to www.level.org.nz or the BRANZ publication 'Passive design'.

See section 2 definitions for high thermal mass construction and wall surface density to determine which types of wall construction apply to table 4.

4.1.5

Where mixed types of wall construction are used (for example, high thermal mass and timber framed walls), the construction R-values may instead be R 3.5 for the roof, R 1.5 for the floor, and for walls, and glazing in those walls:

(a) As per table 3 for solid timber walls;

(b) As per table 4 for high thermal mass walls; and

(c) As per table 2 for all other types of walls.

4.1.6

There are no R-value requirements for the door area (the unglazed parts of doors).

C4.1.6

Doors in a house or small building may not have a significant impact on the heat loss of the building. However, if the door area is over either 6 m² or 6% of the total wall area (whichever is the greater) then the calculation or modelling method should be used.

Garages should form part of the unconditioned space of a building, that is, they should be outside the thermal envelope. The external walls, roof, and floor of garages should also be insulated, even though they often do not form part of the thermal envelope of the building.

4.1.7

There are no R-value requirements for decorative glazing and louvres.

C4.1.7

Decorative glazing and louvres with a combined total area of 3 m² or less may not have a significant impact on the heat loss of the building. This allowance accommodates designers who choose to use single glazed decorative products including traditional leadlight glazing and louvres of any type (such as glass, wood, and aluminium) to create architectural features.

Table 2 – Construction R-values for buildings with any wall type

Building element	Construction R-values ($m^2 \cdot °C/W$)		
	Climate zone 1	Climate zone 2	Climate zone 3
Roof	R 2.9	R 2.9	R 3.3
Wall	R 1.9	R 1.9	R 2.0
Floor	R 1.3	R 1.3	R 1.3
Windows and glazing	R 0.26	R 0.26	R 0.26
Skylights	R 0.26	R 0.26	R 0.31

Table 3 – Construction R-values for buildings with solid timber walls

Building element	Construction R-values ($m^2 \cdot °C/W$)					
	Climate zone 1		Climate zone 2		Climate zone 3	
	Option 1a	Option 1b	Option 2a	Option 2b	Option 3a	Option 3b
Roof	R 3.5	R 3.5	R 3.5	R 3.5	R 3.5	R 3.5
Walls – external 75 mm thick and timber framed internal walls	R 1.3	R 1.0	R 1.4	R 1.1	R 1.6	R 1.2
Walls – external 60 mm thick and solid timber internal walls 45 mm thick	R 1.0	R 0.8	R 1.3	R 1.0	R 1.6	R 1.2
Walls – external 90 mm thick and solid timber internal walls 45 mm thick	R 1.0	R 0.8	R 1.2	R 0.9	R 1.4	R 1.1
Walls – external 60 mm thick and solid timber internal walls 60 mm thick	R 1.0	R 0.8	R 1.2	R 0.9	R 1.4	R 1.1
Floor	R 1.3	R 1.3	R 1.3	R 1.3	R 1.3	R 1.3
Windows and glazing	R 0.26	R 0.31	R 0.26	R 0.31	R 0.26	R 0.31
Skylights	R 0.26	R 0.31	R 0.26	R 0.31	R 0.31	R 0.31

NOTE –

(1) At least 85% of internal walls shall be solid timber when using the wall construction R-values for solid timber external walls.

(2) Solid timber shall be exposed to the inside.

Table 4 – Construction R-values for buildings with high thermal mass walls

Building element	Construction R-values ($m^2 \cdot °C/W$)					
	Climate zone 1		Climate zone 2		Climate zone 3	
	Option 1a	Option 1b	Option 2a	Option 2b	Option 3a	Option 3b
Roof	R 3.5	R 3.5	R 3.5	R 3.5	R 3.5	R 3.5
Wall	R 0.8	R 0.8	R 1.0	R 0.9	R 1.2	R 1.0
Floor	R 1.5	R 1.3	R 1.5	R 1.3	R 1.5	R 1.3
Windows and glazing	R 0.26	R 0.31	R 0.26	R 0.31	R 0.26	R 0.31
Skylights	R 0.26	R 0.31	R 0.26	R 0.31	R 0.31	R 0.31

NOTE – The thermal mass shall be exposed to the inside, (see definitions of high thermal mass construction and wall surface density).

CTable 4

The table below provides information on approximate wall surface densities for some common concrete and masonry wall types. For further guidance on high thermal mass construction see the definition and 4.1.4. For partially filled refer to NZS 4229.

Wall construction	Thickness (mm)	Approximate wall surface density, Fully filled (kg/m^2)	Approximate wall surface density, Partially filled (kg/m^2)
Masonry block	140 mm	280	170 – 180 (does not meet high thermal mass requirements)
Masonry block	190 mm	380	230 – 240
Masonry block	240 mm	480	290 – 300
Structural concrete panel	100 mm	230	N/A

4.2 Calculation method

4.2.1

The calculation method shall only be used where the glazing area is 40% or less of the total wall area.

> ***C4.2.1***
> *The calculation method allows for buildings to have:*
>
> *(a) A glazing area greater than 30% of the total wall area; and/or*
>
> *(b) A reduction in the construction R-value of some building elements if this is compensated for by increasing the construction R-value of other building elements.*

4.2.2

Building elements that form part of the thermal envelope with construction R-values different from those in the schedule method may be used, providing the heat loss of the proposed building ($HL_{Proposed}$) is no more than the heat loss of the reference building ($HL_{Reference}$) for the relevant climate zone, wall construction type, and glazing area.

4.2.3

$HL_{Reference}$ shall be calculated using the equations in table 5 except where 4.2.4, 4.2.5 or 4.2.6 applies.

4.2.4

For a building where all the walls in the thermal envelope are of solid timber construction, $HL_{Reference}$ may instead be calculated using the equations in table 6.

4.2.5

For a building where all the walls in the thermal envelope are of high thermal mass construction (see definition), $HL_{Reference}$ may instead be calculated using the equations in table 7.

4.2.6

Where a design has a mix of different wall construction types then $HL_{Reference}$ may instead be calculated as the sum of the $HL_{Reference}$ for each type of wall construction multiplied by the fraction of the wall area of each type (see worked example F3 in Appendix F).

4.2.7

$HL_{Proposed}$ shall be calculated as the sum of all the building element heat losses according to equation 1.

$$HL_{Proposed} = \frac{A_{Roof}}{R_{Roof}} + \frac{A_{Wall}}{R_{Wall}} + \frac{A_{Floor}}{R_{Floor}} + \frac{A_{Glazing}}{R_{Window}} + \frac{A_{Door}}{R_{Door}} + \frac{A_{Skylight}}{R_{Skylight}} \quad \text{....... Equation 1}$$

where A is area (m^2), and R is the construction R-value ($m^2 \cdot °C/W$) in the proposed thermal envelope. If A_{Door} is no more than 6 m^2 or 6% of the total wall area (whichever is greater) then A_{Door} shall be set to zero in equation 1.

Where a building element is proposed to have parts with different thermal resistances (for example walls with different construction R-values), the corresponding term in the proposed building equation shall be expanded to suit (see worked example F2 in Appendix F).

4.2.8

The construction R-value in the proposed building for roofs, walls, and floors, that form part of the building thermal envelope shall be at least 50% of the construction R-value of the corresponding building element in the reference building equation. If 4.2.6 has been used for the reference building equation, the wall construction R-value shall be at least 50% of the construction R-value in the reference building equation that corresponds to that wall construction type.

C4.2.8
There are also minimum R-values required for housing to control internal moisture. Refer to NZBC Clause E3.

4.2.9

Where the construction R-value of a building element is not known, default construction R-values of 0.18 for an opaque building element and 0.15 for glazing shall be used in the heat loss equation for the proposed building.

CTable 5, Table 6, and Table 7
When a building has more than 30% of the total wall area glazed, the portion of glazing higher than 30% of the total wall area has a higher construction R-value in the reference heat loss equation. This requirement ensures that the heat losses of buildings with large areas of glazing are not significantly higher than buildings with 30% of the total wall area glazed. In the proposed building the construction R-value of all the glazing may be the same, or a mixture of R-values, depending on the results of the heat loss equation.

Table 5 – Reference building heat loss equations

Glazing area	Climate zone	Reference building heat loss equation
≤ 30% of total wall area	1 and 2	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{2.9} + \frac{A_{70\% \text{ of total wall area}}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{30\% \text{ of total wall area}}}{0.26}$
	3	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.3} + \frac{A_{70\% \text{ of total wall area}}}{2.0} + \frac{A_{Floor}}{1.3} + \frac{A_{30\% \text{ of total wall area}}}{0.26}$
> 30% of total wall area	1 and 2	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{2.9} + \frac{A_{Wall} + A_{Door}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{30\% \text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\% \text{ of total wall area}}}{0.4}$
	3	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.3} + \frac{A_{Wall} + A_{Door}}{2.0} + \frac{A_{Floor}}{1.3} + \frac{A_{30\% \text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\% \text{ of total wall area}}}{0.4}$

Table 6 – Reference building heat loss equations – Solid timber wall construction

Area of glazing	Climate zone	Reference building heat loss equation
≤ 30% of total wall area	1	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{70\%\ of\ total\ wall\ area}}{R_{Wall}} + \frac{A_{Floor}}{1.3} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26}$
	2	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{70\%\ of\ total\ wall\ area}}{R_{Wall}} + \frac{A_{Floor}}{1.3} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26}$
	3	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{70\%\ of\ total\ wall\ area}}{R_{Wall}} + \frac{A_{Floor}}{1.3} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26}$
> 30% of total wall area	1	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{Wall} + A_{Door}}{R_{Wall}} + \frac{A_{Floor}}{1.3} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26} + \frac{A_{Glazing} - A_{30\%\ of\ total\ wall\ area}}{0.31}$
	2	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{Wall} + A_{Door}}{R_{Wall}} + \frac{A_{Floor}}{1.3} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26} + \frac{A_{Glazing} - A_{30\%\ of\ total\ wall\ area}}{0.34}$
	3	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{Wall} + A_{Door}}{R_{Wall}} + \frac{A_{Floor}}{1.3} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26} + \frac{A_{Glazing} - A_{30\%\ of\ total\ wall\ area}}{0.34}$

NOTE –
(1) Solid timber shall be exposed to the inside.
(2) R_{Wall} is the construction R-value for the appropriate construction option from table 3, options 1a, 2a, or 3a only.

