New Zealand Standard

Energy Efficiency –
Small Building Envelope

Superseding NZS 4218:1996

NZS 4218:2004

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This Standard was prepared by the Energy Efficiency – Small Building Envelope Committee (P 4218) for the Standards Council established under the Standards Act 1988.

The Committee consisted of representatives of the following:

Building Industry Authority
Building Research Association of New Zealand
Cement and Concrete Association of New Zealand
Claddings Institute of New Zealand
Employers and Manufacturers' Association (Northern Branch)
Energy Efficiency and Conservation Authority (EECA)
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NEW ZEALAND STANDARD

ENERGY EFFICIENCY – SMALL BUILDING ENVELOPE

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REFERENCED DOCUMENTS

NEW ZEALAND STANDARDS

NZS 4214:2002 (Int)	Methods of determining the total thermal resistance of parts of buildings
NZS 4243:1996	Energy efficiency – Large buildings
NZS 4303:1990	Ventilation for acceptable indoor air quality
SNZ/PAS 4244:2003	Insulation of lightweight-framed and solid-timber houses

JOINT AUSTRALIAN/NEW ZEALAND STANDARDS

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

OTHER PUBLICATIONS

Building Research Association of New Zealand (BRANZ), House Insulation Guide 1995.

Building Research Association of New Zealand (BRANZ), Annual Loss Factor Design Manual: 1990 (Revised 1993).

How to choose the most efficient windows for your home: Window Efficiency Rating Scheme (WERS)(published by WANZ).

Isaacs N., Donn M., Lee J., Bannister P., Guan L., Bassett M., Page I., and Stoecklein A. A Sensible Step to Building Energy Efficiency: 1995 Revision of NZBC Clause H1; Centre for Building Performance Research, Victoria University of Wellington, 1995.

Burgess J., DC0790 EZ01 Economic Analysis of New Zealand Window Insulation Values in Housing – An Update. BRANZ, 2004.

Judkoff R., and Neymark J. 1995 International Energy Agency Building Energy Simulation Test (BESTEST) and Diagnostic Method; NREL/TP-472-6231Golden, Colorado, USA; National Renewable Energy Laboratory.

Standard 90.1-89 – Energy Code for Commercial and High-Rise Residential Buildings (Based on ASHRAE/IES 90.1-1989) 100 pp. ASHRAE, Atlanta, 1998. ISBN/ISSN 1-883413-09-05.

Standard 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.

NEW ZEALAND LEGISLATION

The Building Regulations 1992
First Schedule: NZ Building Code (NZBC)

LATEST REVISIONS

The users of this Standard should ensure that their copies of the above-mentioned New Zealand Standards and referenced overseas Standards are the latest revisions or include the latest amendments. Such amendments are listed in the annual Standards New Zealand *Catalogue* which is supplemented by lists contained in the monthly magazine *Standards Update* issued free of charge to committee and subscribing members of Standards New Zealand.

FOREWORD

This revision of NZS 4218:1996 incorporates glazing into the schedule and calculation methods of compliance with the required performance and focuses on excessive heat-loss through the area of glazing. The purpose of this Standard is to provide details and guidance to meet adequate energy efficiency performance requirements for the building envelope of housing and small buildings. The insulation requirements are based on an economic cost benefit analysis (refer to *A Sensible Step to Building Energy Efficiency* listed under Other Publications in the Referenced Documents section). The window insulation levels are based on research reported in *Economic Analysis of New Zealand Window Insulation Values in Housing – An Update*. The minimum insulation levels in this Standard are the least lifecycle cost option for the building owner based on current knowledge of insulation, current and forecast energy costs, and heating behaviour.

Design of small buildings should consider solar gain from glazing, thermal insulation and thermal mass. To find guidance on achieving a good balance between some of these, designers should refer to SNZ/PAS 4244 *Insulation of lightweight-framed and solid-timber houses*. Energy efficient buildings provide comfort and health benefits both to the nation, and the building occupier, by reducing overall energy consumption whilst retaining or improving on the existing levels of service. These benefits are emphasized in colder climate zones.

This revision also brings the window R-values into line with the Window Efficiency Rating Scheme (WERS) and adds an Appendix on glazing performance. It also focuses on areas of glazing above 30 % of the total wall area as these significantly affect thermal efficiency of the envelope.

It is intended that this revision will be cited in the New Zealand Building Code Clause H1 list of Approved Documents.

The terms "normative" and "informative" are 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.

The reason for bringing this document out as a revision is recognition that the lack of reference to the insulation properties of glazing in the existing insulation-oriented version of the document is anomalous. A clear medium term goal is to develop this Standard to a level where it truly reflects the dynamic nature of the energy balance in a house. A Standard that guides the achievement of both comfort and energy efficiency through the balancing of solar gain from glazing, insulation, thermal mass and solar shading is the obvious next step. That Standard will eventually supersede this one. Work on it began with the analysis and drafting of SNZ/PAS 4244 and this Standard. It is partially recognized in this Standard which differentiates between North facing (see Appendix H) glazing which can provide a positive ➤

heating benefit and glazing of other orientations which is less likely to provide a heating benefit.

In the planned future dynamic energy balance version of this Standard, the limitations of the current prescriptive approach to the specification of insulation will be addressed. The principal limitation of prescriptive Standards is that they prescribe exactly what values of component performance are permitted: for example, this Standard lists in the tables the minimum permitted R-values for walls, roofs, floors and windows. These minima can only be based on construction knowledge at the time of writing and may not allow new and innovative materials. A new and innovative wall design might have a lower than permitted R-value but be very good at heating the building by collecting solar energy.

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 6020.

NEW ZEALAND STANDARD

ENERGY EFFICIENCY – SMALL BUILDING ENVELOPE

1 GENERAL

1.1 Scope

1.1.1
This Standard specifies thermal insulation requirements for housing and small buildings to achieve an adequate level of energy efficiency.

1.1.2
This Standard provides three methods of demonstrating compliance:

Schedule method	Selecting from the set of minimum requirements. These values provide a building with the thermal insulation requirements for minimum acceptable energy efficiency (refer 3.1).
Calculation method	Use of a simple calculation to achieve heat retention no worse than that of the reference building, utilizing components with different thermal resistance values (refer 3.2).
Modelling method	A comparative method that uses a suitable computer modelling technique to examine an individual design to ensure that the proposed building design will use no more energy than a reference building design (refer 3.3).

Figure 1 provides a flowchart for guidance.

1.1.3
The requirements of this Standard shall apply to those components of a building that separate a conditioned space from the external environment, or from an adjoining unconditioned space such as a storage space, garage or a conservatory.

1.2 Definitions

1.2.1
For the purposes of this Standard the following definitions shall apply:

BUILDING ENVELOPE. The building thermal envelope plus the exterior surface of any spaces not requiring conditioning e.g. garage, floor space (below insulating layer) roof space (above any outer surface defining an attic or when there is no attic above the insulating layer).

BUILDING ENVELOPE COMPONENT. An area of the building envelope, such as roof, wall, floor or glazing, of a given construction and to which a single thermal resistance value may be allocated.

BUILDING THERMAL ENVELOPE. The roof, wall, glazing and the floor construction, between unconditioned external spaces and conditioned spaces, enclosing all habitable spaces, bathrooms, kitchens and other rooms in the building likely to require conditioning.