Table 7 – Reference building heat loss equations – High thermal mass wall construction

Area of glazing	Climate zone	Reference building heat loss equation
≤ 30% of total wall area	1	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{70\% \text{ of total wall area}}}{0.8} + \frac{A_{Floor}}{1.5} + \frac{A_{30\% \text{ of total wall area}}}{0.26}$
	2	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{70\% \text{ of total wall area}}}{1.0} + \frac{A_{Floor}}{1.5} + \frac{A_{30\% \text{ of total wall area}}}{0.26}$
	3	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{70\% \text{ of total wall area}}}{1.2} + \frac{A_{Floor}}{1.5} + \frac{A_{30\% \text{ of total wall area}}}{0.26}$
> 30% of total wall area	1	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{Wall} + A_{Door}}{0.8} + \frac{A_{Floor}}{1.5} + \frac{A_{30\% \text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\% \text{ of total wall area}}}{0.26}$
	2	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{Wall} + A_{Door}}{1.0} + \frac{A_{Floor}}{1.5} + \frac{A_{30\% \text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\% \text{ of total wall area}}}{0.31}$
	3	$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{Wall} + A_{Door}}{1.2} + \frac{A_{Floor}}{1.5} + \frac{A_{30\% \text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\% \text{ of total wall area}}}{0.34}$

NOTE – The thermal mass shall be exposed to the inside, (see definitions of high thermal mass construction and wall surface density).

4.3 Modelling method

4.3.1

The modelling method may be used for any proposed building design. All buildings where the glazing area is more than 40% of the total wall area shall use the modelling method.

C4.3.1

Acceptable modelling software requirements are set out in Appendix G1.3.

4.3.2

The proposed building and the reference building shall be modelled, and the annual heating load and cooling load calculated, following the requirements described in Appendix G.

4.3.3

The sum of the calculated annual heating load and annual cooling load of the proposed building shall not exceed that of the reference building with construction R-values from table 2.

APPENDIX A – MEASUREMENT DETAILS

(Informative)

Figures A1 to A10 illustrate how the dimensions and areas of building elements in the thermal envelope should be measured.