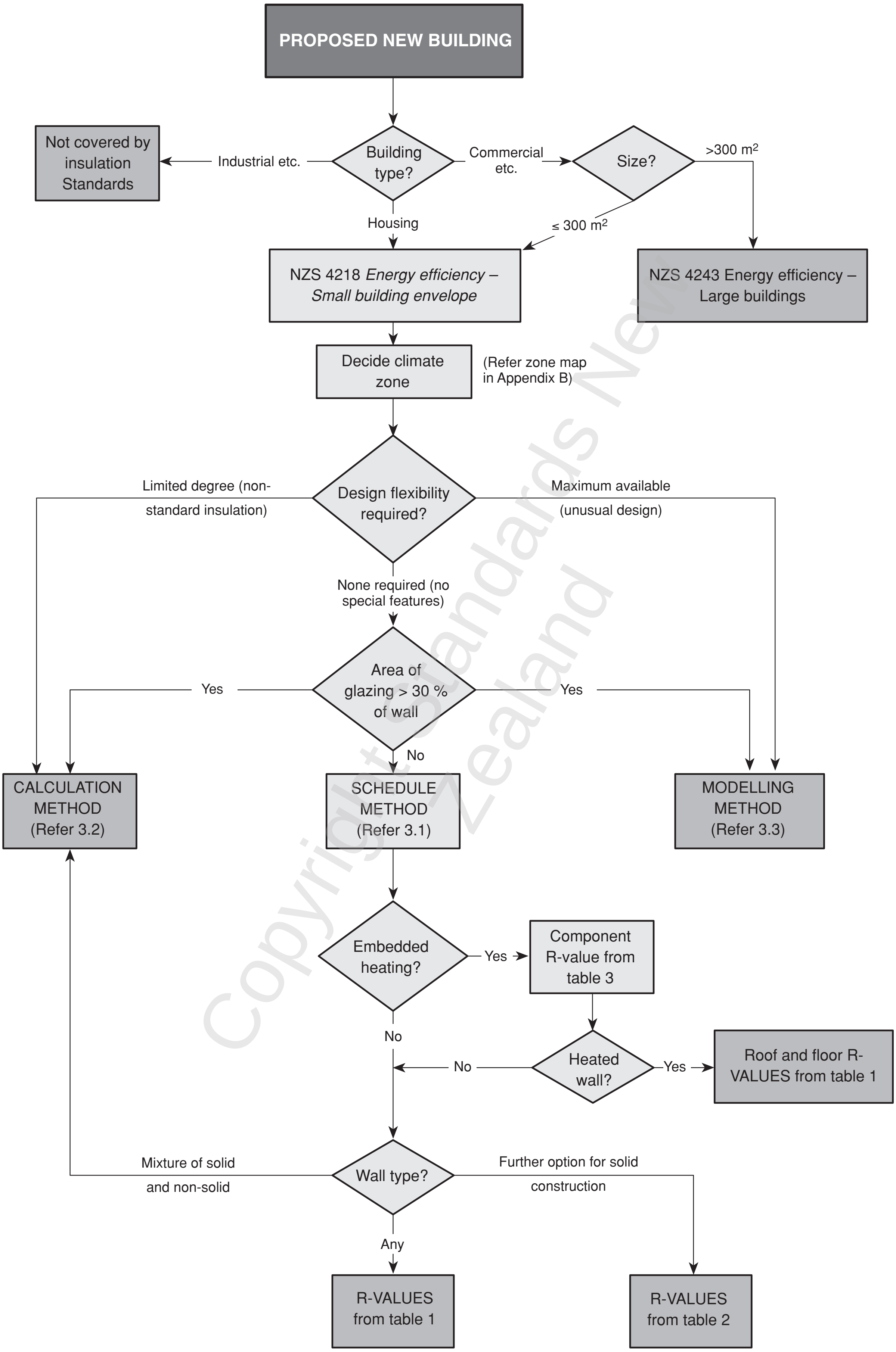

Figure 1 – Decision flowchart

CONDITIONED SPACE. That part of a building within the building thermal envelope, including habitable spaces that may be directly or indirectly heated or cooled for occupant comfort.

COOLING LOAD. The amount of heat energy removed from the building to maintain it below the required maximum temperature (the amount of heat removed by the chosen appliances, not the amount of fuel required to run them).

DEFAULT. Values to be used for modelling purposes, unless the designer can demonstrate that a different assumption better characterizes the building's use over its expected life. Any modification of a default assumption shall be used in modelling both the proposed building and the reference building.

FLOOR AREA. The area of floor within the external walls.