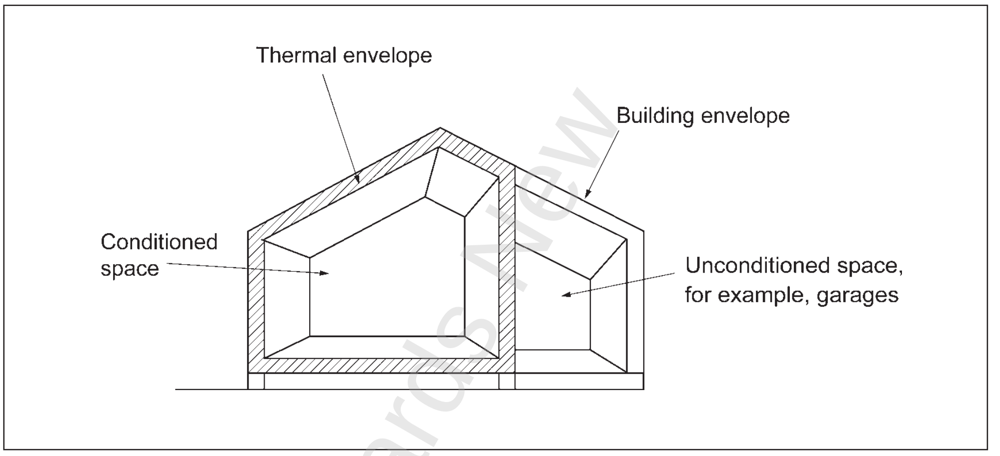

Figure A1 – Thermal envelope

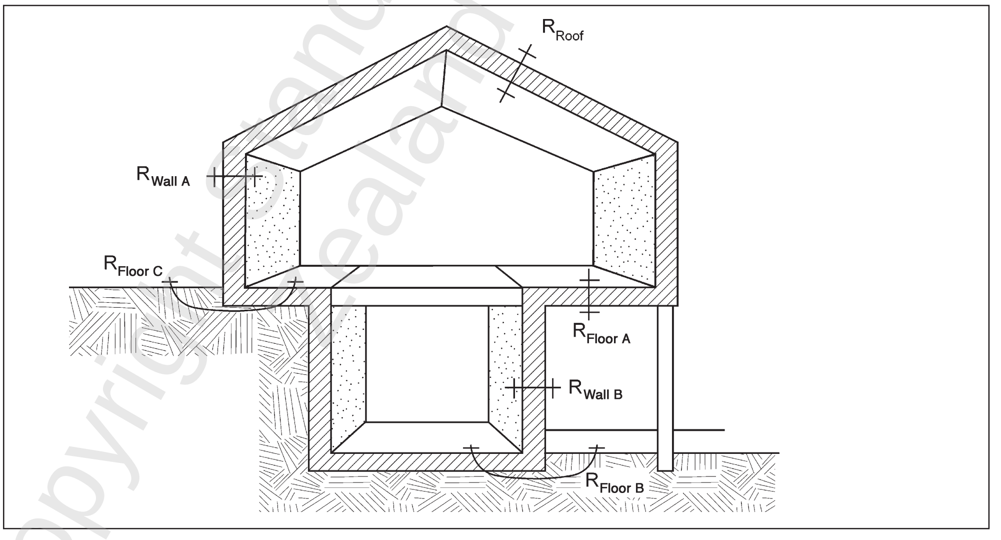

Figure A2 – R-value locations

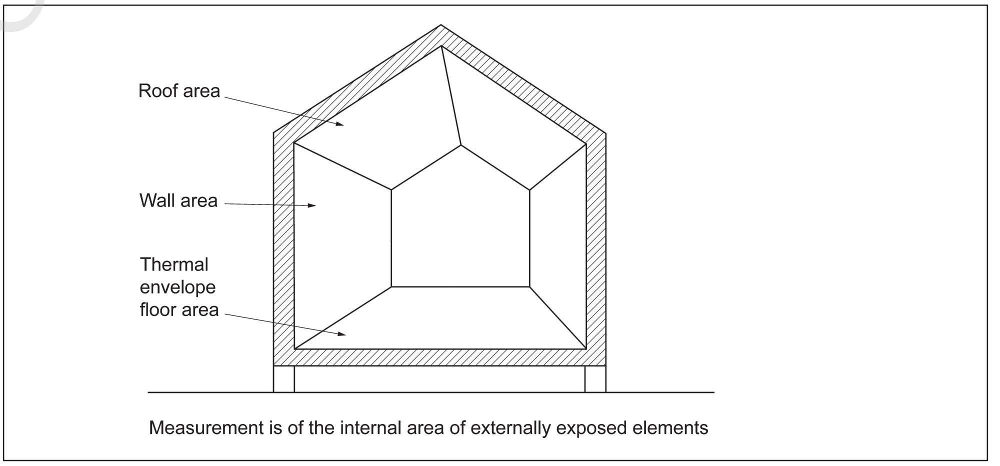

Figure A3 – Element measurements

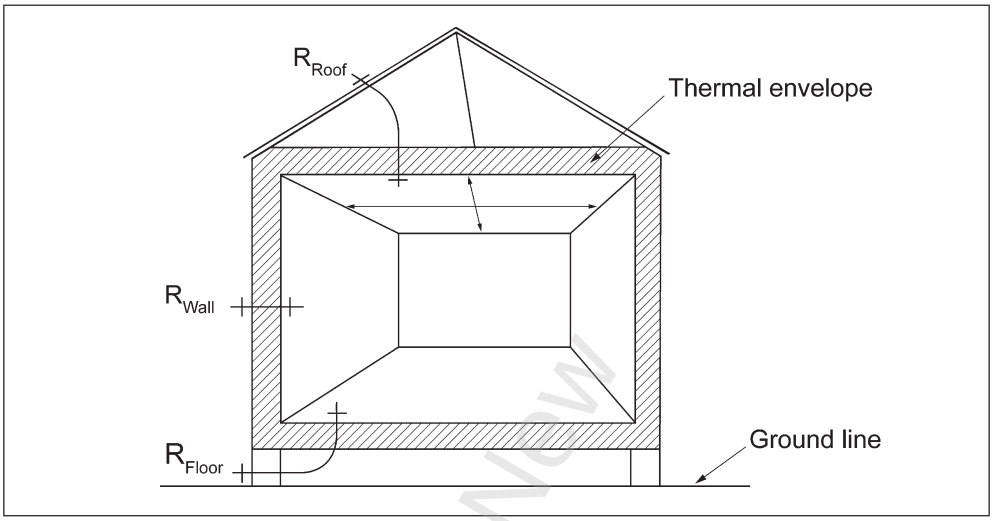

Figure A4 – Roof measurement – Flat ceiling

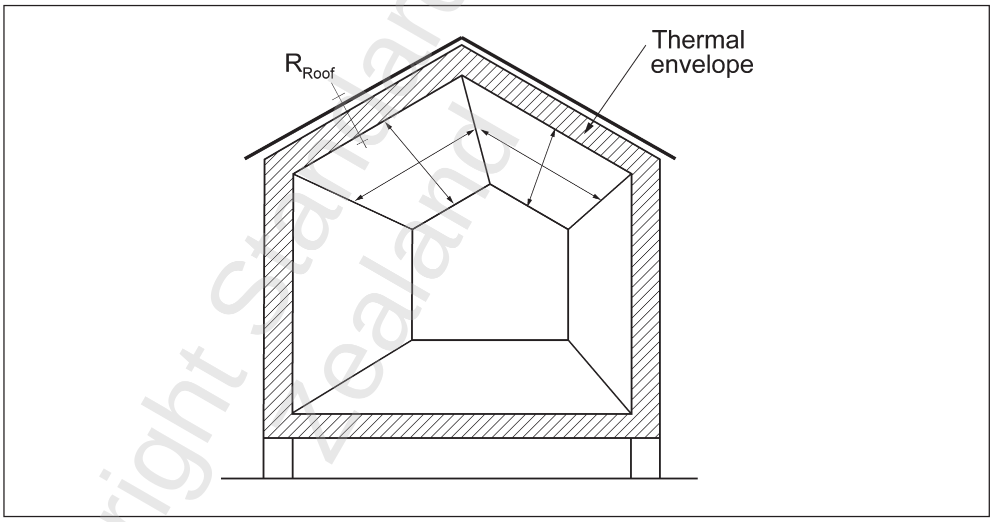

Figure A5 – Roof area measurements – Pitched ceiling

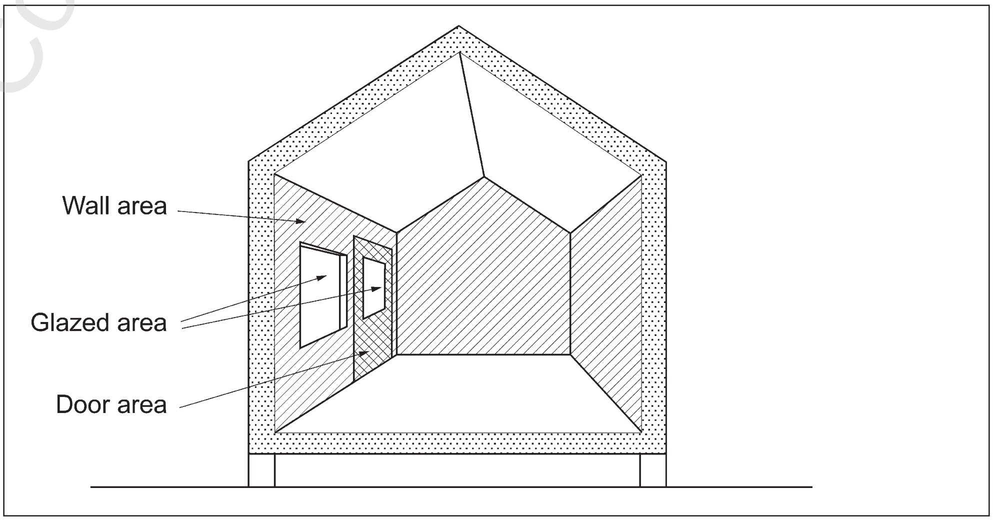

Figure A6 – Wall area measurements

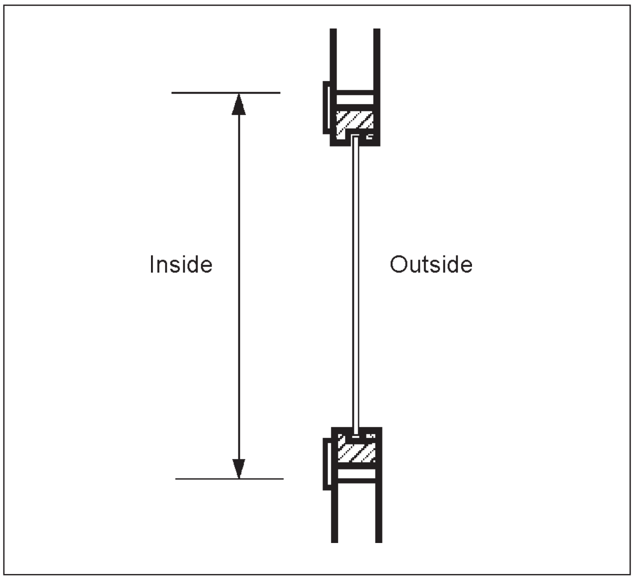

Figure A7 – Window measurement – Single window

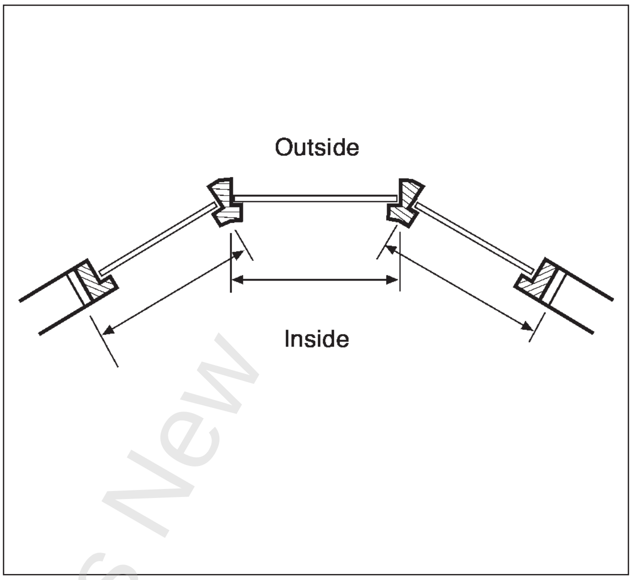

Figure A8 – Bay window measurement

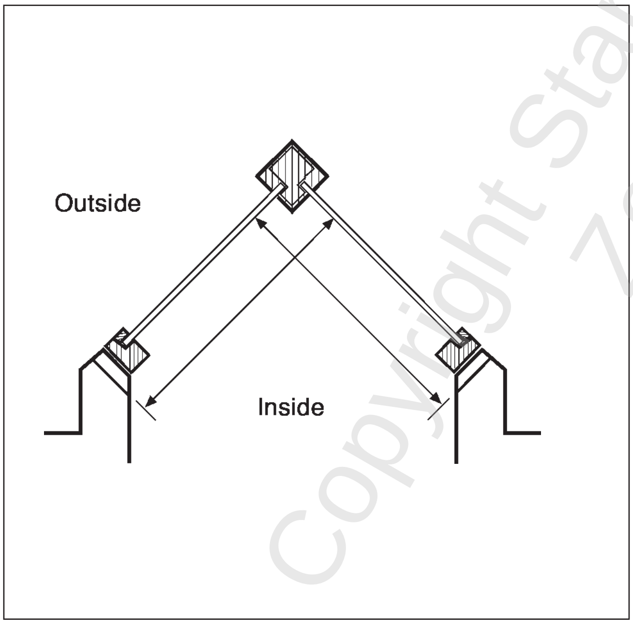

Figure A9 – Skylight measurement

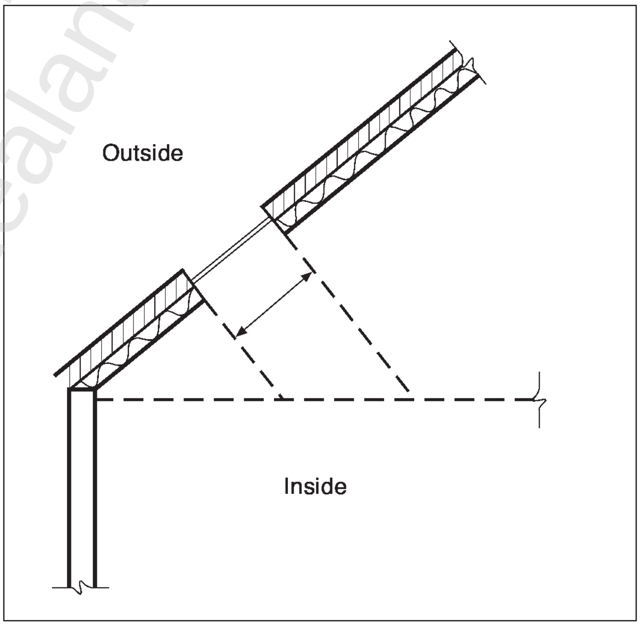

Figure A10 – Skylight with light shaft

APPENDIX B – CLIMATE ZONES

(Normative)

CB1
The climate zone boundaries are based on climatic data taking into consideration territorial authority boundaries, providing for three zones (see figure B1).

B1

Zone 1 comprises the Thames-Coromandel District, the Franklin District, and all districts north of these, and all offshore islands north of 37°15' south.

B2

Zone 2 comprises all of the North Island excluding Zone 1, the Taupo District, the Ruapehu District, and that part of the Rangitikei District north of 39°50' south.

B3

Zone 3 comprises the Taupo District, the Ruapehu District, that part of the Rangitikei District north of 39°50' south, the South Island, Stewart Island, the Chatham Islands, and all offshore islands not in Zone 1.

CB3
The latitude of 39°50' south lies just to the south of Mangaweka. Mangaweka is in Zone 3, while Ohingaiti is in Zone 2.

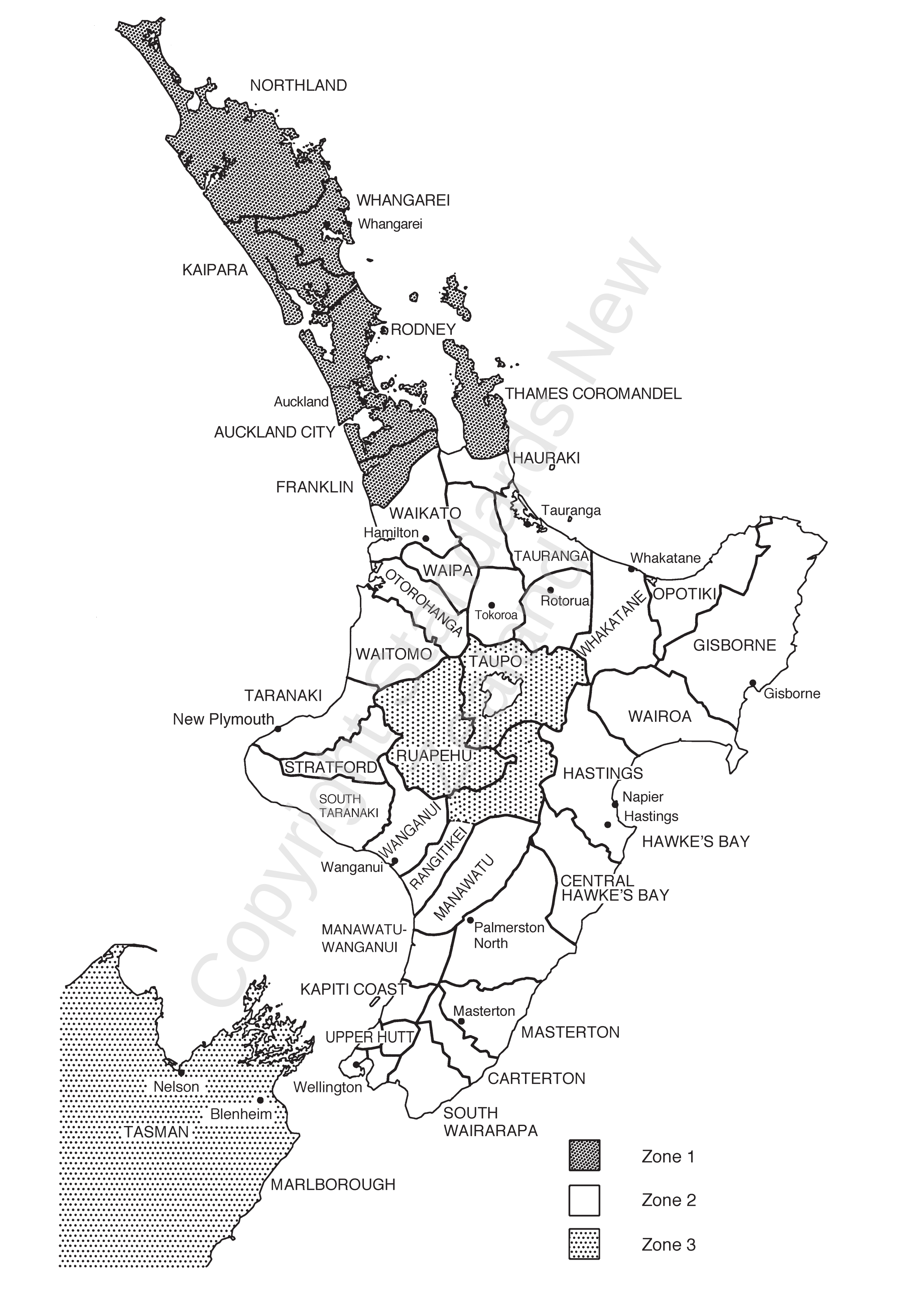

Figure B1– Climate zones

APPENDIX C – WINDOWS AND GLAZING

(Normative)

C1 Construction R-value

The construction R-values for windows shall include the effects of both the glazing materials and the frame materials, and are defined as R_{Window}. R_{Window} shall be determined using the assumptions and methods described in C2, or determined from the performance tables provided in C3.

CC1

The thermal performance of a window shall take account of both the glazing materials and the frame material in order to provide the true thermal resistance (R-value, or the reciprocal of this being the thermal transmission or U-value) of the window as a 'total product'. The thermal performance of glazing products is measured without the influence of the frame and is normally quoted as centre of glass (COG) U-values or R-values.

The window size and frame material have a major bearing on the total thermal resistance of the window as a building element and often the centre of glass R-value (R_{COG}) and the total thermal resistance (R_{Window}) values are dissimilar. For large windows the centre of glass R-value (R_{COG}) will have more bearing on the overall performance than in a small window, which is dominated by the frame performance.

The amount of free heat that enters a window from the sun is measured with the SHGC or the shading coefficient (SC). If the SHGC is below 0.69 the solar heat captured in winter may fall below an acceptable level and this should be considered in design.

C2 Standard window modelling

To calculate R_{Window} for vertical windows, use a generic window, of size 1800 mm wide x 1500 mm high with a central mullion and one opening light.

Calculate R_{Window} of the glass and frame using the 'Standard Window R-value Calculation Procedure'. This procedure will calculate the total window U-value (U_{Window}) and the inverse (1/U) will give R_{Window}. The procedure is available from the BRANZ website http://www.branz.co.nz.

CC2

The standard window described in C2 gives typical R_{Window} R-values for standard aluminium joinery of 0.15 ($m^2 \cdot °C/W$) for single glazing and 0.26 ($m^2 \cdot °C/W$) for a standard IGU, based on a 4 mm glass/12 mm air/4 mm glass combination.

The BRANZ website provides information on the glazing systems used for the generic windows, and also has additional information about alternative framing and glazing options.

The R/U-values of windows constructed of different materials vary, as indicated in table C1 to table C4.

C3 Performance tables

R_{window} for windows and glazing may be determined from table C1 to table C4.

CC3

Table C1 to table C4 show both R_{Window} and U_{Window} of window systems with different glass types along with the U_{COG} and R_{COG}, so that designers have a guide to the total performance of a window given the U_{COG} for any glass type.

$SHGC_{COG}$ and SC_{COG} are given to allow comparison of the solar control or summer cooling performance of the window. The shading coefficient is calculated as SC = SHGC/0.86.

C4 Skylights

The 'Standard Window R-value Calculation Procedure' may be used for modelling skylights by changing the window tilt or slope and thus the heat flow requirements.

Alternatively manufacturer's data for the construction R-value (R_{Window}) may be used or in the absence of this information R_{Window} may be determined from table C1 to table C4.

Table C1 – Thermal performance of generic windows in aluminium frame

Code	mm	Outer	Space mm	Inner pane mm	Inner pane	SHGC COG	SC COG	U COG	R COG	U Window	R Window
SINGLE GLASS in aluminium frame											
101	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.70	0.15
102	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	6.58	0.15
103	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.81	0.21
104	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	5.21	0.19
105	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.68	0.15
106	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.68	0.15
107	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.66	0.15
108	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.68	0.15
109	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	6.65	0.15
INSULATING GLASS UNITS in aluminium frame											
110	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	4.22	0.24
111	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	4.06	0.25
112	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.96	0.25
113	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.90	0.26
114	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.89	0.26
115	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.89	0.26
116	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.89	0.26
117	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.89	0.26
118	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.89	0.26
119	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.90	0.26
120	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.82	0.26
121	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.78	0.26
122	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.78	0.26
123	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	3.28	0.31
124	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	3.44	0.29
125	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	3.27	0.31
126	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	3.27	0.31
127	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	3.14	0.32
128	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	3.09	0.32

NOTE –
(1) For single glazing the Low E coated surface is on surface 2 inside the building.
(2) For an IGU the Low E coating is on surface 2 if an outer pane and surface 3 of the IGU if an inner pane.
(3) The performance of units containing argon gas is based on the cavity having a 90 % argon/10 % air mix.

CTable C1

Manufacturers should be consulted about the suitability of using single glazed Low E glass.

Low E coatings on single glazing can have a lower surface temperature in winter, and so can collect more condensation, which temporarily removes the benefit of the low emissivity surface.

Table C2 – Thermal performance of generic windows in composite aluminium frame

Code	mm	Outer	Space	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{Window}	R_{Window}
SINGLE GLASS in composite frame											
201	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.58	0.15
202	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	6.46	0.15
203	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.69	0.21
204	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	5.09	0.20
205	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.56	0.15
206	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.56	0.15
207	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.53	0.15
208	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.56	0.15
209	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	6.53	0.15
INSULATING GLASS UNITS in composite frame											
210	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	4.19	0.24
211	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	4.03	0.25
212	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.92	0.25
213	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.86	0.26
214	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.86	0.26
215	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.86	0.26
216	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.85	0.26
217	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.86	0.26
218	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.85	0.26
219	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.86	0.26
220	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.79	0.26
221	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.74	0.27
222	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.74	0.27
223	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	3.24	0.31
224	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	3.41	0.29
225	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	3.24	0.31
226	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	3.24	0.31
227	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	3.10	0.32
228	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	3.06	0.33

NOTE –
(1) For single glazing the Low E coated surface is on surface 2 inside the building.
(2) For an IGU the Low E coating is on surface 2 if an outer pane and surface 3 of the IGU if an inner pane.
(3) The performance of units containing argon gas is based on the cavity having a 90 % argon/10 % air mix.

CTable C2

Manufacturers should be consulted about the suitability of using single glazed Low E glass.

Low E coatings on single glazing can have a lower surface temperature in winter, and so can collect more condensation, which temporarily removes the benefit of the low emissivity surface.

Table C3 – Thermal performance of generic windows in thermally broken aluminium frame

Code	mm	Outer	Space mm	Inner pane mm	Inner pane	$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{Window}	R_{Window}
SINGLE GLASS in thermally broken aluminium frame											
301	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.04	0.17
302	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	5.92	0.17
303	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.16	0.24
304	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	4.55	0.22
305	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.02	0.17
306	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.02	0.17
307	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.00	0.17
308	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.02	0.17
309	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	5.99	0.17
IGU in thermally broken aluminium frame											
310	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	3.54	0.28
311	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	3.38	0.30
312	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.28	0.31
313	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.22	0.31
314	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.21	0.31
315	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.21	0.31
316	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.21	0.31
317	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.21	0.31
318	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.20	0.31
319	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.22	0.31
320	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.14	0.32
321	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.10	0.32
322	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.10	0.32
323	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	2.60	0.39
324	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	2.76	0.36
325	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	2.59	0.39
326	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	2.59	0.39
327	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	2.46	0.41
328	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	2.41	0.41

NOTE –
(1) For single glazing the Low E coated surface is on surface 2 inside the building.
(2) For an IGU the Low E coating is on surface 2 if an outer pane and surface 3 of the IGU if an inner pane.
(3) The performance of units containing argon gas is based on the cavity having a 90 % argon/10 % air mix.

CTable C3

Manufacturers should be consulted about the suitability of using single glazed Low E glass.

Low E coatings on single glazing can have a lower surface temperature in winter, and so can collect more condensation, which temporarily removes the benefit of the low emissivity surface.

Table C4 – Thermal performance of generic windows in PVC/wooden frame

Code	mm	Outer	Space mm	Inner pane mm		SHGC COG	SC COG	U COG	R COG	U Window	R Window
SINGLE GLASS in PVC or Wooden frame											
401	4	Clear	–	–	–	0.85	0.97	5.88	0.17	5.23	0.19
402	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	5.11	0.20
403	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	3.35	0.30
404	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	3.74	0.27
405	5	Grey	–	–	–	0.62	0.71	5.85	0.17	5.21	0.19
406	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	5.21	0.19
407	6	Green	–	–	–	0.61	0.71	5.82	0.17	5.19	0.19
408	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	5.21	0.19
409	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	5.18	0.19
IGU in PVC or Wooden frame											
410	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	3.07	0.33
411	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	2.91	0.34
412	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	2.81	0.36
413	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	2.75	0.36
414	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	2.75	0.36
415	5	Bronze	12	4	Clear	0.56	0.64	2.73	0.37	2.75	0.36
416	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	2.74	0.36
417	5	Evergreen	12	4	Clear	0.46	0.54	2.73	0.37	2.75	0.36
418	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	2.74	0.36
419	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	2.75	0.36
420	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	2.67	0.37
421	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	2.63	0.38
422	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	2.63	0.38
423	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	2.13	0.47
424	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	2.29	0.44
425	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	2.13	0.47
426	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	2.13	0.47
427	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	1.99	0.50
428	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	1.95	0.51

NOTE –
(1) For single glazing the Low E coated surface is on surface 2 inside the building.
(2) For an IGU the Low E coating is on surface 2 if an outer pane and surface 3 of the IGU if an inner pane.
(3) The performance of units containing argon gas is based on the cavity having a 90% argon/10% air mix.