GLAZING. A transparent or translucent area in a building envelope component.

AREA OF GLAZING. The total area of glazing (including skylights) and glazed area of doors in the building thermal envelope, including frames and opening tolerances.

HEATED ROOF, WALL, OR FLOOR. Any roof, wall, or floor incorporating embedded pipes, electrical cables, or similar means of raising the temperature of the roof, wall, or floor for room heating.

HEATING LOAD. The amount of heat energy supplied to the building to maintain it at the required temperature (the amount of heat delivered by the chosen appliances, not the amount of fuel required to run them).

HOUSING. Buildings or use where there is self care and service (internal management). For the purposes of this Standard, the three basic types are:

DETACHED DWELLING . A building or use where a group of people live as a single household or family (e.g. holiday cottage, boarding house accommodating fewer than six people, dwelling or hut).

GROUP DWELLING. A building or use where groups of people live as one large extended family (e.g. commune or marae).

MULTI-UNIT DWELLING. A building or use that contains more than one separate household or family (e.g. attached dwelling, flat or multi-unit apartment).

INSULATION PLANE. The plane within a building envelope component where the predominant R-value is achieved.

LARGE BUILDING. Any building of floor area exceeding 300 m^2 but excluding housing, industrial and ancillary buildings, and non-habitable outbuildings.

NON-SOLID CONSTRUCTION. Wall construction methods other than solid construction (e.g. timber-framed construction).

PLUG LOAD. The electrical load drawn by electrical appliances connected to the building electrical reticulation system by way of general purpose socket outlets.

R-VALUE (TOTAL THERMAL RESISTANCE). The value of thermal resistance of a building element (e.g. 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 component, when there is unit heat ➤

flow in unit time through unit area using internal and external conditions considered as typical for buildings (m^2 °C/W).

NOTE – Thermal resistances for materials forming parts of building elements are often quoted excluding surface resistances. R-values for whole building elements, and for glazing, are normally quoted including surface resistances.

REFERENCE BUILDING. A building design, with identical dimensions and functions to the proposed building, that in all respects is compliant with the requirements of the clauses and tables laid down in the calculation or modelling method.

ROOF AREA. For the purposes of calculation, the roof area is that part of the thermal envelope associated with the roof, excluding skylight area (see Appendix F).

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.

SKYLIGHT. A translucent or transparent area within the roof building envelope component.

SKYLIGHT AREA. The area of skylight where it interrupts the insulation plane, including window frames and opening tolerances. (A total area less than 0.6 m^2 may be ignored for calculation purposes.)

SMALL BUILDING. A building less than or equal to 300 m^2 floor area that is occupied and expected to be conditioned.

SOLID CONSTRUCTION. Solid timber, masonry, concrete and earth wall constructions.

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 the resistance to heat flow through a uniform homogeneous material of given thickness. It can be determined by measuring the temperature difference between the hot and cold surfaces when there is unit heat flow in unit time through unit area (m^2 °C/W).

TOTAL WALL AREA. For the purposes of calculation, the total wall area is deemed to be the wall area plus the area of glazing. (See also wall 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 (W/m^2 °C/W or W/m^2K/W). It is calculated as (U-value) U = 1/R (Thermal resistance). Refer to AS/NZS 4668 and AS/NZS 4666 for further information.

UNCONDITIONED SPACE. That part of a building that would not normally be conditioned for occupant comfort (e.g. garage, conservatory).

WALL. Any vertical or near vertical part of the building that is not part of the glazed area and is at an angle from the horizontal greater than 60°.

WALL AREA. For the purposes of calculation, the area of the wall shall be the area of the internally exposed external wall, including any door openings, but excluding area of glazing. (See also total wall area.)

WERS (Window Efficiency Rating Scheme). A four category, five star performance rating system for windows and the official rating system of the Window Association of New Zealand.

1.2.2
For the purposes of this Standard the word "shall" refers to practices that are mandatory for compliance with this Standard, while the word "should" refers to practices which are advised or recommended.