CTable C4

Manufacturers should be consulted about the suitability of using single glazed Low E glass.

Low E coatings on single glazing can have a lower surface temperature in winter, and so can collect more condensation, which temporarily removes the benefit of the low emissivity surface.

APPENDIX D – ALTERATIONS

(Informative)

D1 Introduction

This informative appendix provides guidance on how this Standard may be applied to 'parts of a building' (for example, an alteration or addition).

CD1
Building elements in the existing part of the building should be upgraded to achieve higher thermal resistance, where practicable (using the construction R-values in the schedule method as a guide).

D1.1 Scope

This appendix shall not be used where the original building was first consented after the Third Edition of the H1 Compliance Document.

D1.2 Alterations

Either the schedule, calculation, or modelling method shall be applied to the alteration only (treating the alteration as if it were a whole building), or D2, D3, or D4 shall apply.

CD2
This appendix allows two ways of applying the compliance methods of this Standard to alterations. Either apply the compliance methods to the alteration only, or apply them to the whole building. In either case, only the building elements in the alteration are required to meet the construction R-value requirements of this Standard.

D2 Schedule method

D2.1

The schedule method (see 4.1) shall only be used where the building meets the requirements of 4.1.1(a) and 4.1.1(c) for the entire building, and 4.1.1(d) for the alteration only.

D2.2

Only the alteration is required to achieve the construction R-values of the schedule method. Therefore, no part of the unaltered building is required to be upgraded.

D3 Calculation method

D3.1

The calculation method (see 4.2) shall only be used where the glazing area is 40% or less of the total wall area for the entire building.

D3.2

Only the alteration is required to achieve the construction R-values determined by the heat loss equation.

D3.3

In the proposed building the existing glazing shall be assumed to have construction R-values of 0.26 unless higher construction R-values can be demonstrated. Other existing building elements in the proposed building shall be assumed to have construction R-values equal to those of the same building elements in the reference building, unless higher construction R-values can be demonstrated.

D4 Modelling method

The modelling method (see 4.3) shall be applied to the entire building with the following changes:

(a) The construction R-values for the proposed building and the reference building shall be the same for the existing part of the building;

(b) In the proposed building, only the alteration (for example, new building elements) may have construction R-values different to the reference building; and

(c) If the construction R-values of any existing building element are changed then this becomes part of the alteration.

CD4 Examples

Example 1: *A window is added to an existing wall. The total glazing area of the whole building after the window is added is 24%, so under D2 the schedule method may be used. The window needs to achieve a construction R-value of 0.26 (from table 2).*

Example 2: *A 110 m² 1930s bungalow with 18% glazing area has a 30 m² extension added with one wall fully glazed with French doors. The extension has more than 30% glazing, so under D1.2 the schedule method cannot be used. The glazing area including the extension has increased to 27%, which is less than the 30% maximum in D2.1 and 4.1.1(a), so the schedule method may be used. The extension needs to have construction R-values from table 2.*

Example 3: *Using Example 1, but with 10 m² of the new glazing single glazed the design fails the schedule method as this glazing does not have an R-value of 0.26 or higher. The calculation method may be used, either on the extension only (D1.2) or the whole building (D3).*

Example 4: *A 100 m² 1970s single storey house with 27% glazing area has a second storey added, with 42% glazing. The schedule method may not be used as the amount of glazing is too high (>30% in the addition alone, and 34.5% for the entire building). The calculation method may not be used on the addition only (42% glazing is more than the 30% limit), but may be applied to the whole building (34.5% glazing is less than the 40% limit). The house has been retrofitted with floor insulation, giving a construction R-value of R 2.2, which is higher than the R 1.3 in the reference equation, so according to D3.3, R 2.2 may be used for the proposed building floor R-value. This reduces the heat loss and makes it easier to meet the heat loss of the reference building.*

APPENDIX E – ORIENTATION

(Normative)

E1 Orientation

A building wall, including the glazing it contains, shall be considered to face north if it faces any direction in the north orientation sector of figure E1. The orientations of skylights and other walls, including the glazing they contain, shall be determined in a similar way.

E2 Description of sectors

Orientation sectors specified in figure E1 are based on true north and are as follows:

North sector lies between north west (more than 315 degrees) and north east (less than 45 degrees);

East sector lies between north east (45 degrees) and south east (135 degrees);

South sector lies between south east (more than 135 degrees) and south west (less than 225 degrees);

West sector lies between south west (225 degrees) and north west (315 degrees).

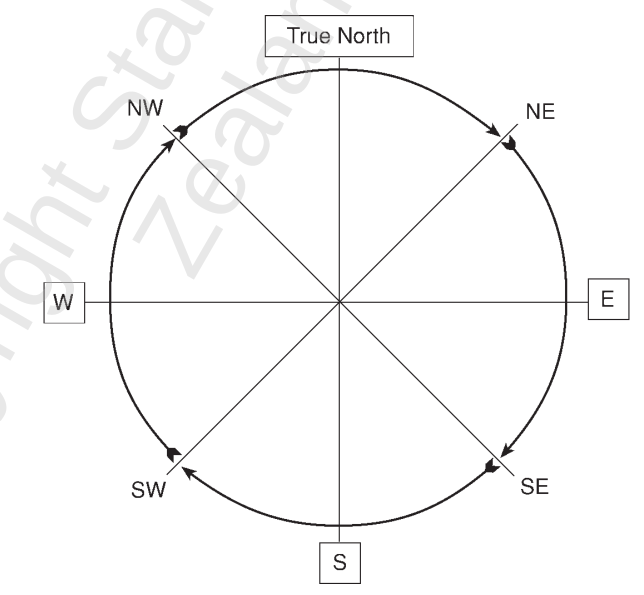

Figure E1 – Orientation sectors

> ***CE2***
> *A compass points toward magnetic north. Magnetic north varies from true north by 19.5° in Auckland, 22° in Wellington and 23.5° in Christchurch. In New Zealand magnetic north is always east of true north. It is important that true north is used for the orientation rather than magnetic north. The following website calculates the difference between magnetic north and true north (magnetic declination) http://www.ngdc.noaa.gov/geomag/magfield.shtml*

APPENDIX F – WORKED EXAMPLES

(Informative)

A variety of worked examples is provided to demonstrate how the calculation method should be used. The examples include one simple example and two more complex examples that together demonstrate how the rules of the calculation method are applied.

F1

This example shows how increasing the construction R-value in one building element allows a decrease in another building element, and how skylights are treated. Consider a house in Zone 3 with timber-framed construction for the walls, a window area of 43 m^2 and 3 m^2 of skylights (see figure F1). There are 2 door openings with total area 8 m^2, of which 2 m^2 is glazing. Thus the total vertical glazing is 45 m^2 including the door glazing.

House internal dimensions:	Length 15 m, width 12 m, height 2.4 m
Total wall area:	(15 m x 2.4 m x 2) + (12 m x 2.4 m x 2) = 129.6 m^2
Floor area (A_{Floor}):	15 m x 12 m = 180 m^2
Roof area (A_{Roof}):	15 m x 12 m – 3 m^2 = 177 m^2 (excludes area of skylights)
Area of skylights ($A_{Skylight}$):	3 m^2
Area of vertical glazing ($A_{Glazing}$):	43 m^2 + 2 m^2 (door) = 45 m^2
Glazing/total wall area %:	45 m^2 / 129.6 m^2 = 34.7%
Door area (A_{Door}):	6 m^2 (excludes glazing in the doors)
Wall area (A_{Wall}):	129.6 m^2 – 45 m^2 – 6 m^2 = 78.6 m^2
Glazing over 30%:	45 m^2 – (129.6 m^2 x 30%) = 6.1 m^2

REFERENCE BUILDING

Following 4.2.3, use appropriate equation from table 5 for a building with > 30% glazing (for Zone 3):

$$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.3} + \frac{A_{Wall} + A_{Door}}{2.0} + \frac{A_{Floor}}{1.3} + \frac{A_{30\% \text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\% \text{ of total wall area}}}{0.4}$$

$$HL_{Reference} = \frac{180}{3.3} + \frac{78.6+6}{2.0} + \frac{180}{1.3} + \frac{38.9}{0.26} + \frac{6.1}{0.4}$$

$$HL_{Reference} = 54.5 + 42.3 + 138.5 + 149.6 + 15.3 = \boxed{400.2 \text{ W/°C}}$$

PROPOSED BUILDING

Assume that the designer is prepared to increase the construction R-value of the roof, but wishes to use double glazing with R 0.26 for all vertical glazing and skylights. The door area (A_{Door}) is no more than 6 m² or 6% of the total wall area (whichever is greater), so A_{Door} is set to zero in the calculation for the proposed building (see 4.2.7). The heat loss of the proposed building is calculated using equation 1 from 4.2.7:

$$HL_{Proposed} = \frac{A_{Roof}}{R_{Roof}} + \frac{A_{Wall}}{R_{Wall}} + \frac{A_{Floor}}{R_{Floor}} + \frac{A_{Glazing}}{R_{Window}} + \frac{A_{Door}}{R_{Door}} + \frac{A_{Skylight}}{R_{Skylight}}$$

$$HL_{Proposed} = \frac{177}{3.3} + \frac{84.6}{2.0} + \frac{180}{1.3} + \frac{45}{0.26} + 0 + \frac{3}{0.26}$$

$$HL_{Proposed} = 53.6 + 42.3 + 138.5 + 173.1 + 0 + 11.5 = \boxed{419.0 \text{ W/°C}}$$

So $HL_{Proposed}$ is too high by 18.8 W/°C, and the roof construction R-value needs to be increased to 5.1 if practically achievable, otherwise the construction R-values of other building elements would need to be increased.

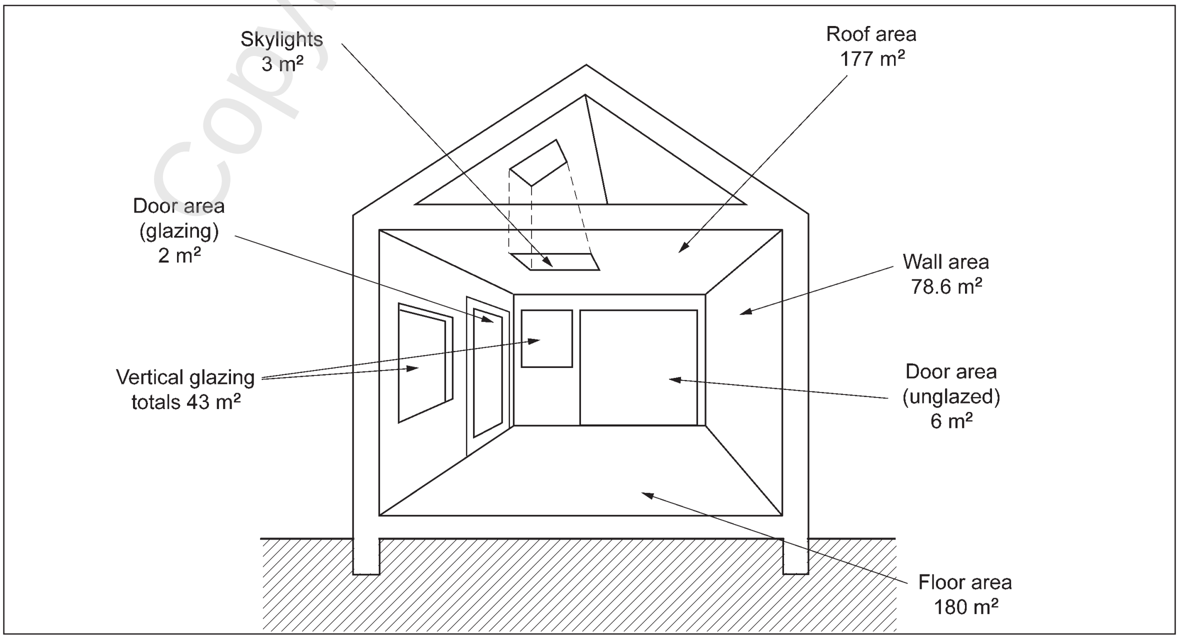

Figure F1 – Simple example design

F2

This example is the same as example F1, but with a variety of glazing types, cladding types, and floor constructions (see figure F2). The reference building is the same, so the reference building heat loss is 400.2 W/°C. The door area is below the door limit so is set to 0 in the calculation for the proposed building. There are 6 m^2 of single glazed leadlights, which come under the definition of decorative glazing and louvres. In the calculation method decorative glazing and louvres are treated the same as any other type of glazing.

The areas and construction R-values for the proposed design are:

Roof (A_{Roof}):	177 m^2 with construction R-value 3.3 (excludes area of skylights)
Wall 1 ($A_{Wall\ 1}$):	44 m^2 with construction R-value 1.8
Wall 2 ($A_{Wall\ 2}$):	34.6 m^2 with construction R-value 2.3
Floor 1 ($A_{Floor\ 1}$):	100 m^2 suspended timber floor with construction R-value 2.1
Floor 2 ($A_{Floor\ 2}$):	80 m^2 slab on ground floor (uninsulated) with construction R-value 1.2
Glazing 1 ($A_{Glazing\ 1}$):	6 m^2 single glazing with R_{Window} 0.15 (4 m^2 window and 2 m^2 glazed door) (see Appendix C)
Glazing 2 ($A_{Glazing\ 2}$):	39 m^2 clear double glazing with R_{Window} 0.26 (see Appendix C)
Skylights ($A_{Skylight}$):	3 m^2 with R_{Window} 0.34 (see Appendix C)
Door area (A_{Door}):	6 m^2 (excludes glazing in the doors)

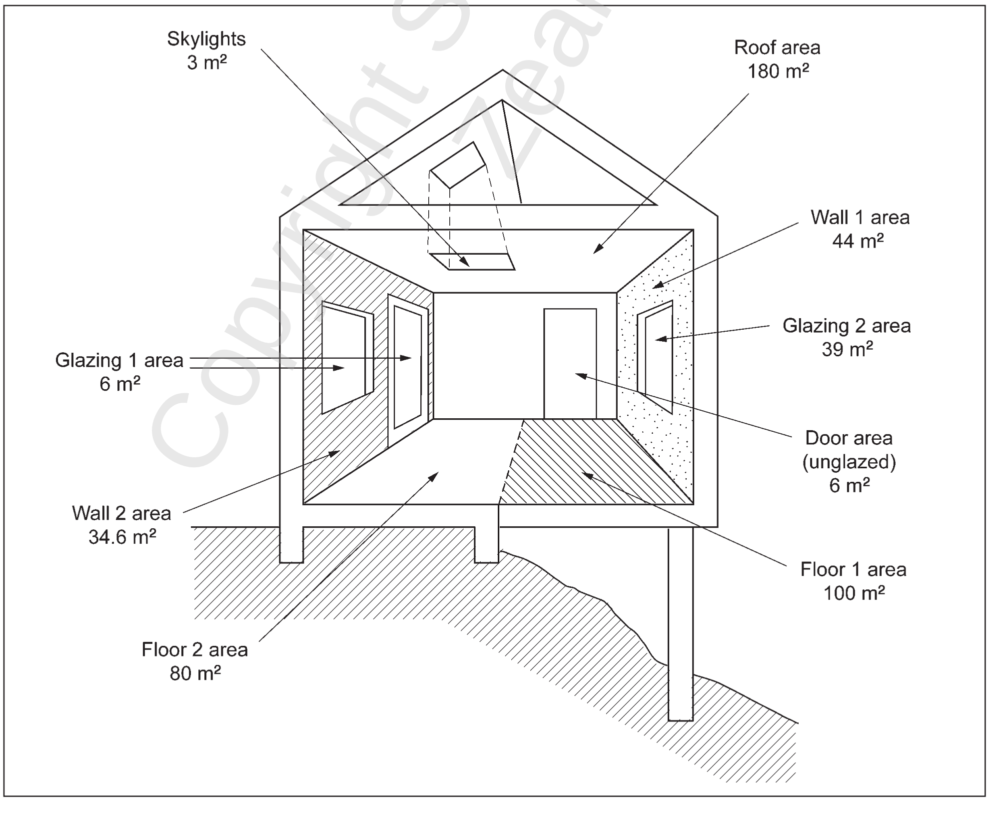

Figure F2 – Example of design with different types of floor, wall, and glazing

Following 4.2.7, equation 1 is expanded for the proposed building for the additional building elements.

$$HL_{Proposed} = \frac{A_{Roof}}{R_{Roof}} + \frac{A_{Wall\ 1}}{R_{Wall\ 1}} + \frac{A_{Wall\ 2}}{R_{Wall\ 2}} + \frac{A_{Floor\ 1}}{R_{Floor\ 1}} + \frac{A_{Floor\ 2}}{R_{Floor\ 2}} + \frac{A_{Glazing1}}{R_{Window1}} + \frac{A_{Glazing\ 2}}{R_{Window\ 2}} + \frac{A_{Door}}{R_{Door}} + \frac{A_{Skylight}}{R_{Skylight}}$$

$$HL_{Proposed} = \frac{177}{3.3} + \frac{44}{1.8} + \frac{34.6}{2.3} + \frac{100}{2.1} + \frac{80}{1.2} + \frac{6}{0.15} + \frac{39}{0.26} + 0 + \frac{3}{0.34}$$

$$HL_{Proposed} = 53.6 + 24.4 + 15.0 + 47.6 + 66.7 + 40.0 + 150.0 + 0 + 8.8 = 406.1 \text{ W/°C}$$

So $HL_{Proposed}$ is too high by 5.9 W/°C, thus the roof construction R-value needs to be increased to 3.7 if practically achievable, otherwise the construction R-values of other building elements would need to be increased.

F3

This example (see figure F3) illustrates how 4.2.6 may be applied to a design that has a mixture of different wall constructions. It is a simple two-storey design in Zone 1 with high thermal mass masonry walls on the ground floor and timber framed walls on the upper floor. The high thermal mass masonry walls are required to comply with table 7 and the definition of high thermal mass walls (that is, have a wall surface density of at least 215 kg/m^2, and have the thermal mass material exposed to the interior).