1.3 Purpose and context of use

1.3.1
This Standard specifies minimum thermal energy performance requirements for buildings to achieve an adequate standard of energy efficiency. The minimum R-values required by this Standard will provide economic benefits relative to an uninsulated building. Higher levels of insulation can provide further benefit.

1.3.2
Methods of measuring the thermal resistance of building envelope components, and a listing of thermal resistances of common building construction methods, are covered in NZS 4214.

1.3.3
This Standard does not address minimum R-values that may be required for other purposes such as controlling internal moisture and achieving comfort conditions. Such other requirements may impose limits and requirements exceeding those of this Standard.

2 GENERAL REQUIREMENTS

2.1 Groups of buildings

2.1.1

A joined group of buildings that are not housing, which together have a total floor area greater than 300 m^2, may be treated as a single large building providing that each building has at least 25 % of its total wall or roof/floor area in common with one or more of the other buildings in the group.

2.2 Integrity of thermal insulation

2.2.1

Insulation shall be installed to achieve and maintain its intended R-value.

NOTE – Construction methods shall not compromise the integrity of the building thermal insulation. The BRANZ House Insulation Guide provides useful guidance.

2.2.2

In all circumstances the requirements of the specific insulation product should be followed.

2.2.3

Insulation shall be carefully inspected for correct installation before cavities are enclosed.

NOTE – Incorrect installation of bulk insulation materials, particularly lack of continuity in the insulation envelope and over-compaction, can seriously compromise the actual insulation levels achieved in practice.

2.3 Conservatories, outbuildings and atria

2.3.1

An unconditioned space attached to the building (e.g. atrium, conservatory, garage, etc.) may be considered outside the building thermal envelope providing there is a separating wall, roof or floor between it and the rest of the building. The wall, roof or floor (inclusive of transparent components) between the space and the rest of the building forms part of the building thermal envelope and must meet the requirements for minimum thermal resistance required by this Standard. Where such a space is conditioned, it shall be treated as being within the building thermal envelope.

3 COMPLIANCE METHODS

Minimum R-values shall be determined by the schedule, calculation or modelling method. Tables 1 and 2 specify minimum R-values for use in the schedule method. The schedule method may be used where:

(a) The building's total area of glazing is 30 % or less of its total wall area, and

(b) The combined area of glazing on East, South and West facing walls is 30 % or less of the combined total wall area of these walls.

The calculation or modelling method may be used when either of these conditions are not met.

The calculation method may be used where the building's total area of glazing is 50 % or less of its total wall area. The modelling method shall be used when this condition is not met.

North facing (see Appendix H) glazing can provide a positive heating benefit, although large amounts may lead to solar overheating.

3.1 Schedule method

3.1.1
Building thermal envelope components between conditioned and unconditioned spaces shall have R-values according to table 1, modified by 3.1.4 and table 3 where applicable.

3.1.2
Solid construction buildings may instead have R-values according to table 2, modified by 3.1.4 and table 3 where applicable.

3.1.3
The floor R-value shall be determined from the inside air to the outside air.

NOTE – NZS 4214 provides calculation for the floor component alone, which in the case of a suspended floor, does not include the effect of a sub-floor perimeter wall (refer figure F1 Appendix F). The thermal resistance of the subfloor perimeter may therefore be added to the floor component R-value as calculated from NZS 4214 in appropriate cases for purposes of compliance with this Standard. Values for sub-floor perimeters may be calculated using BRANZ House Insulation Guide. Clause 3.1.3 places suspended floors on the same R-value basis as slab-on-ground floors.

3.1.4
Where solid construction achieves the minimum R-value requirements for non-solid construction, then it may be treated as a non-solid construction with respect to table 1. Table 2 provides alternative minimum R-values for solid construction.

Table 1 – Non-solid construction – minimum R-values for schedule method (only where area of glazing is 30 % or less of total wall area)

Building thermal envelope component	Minimum R-values (m^2 °C/W)		
	Climate zone 1	Climate zone 2	Climate zone 3
Roof	R 1.9	R 1.9	R 2.5
Wall	R 1.5	R 1.5	R 1.9
Floor	R 1.3	R 1.3	R 1.3
Glazing	R 0.15	R 0.15	R 0.26

NOTE –
(1) The R-values given in this table are those applicable to the reference building as described in this Standard.
(2) Climate zone boundaries are shown in Appendix B.
(3) If the sum of the area of glazing on the East, South and West facing walls (see Appendix H) is more than 30 % of the total wall area of all of these walls then either the calculation or modelling method shall be used.
(4) Carpets or floor coverings are not included in the floor R-value. The floor R-value is met by concrete slab-on-ground and suspended floors with continuous enclosed perimeter with 100 mm drooped foil. Exposed floors will require additional treatment e.g. pole houses.
(5) The R-values for glazing refer to whole window R-values (glass and frame). The values in this table are for a standard WERS window (Appendix G). Any proposed area of glazing shall be considered to have an R-value as given in Appendix G.
(6) There are no R-value requirements for the opaque parts of a door or a door set.

Table 2 – Solid construction – alternative minimum R-values for schedule method (only where area of glazing is 30 % or less of total wall area)

Building thermal envelope component	Minimum R-values (m^2 °C/W)		
	Climate zone 1	Climate zone 2	Climate zone 3
Roof	R 3.0	R 3.0	R 3.0
Wall	R 0.6	R 0.6	R 1.0
Floor	R 1.3	R 1.3	R 1.3
Glazing	R 0.15	R 0.15	R 0.26

NOTE –
(1) The R-values given in this table are those applicable to the reference building as described in this Standard.
(2) Climate zone boundaries are shown in Appendix B.
(3) If the sum of the area of glazing on the East, South and West facing walls (see Appendix H) is more than 30 % of the total wall area of all of these walls, then the calculation or modelling method shall be used.
(4) Carpets or floor coverings are not included in the floor R-value. The floor R-value is met by concrete slab-on-ground and suspended floors with continuous enclosed perimeter with 100 mm drooped foil. Exposed floors will require additional treatment e.g. pole houses.
(5) The R-values for glazing refer to whole window R-values (glass and frame). The values in this table are for a standard WERS window (Appendix G). Any proposed area of glazing shall be considered to have an R-value as given in Appendix G.
(6) There are no R-value requirements for the opaque parts of a door or a door set.

3.1.5
Table 3 applies to building envelope components that contain embedded heating systems. Any glazing shall meet the appropriate zone requirements of table 1 or table 2.

Table 3 – Heated walls, ceilings or floors – minimum R-values for schedule method

Building thermal envelope component	Minimum values for climate zones 1, 2 and 3 ($m^2\ ^oC/W$)
Heated ceiling (R_{OUT})	R 3.0
Heated wall (R_{OUT})	R 2.2
Heated floor (R_{OUT})	R 1.7
where $R_{IN}/R_{OUT} < 0.1$ and R_{IN} is the thermal resistance between the heated plane and the inside air; R_{OUT} is the thermal resistance between the heated plane and the outside air.	
NOTE – Carpets or floor coverings are not included in the floor R-value. Floor coverings e.g. carpet or cork will reduce the efficiency of the heated floor.	

3.2 Calculation method

3.2.1
This method allows for a building to have more than one type of wall construction, glazing over 30 % of total wall area, a mix of glazing types, etc., or to relax some R-value requirements providing this is compensated for by a higher R-value elsewhere in the building thermal envelope.

3.2.2
Building thermal envelope components with R-values and conditions different from those given by table 1 or table 2 may be used providing the heat loss, as calculated by Equation 2 in 3.2.4, of the proposed building, is less than or equal to the heat loss of the reference building for the relevant climate zone, construction type and design. For compliance:

$$HL_{Proposed} \leq HL_{Reference} \qquad \text{(Eq. 1)}$$

where

$HL_{Proposed}$ is the heat loss of the proposed building

$HL_{Reference}$ is the heat loss of the reference building.