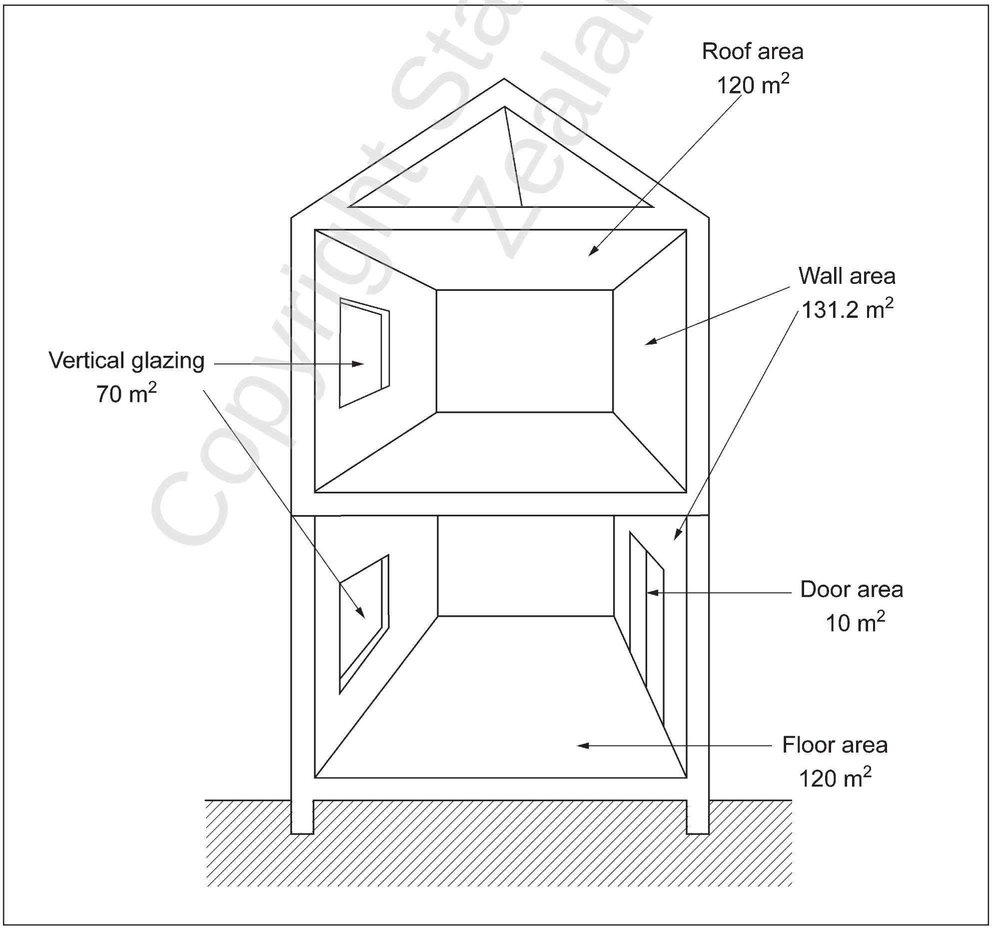

Figure F3 – Example of mixed timber framed and high thermal mass construction

House interior dimensions:	Length 12 m, width 10 m, room height 2.4 m, 2 storeys
Total wall area:	(12m + 12m + 10m + 10m) x 2.4 m x 2 = 211.2 m^2
Floor area:	12 m x 10 m = 120 m^2
Skylight area:	0 m^2
Roof area:	12 m x 10 m = 120 m^2
Glazing area:	70 m^2
Glazing at ground floor:	18.9 m^2 → 27 % of glazing area
Glazing at 1st floor:	51.1 m^2 → 73 % of glazing area
Door area:	10 m^2
Wall area:	211.2 m^2 – 70 m^2 – 10 m^2 = 131.2 m^2
High thermal mass wall area:	(12m + 12m + 10m + 10m) x 2.4 – (70 m^2 x 0.27 (glazing)) – 8 m^2 (doors) = 78.7 m^2 → 60% of wall area
Timber framed wall area:	(12m + 12m + 10m + 10m) x 2.4 – (70 m^2 x 0.73) (glazing) – 2 m^2 (doors) = 52.5 m2 → 40% of wall area
70% of total wall area:	147.8 m^2
30% of total wall area:	63.4 m^2

REFERENCE BUILDING

Clause 4.2.6 allows the reference heat loss for the mixed construction to be calculated as a wall area weighted average of the reference heat loss equation from table 5 and table 7.

From table 5

$$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{2.9} + \frac{A_{Wall} + A_{Door}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26} + \frac{A_{Glazing} - A_{30\%\ of\ total\ wall\ area}}{0.4}$$

$$HL_{Reference} = \frac{120}{2.9} + \frac{131.2 + 10}{1.9} + \frac{120}{1.3} + \frac{63.4}{0.26} + \frac{70 - 63.4}{0.4} = 468\ W/°C$$

From table 7

$$HL_{Reference} = \frac{A_{Roof} + A_{Skylight}}{3.5} + \frac{A_{Wall} + A_{Door}}{0.8} + \frac{A_{Floor}}{1.5} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.26} + \frac{A_{Glazing} - A_{30\%\ of\ total\ wall\ area}}{0.26}$$

$$HL_{Reference} = \frac{120}{3.5} + \frac{131.2 + 10}{0.8} + \frac{120}{1.5} + \frac{63.4}{0.26} + \frac{70 - 63.4}{0.26} = 560\ W/°C$$

The fraction of high thermal mass wall of the wall area is 78.7/131.2 = 0.6, and the fraction of timber framed wall is 52.5/131.2 = 0.4 (or simply 1 – 0.6).

The reference heat loss is calculated as:

$HL_{Reference}$ = ($HL_{Reference}$ from table 5 x 0.4) + ($HL_{Reference}$ from table 7 x 0.6)

$HL_{Reference}$ = (468 x 0.4) + (560 x 0.6) = 523.2 W/°C

PROPOSED BUILDING

The proposed building construction R-values are:

Roof	=	3.5
Wall, high thermal mass	=	0.8
Wall, timber framed	=	1.9
Glazing	=	0.26
Floor	=	1.5
Doors	=	0.18 (default value)

The proposed building heat loss equation is:

$$HL_{Proposed} = \frac{A_{Roof}}{R_{Roof}} + \frac{A_{Wall}}{R_{Wall}} + \frac{A_{Floor}}{R_{Floor}} + \frac{A_{Glazing}}{R_{Glazing}} + \frac{A_{Door}}{R_{Door}} + \frac{A_{Skylight}}{R_{Skylight}}$$

which is expanded for the two types of wall construction, where Wall 1 is for the high thermal mass walls, and Wall 2 is for the timber-framed walls.

$$HL_{Proposed} = \frac{A_{Roof}}{R_{Roof}} + \frac{A_{Wall\ 1}}{R_{Wall\ 1}} + \frac{A_{Wall\ 2}}{R_{Wall\ 2}} + \frac{A_{Floor}}{R_{Floor}} + \frac{A_{Glazing}}{R_{Window}} + \frac{A_{Door}}{R_{Door}} + \frac{A_{Skylight}}{R_{Skylight}}$$

$$HL_{Proposed} = \frac{120}{3.5} + \frac{78.7}{0.8} + \frac{52.5}{1.9} + \frac{120}{1.5} + \frac{70}{0.26} + \frac{0}{0.18} + 0 = 509.5\ W/°C$$

$HL_{Proposed}$ is lower than $HL_{Reference}$ (523.2 W/°C) so the design passes.

APPENDIX G – MODELLING METHOD – BUILDING ENERGY USE COMPARISON

(Normative)

G1 MODELLING REQUIREMENTS

G1.1 Overview

G1.1.1

The energy performance of a proposed building shall be assessed by using a simulation of the building to predict its loads for space heating and cooling. This is compared with the loads for space heating and cooling of a reference building that is the same design and orientation as the proposed building, but has building elements with construction R-values from table 2. Both buildings shall be modelled using the same simulation method.

G1.1.2

The sum of the calculated annual heating load and annual cooling load of the proposed building shall not exceed that of the reference building with construction R-values from table 2.

G1.2 Modelling principles

G1.2.1

The proposed building and reference building shall both be analysed using the same techniques and assumptions except where differences in energy efficiency features that are specified in this Standard require a different approach.

G1.2.2

The specifications of the proposed building used in the analysis shall be as similar as is reasonably practicable to those in the plans submitted for a building consent.

G1.2.3

Features that may differ between the proposed building and the reference building are:

(a) Wall construction R-value and thermal mass;

(b) Floor construction R-value;

(c) Roof construction R-value and thermal mass;

(d) Window size and orientation, construction R-value, solar heat gain coefficient (SHGC), and external shading devices;

(e) Heating, cooling, and ventilation plant (sizing only).

G1.2.4

The results of the thermal modelling should not be construed as a guarantee of the actual energy use of the building.

G1.3 Modelling software requirements

If the application for which the software is to be used has been documented according to the ANSI/ASHRAE Standard 140 procedure, then the method shall pass ANSI/ASHRAE Standard 140 test.

If the application for which the software is to be used has not been documented according to the ANSI/ASHRAE Standard 140 procedure, the method shall be tested to BESTEST described on the International Energy Agency on the Solar Heating and Cooling Programme website (http://www.iea-shc.org/) or the Energy Conservation in Buildings and Community Systems Programme website (http://www.ecbcs.org/) and pass the BESTEST.

G1.4 Default values

G1.4.1

The default values and schedules included in this appendix shall be used unless the designer can demonstrate that different assumptions better characterise the building's use over its expected life. Any modification of default assumptions shall be used in modelling both the proposed building and the reference building.

G1.4.2

Other aspects of the building's performance for which no default values are provided may be modelled according to the designer's discretion as is most appropriate for the building, but they must be the same for both the proposed building and the reference building.

G1.4.3

In all the following cases, modelling is to be identical for both reference and proposed buildings. Some of these items have limitations on the input values others have default schedules that may be used when actual figures are not known. In all cases these values shall be reasonable approximations of the requirements on the buildings and its use during its expected life:

(a) Heating, set-points, and schedules;

(b) Cooling, set-points, and schedules;

(c) Ventilation, set-points, and schedules;

(d) Fresh air ventilation, air change rates, and schedules;

(e) Internal gains loads and schedules;

(f) Occupancy loads and schedules;

(g) The location and R-values of carpets and floor coverings;

(h) Incidental shading.

G1.5 Climate data

Both the proposed building and the reference building shall be modelled using the same climate data. The climate data shall be from a weather station that best represents the climate at the building site. The climate data shall represent an average year for the site, over at least a 10-year period.

CG1.5
Using the relevant Home Energy Rating Scheme (HERS) climate data is one way to achieve the requirement described in G1.5.1. Contact the Energy Efficiency and Conservation Authority (EECA) for HERS climate data.

G1.6 Thermal zones

G1.6.1
The model of the proposed and reference buildings shall be identically and suitably divided into separate thermal zones.

G1.6.2
Spaces that are likely to have significantly different space conditioning requirements shall be modelled as separate zones.

G1.6.3
The conditioned space shall be divided into a minimum of three thermal zones.

G1.6.4
Roof spaces and enclosed subfloor spaces shall be modelled as thermal zones.

G1.6.5
The model shall have a representation of internal conductive heat flows between thermal zones. Internal partitions between thermal zones require modelling and shall be described in terms of their location, surface area, pitch, and construction R-value.

G1.6.6
The same internal partitions as modelled in the proposed building shall be modelled in the reference building.

G1.6.7
Internal partitions within a thermal zone which may affect the thermal performance of the building shall be modelled.

G1.7 Adjoining spaces

G1.7.1

Building elements that separate adjoining conditioned spaces of dwellings may be assumed to have no heat transfer.

G1.7.2

Building elements separating conditioned space from adjacent unconditioned space (for example, a garage) may be modelled with a construction R-value that is 0.5 higher than the actual construction R-value and zero solar absorptance (this adjustment to the construction R-value takes into account the insulation from the still air in the unconditioned space).

G1.8 Thermal mass

The thermal mass may either:

(a) Be modelled the same way for both the proposed and the reference building; or

(b) Be modelled as proposed for the proposed building and modelled as lightweight for the reference building.

G1.9 Thermal mass of contents

The thermal mass of the contents shall be the same for both models, and may be regarded as zero for modelling purposes.

G1.10 Floor coverings

Floor coverings shall be modelled as proposed in both the reference and proposed building. If no floor coverings are specified, ceramic tiles shall be modelled in wet areas (kitchens, bathrooms, toilets, and laundries) and carpet to all other areas.

G1.11 Shading

G1.11.1

Exterior shading such as fins and overhangs shall be modelled as proposed in the proposed building, but need not be modelled in the reference building.