NOTE – Appendix E provides an example of acceptable building component combinations.

3.2.3
$HL_{Reference}$ shall be calculated from equation 2 in 3.2.4 using the thermal resistance and conditions for roof, wall and floor from tables 1, or 2 as appropriate. The glazing and door thermal resistances for the calculation of $HL_{Reference}$ shall be those given in table 4. In Zone 3 where the area of glazing is less than or equal to 30 % of total wall area, the area of glazing of the reference building for use in equation 2 shall be set to 30 %. The wall area of the reference building is therefore 70 % of its total wall area.

Table 4 – Reference building – area of glazing R-values

Building thermal envelope component	R-value (m^2 °C/W)		
	Climate zone 1	**Climate zone 2**	**Climate zone 3**
Area of glazing up to 30 % of total wall area	0.15	0.15	0.26
The proportion of the area of glazing over 30 % of total wall area	0.22	0.26	0.31
Glazing – skylights(2) greater than 0.6 m^2	0.26	0.26	0.26

NOTE –
(1) The minimum R-values for the area of glazing shall be accepted as 0.15, 0.22 and 0.26 for single glazing, single low-e glazing and clear insulating glass units (IGU) respectively except where a higher R-value can be demonstrated by calculation or measurement using NZS 4214 or an internationally accepted computer software program. The value of 0.31 relates to an IGU with a low-e pane (see Appendix G).
(2) The total skylight area may be ignored if less than 0.6 m^2.
(3) Total area of glazing over 50 % of total wall area may cause excessive heat gain and/or heat loss, and the modelling method shall be used in these cases.
(4) Non-glazed areas of door openings greater than 3 m^2 are treated as wall.
(5) This table applies to both solid and non-solid construction.

3.2.4
The heat flow (HL) through the building fabric is calculated by the building heat loss in Equation 2.

$$HL = \frac{A_{Roof}}{R_{Roof}} + \frac{A_{Wall}}{R_{Wall}} + \frac{A_{Floor}}{R_{Floor}} + \frac{A_{Glazing}}{R_{Glazing}} \quad \text{(Eq. 2)}$$

where

A_{Roof} is the roof area (m^2)
A_{Wall} is the wall area (m^2)
A_{Floor} is the floor area (m^2)
$A_{Glazing}$ is the area of glazing (m^2)

and

R_{Roof} , R_{Wall} , R_{Floor} and $R_{Glazing}$ are the proposed or reference R-values (m^2 °C/W) of the corresponding building envelope components.

NOTE –
(1) Appendix C provides additional detail. Appendix D provides a worked example.
(2) The area values used in the equation shall be the same for both the proposed and reference buildings.

3.2.5
Where a building thermal envelope component is proposed to have two or more methods of construction with different thermal resistances (Wall 1 and Wall 2 in the example), the corresponding term in the proposed building thermal characteristic shall be expanded to suit.

For example: $\frac{A_{Wall}}{R_{Wall}}$ becomes $\frac{A_{Wall\ 1}}{R_{Wall\ 1}} + \frac{A_{Wall\ 2}}{R_{Wall\ 2}}$

3.2.6
When the calculation method is used, the reduction in the R-value for a given component shall not be greater than 40 % of the R-value required in table 1 or table 2 except in the case of glazing where the reduction in the R-value can be from clear double glazing to the R-value of single-glazing.

For example: R 3.0 → minimum possible is R 1.8
R 1.5 → minimum possible is R 0.9
R 1.0 → minimum possible is R 0.6

NOTE – Designers should also be aware of the minimum R-values for housing, required in the Acceptable Solution of the NZBC Approved Document E3, Internal Moisture.

3.2.7
There are no R-value requirements for non-glazed doors with an opening area of 3 m^2 or less. Non-glazed areas of door openings greater than 3 m^2 are treated as wall.

NOTE – This clause repeats note 4 to table 4.

3.2.8
For the purposes of calculation, the area of glazing includes glazing in walls, roofs (skylights) and doors (see table 4).