G1.11.2

No account shall be taken of internal shading devices such as blinds, drapes, and other non-permanent window treatments.

G1.12 Incidental shading

G1.12.1

Shading by structures and terrain that have a significant effect on the building shall be modelled in the same way for the reference building and the proposed building.

G1.12.2

No account shall be taken of trees or vegetation.

G1.13 Infiltration

Infiltration assumptions for reference and proposed buildings shall be the same, and shall be reasonable for the building construction, location, and use.

G2 THERMAL ENVELOPE

G2.1 Thermal envelope building elements

G2.1.1

All building elements shall be described in terms of surface area, orientation, pitch, and construction R-value. Areas of glazing shall have their solar heat gain coefficient (SHGC) specified.

G2.1.2

The solar absorption of external building elements, except as per G1.11.2, shall be modelled in both the reference and proposed building as proposed. If solar absorption is not specified, they shall be modelled in both the reference and proposed buildings as 0.5.

G2.1.3

Construction R-values for windows and SHGC shall be either as specified:

(a) In Appendix C of this Standard;

(b) As calculated using the standard window modelling procedure as described in C2; or

(c) With software that calculates total window thermal performance indices (such as U-values, solar heat gain coefficients, shading coefficients, and visible transmittances) and is consistent with ASHRAE SPC 142 or ISO 15099.

G2.1.4

When the modelling program calculates and adds its own surface resistances to the input resistance, the input resistances shall be the R-values derived as specified in this Standard less the standardised surface resistances of 0.03 $m^2 \cdot °C/W$ outside and 0.09 $m^2 \cdot °C/W$ inside (0.12 $m^2 \cdot °C/W$ total). The same method of calculation shall be used for the proposed building and the reference building.

G3 REFERENCE BUILDING MODELLING REQUIREMENTS

G3.1

The reference building shall be modelled as identical to the proposed building in every way except for the requirements as outlined in G3.2, G3.3.1, G3.3.2, G3.4, and G3.5.

G3.2

The building elements in the reference building shall have construction R-values from table 1 (if that building element contains an embedded heating system), or table 2 (if the building element does not contain an embedded heating system).

G3.3 Glazing area

G3.3.1

If the glazing area in the proposed building is more than 30% of the total wall area, then the glazing area of the reference building shall be 30% of the total wall area. If the glazing area of the proposed building is 30% or less of the total wall area, then the glazing area of the reference building shall either be the same as the proposed building or 30% of the total wall area (at the discretion of the modeller).

G3.3.2

If the glazing area in the proposed building and the reference building are different, then the glazing area in the reference building shall either be distributed evenly around the building, or the size of each glazed unit be changed by the same proportion to achieve a glazing area of 30% and be modelled in the same location with the same head height as in the proposed building.

G3.4 Skylight area

In the reference building the roof area (A_{Roof}) shall be set equal to the total roof area and the skylight area ($A_{Skylight}$) shall be set to zero.

G3.5 Door area

In the reference building:

(a) The door area that is no more than either 6 m^2 or 6% of the total wall area (whichever is greater) shall have a construction R-value of 0.18 (or higher at the designer's discretion);

(b) Any remaining door area shall have the same construction R-value as the reference building wall.

CG3.5
Doors are treated differently for the calculation method. If the door area is below these limits the heat loss is set to zero.

G4 SPACE CONDITIONING

G4.1 Control temperatures

G4.1.1

For housing a minimum temperature of 18°C from 7am – 11pm, 16°C overnight, and a maximum temperature of 25°C at any time, is required to be modelled. Prior to the use of artificial cooling, natural ventilation shall be modelled at a set point of 24°C. The ventilation rate shall be reasonable for the amount of available venting area for each zone and shall be the same for the reference and proposed buildings.

G4.1.2

For buildings other than housing a minimum temperature of 18°C and a maximum temperature of 25°C from 8am – 6pm, five days a week, shall be modelled unless a different schedule can be justified for the life of the building.

G4.2 Ventilation

The fresh air ventilation rate and schedule shall be the same for both the proposed building and the reference building.

The minimum infiltration rate shall be:

(a) 0.5 air changes per hour for housing; and

(b) As specified in NZS 4303 for commercial buildings.

G5 CONDITIONING SYSTEM MODELLING

G5.1

This Standard has no requirements for the performance of heating, cooling, and ventilating equipment. Thus no credit may be given for a high performance system, and no requirements are made of systems.

G5.2

The calculation of the annual loads for space heating and cooling does not include an assessment of heating, cooling, and ventilating equipment. A simulation of the heating, cooling, and ventilating equipment is not required, but shall be the same for the proposed and reference building if modelled.

G6 LIGHTING

Lighting need not be modelled. However, if it is, it shall be the same for both the proposed building and the reference building.

G7 INTERNAL LOADS

G7.1 Domestic hot water

For both the reference and the proposed buildings, the power density for an internal cylinder shall either be ignored, or the default value from table G1 shall be used.

G7.2 Occupants and plug loads

G7.2.1

Table G1 gives values for the maximum heat release into a building from occupants and plug loads. These are modified by the factors from the relevant part of table G2 to provide default values for heat release at different times of day. Either these default values or the values in AccuRate NZ software shall be used unless other suitable parameters specific to the building's use are shown to be more appropriate. All internal gains are regarded as sensible heat.

CG7.2.1

AccuRate NZ is the rating tool developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and used for the New Zealand Home Energy Rating Scheme (HERS). AccuRate NZ assigns a star rating to a dwelling based on its calculated annual heating and cooling energy requirements.

G7.2.2

Spaces defined as unconditioned shall be assigned zero internal gains.

G7.3 Process loads

G7.3.1

Process loads are those heat loads that result from the production of goods within a building.

G7.3.2

Only in circumstances where process loads are significant, and it can be shown that they will continue for the expected life of the building, may they be modelled. Process loads shall be the same in both the proposed and reference buildings.

G8 REFERENCE BUILDING

G8.1 Schedules

The default power densities for internal gains from occupants and plug loads are shown in table G1.

Table G1 – Default power densities for internal gains from occupants and plug loads

Building type	**Occupancy** (W/m²)	**Plug load** (W/m²)
Assembly	14.5	2.7
Car parking	NA	NA
Health/institutional	3.6	10.7
Hotel/motel	2.9	2.7
Housing	See note	24.5
Office	2.7	8.1
Restaurant	7.3	1.1
Retail	2.4	2.7
School	9.7	5.4
Warehouse	0.1	1.1

NOTE –
Housing modelling assumptions:
DHW contribution (per building for each internal cylinder) .... 100 W
Occupants (up to 50 m^2 floor area) (sensible heat) .... 150 W
Occupants (per m^2 over 50 m^2 floor area) (sensible heat) .... 3 W/m^2

The default schedules for occupancy and plug loads are shown in table G2.

Table G2 – Default schedules for occupancy and plug loads – Percentage of maximum load or percentage of power density

Assembly

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	0	20	80	20	0
Saturday	0	20	60	60	0
Sunday	0	20	70	70	0
Plug load					
Week	5	40	75	75	5
Saturday	5	30	50	50	5
Sunday	5	30	65	65	5

Health/consultancy

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	0	80	80	30	0
Saturday	0	40	40	0	0
Sunday	0	5	5	0	0
Plug load					
Week	10	90	90	30	10
Saturday	10	40	40	10	10
Sunday	5	10	10	5	5

Health/residential care

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	70	90	90	85	70
Saturday	70	90	90	85	70
Sunday	70	90	90	85	70
Plug load					
Week	20	90	85	80	20
Saturday	20	90	85	80	20
Sunday	20	90	85	80	20

Hotel/motel

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	90	40	20	70	90
Saturday	90	50	30	60	70
Sunday	70	70	30	60	80
Plug load					
Week	10	40	25	60	60
Saturday	10	40	25	60	60
Sunday	10	30	30	50	50

Table G2 – Default schedules for occupancy and plug loads – Percentage of maximum load or percentage of power density (continued)

Housing

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	100	60	60	100	100
Saturday	100	100	50	70	100
Sunday	100	100	50	70	100
Plug load					
Week	3	23	23	27	20
Saturday	3	23	23	27	20
Sunday	3	23	23	27	20

Office

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	0	95	95	5	0
Saturday	0	10	5	0	0
Sunday	0	5	5	0	0
Plug load					
Week	5	90	90	30	5
Saturday	5	30	15	5	5
Sunday	5	5	5	5	5

Restaurant

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	0	5	50	80	35
Saturday	0	0	45	70	55
Sunday	0	0	20	55	20
Plug load					
Week	15	40	90	90	50
Saturday	15	30	80	90	50
Sunday	15	30	70	60	50

Retail

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	0	60	70	40	0
Saturday	0	60	80	20	0
Sunday	0	10	40	0	0
Plug load					
Week	5	90	90	50	5
Saturday	5	90	90	30	5
Sunday	5	40	40	5	5

Table G2 – Default schedules for occupancy and plug loads – Percentage of maximum load or percentage of power density (continued)

School

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	0	95	95	10	0
Saturday	0	10	10	0	0
Sunday	0	0	0	0	0
Plug load					
Week	5	95	95	30	5
Saturday	5	15	15	5	5
Sunday	5	5	5	5	5

Warehouse

	12am – 8am	8am – 11am	11am – 6pm	6pm – 10pm	10pm – 12am
Occupancy					
Week	0	90	85	0	0
Saturday	0	20	10	0	0
Sunday	0	0	0	0	0
Plug load					
Week	5	90	90	5	5
Saturday	5	24	5	5	5
Sunday	5	5	5	5	5

G9 INFORMATION AND DOCUMENTATION

G9.1 Supporting documentation

All analyses submitted shall be accompanied by an energy analysis comparison report. The report shall provide:

(a) The name of the modeller;

(b) The thermal modelling program name, version number, and supplier;

(c) Technical detail on the reference and proposed building designs and the differences between the designs;

(d) The sum of the heating load and cooling load for the reference and proposed designs;

(e) Where possible, the heating load and cooling load for the reference and proposed designs.

Approved by the Standards Council on 26 June 2009 to be an New Zealand Standard pursuant to the provisions of section 10 of the Standards Act 1988.

First published: 7 July 2009

Project No. P 4218
Draft for comment No. DZ 4218
Typeset by: Standards New Zealand
Printed by: The Colour Guy