3.3 Modelling method

3.3.1
Building envelope components need not comply with the requirements of 3.1 or 3.2 providing the energy use of the proposed design does not exceed the energy use of the reference building.

3.3.2
A proposed building design is modelled, and its energy use calculated, using an acceptable computer modelling method. This is compared with the energy use of a reference building design. The reference building shall be modelled using the same method, and shall have the same size and shape as the proposed design, but shall have thermal characteristics and conditions according to 3.1.

3.3.3
The computer modelling and calculation (simulation) method used shall be tested according to ANSI/ASHRAE Standard 140 and the results shall be furnished by the software provider. Other methods approved by a suitable authority (e.g. the Building Industry Authority) may also be used.

3.3.4
Appendix A provides requirements for the modelling inputs and outputs.

APPENDIX A
MODELLING METHOD – BUILDING ENERGY USE COMPARISON

(Normative)

A1 MODELLING REQUIREMENTS

A1.1 Overview

A1.1.1
The energy performance of a proposed building may be assessed by using a simulation of the building to predict its energy use. This is compared with the energy use of a reference building that is the same shape and size as the proposed building, but has thermal characteristics according to 3.1 of this Standard. Both buildings shall be modelled using the same simulation method.

A1.1.2
To comply with this Standard the proposed building need not comply with the schedule method or the calculation method, in 3.1 and 3.2, provided the proposed building has an annual assessed energy use which is no more than that of the reference building when modelled as described in this Standard.

A1.2 Modelling principles

A1.2.1
Where specified, the modelling techniques and assumptions prescribed in this Standard shall be used; however, in many areas the proper exercise of professional judgment is required. Two rules shall be used in meeting this requirement. Firstly, the proposed building and reference building shall both be analysed using the same techniques and assumptions except where differences in energy efficiency features require a different approach. Secondly, simplifying assumptions that may reduce the energy use of the proposed building in relation to the reference building are not permitted.

A1.2.2
The designer is to use professional judgement to check that the modelling method and assumptions used provide a reasonably accurate representation of the expected energy use of the building. However due to the number of assumptions that are necessary, the results of the analysis shall not be construed as a guarantee of the actual performance of the building.

A1.2.3
The specifications of the proposed building project used in the analysis shall be as similar as is reasonably practicable to those in the plans submitted for a building consent.

A1.3 Modelling restrictions

A1.3.1
The proposed and the reference buildings shall be the same as each other and modelled in the same manner using the same assumptions, except with respect to energy efficiency changes such as are allowed for in this Standard.

A1.3.2
Features that may differ between the proposed building and the reference building are:

(a) Wall R-value and thermal mass;

(b) Floor R-value;

(c) Roof R-value and thermal mass;

(d) Window size and orientation, R-value, shading coefficient, and external shading devices;

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

A1.4 Default values

A1.4.1

The given default values shall be used unless the designer can demonstrate that a different assumption better characterizes the building's use over its expected life. Any modification of a default assumption shall be used in modelling both the proposed building and the reference building.

A1.4.2

Other aspects of the building's performance 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. (Often, these features are ones that are likely to change over the life of the building and thus no credit is given for them.)

A1.4.3

In all the following cases, modelling is to be identical for both reference and proposed buildings. Some of these items have limitations on the values that can be input, others have default schedules that can 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 rate and schedule;

(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;

(i) Heating, cooling and ventilation plant, type and modelling method.

A1.5 The building's energy performance

A1.5.1

If the purpose of carrying out thermal modelling is to demonstrate compliance with the New Zealand Building Code, it should be noted that compliance with this Code represents attainment of a minimum level of energy efficiency. It does not represent good design or energy efficient design. Most designers will find considerable scope for improving energy performance of buildings beyond the level of these requirements. The modelling methods described could be extended to assist in improving the energy efficiency of the design, but this is not the purpose of the Standard.

A1.5.2
The building is to be modelled as it is intended to be used. It is recognized that it is possible to add energy efficiency measures after completion of the building, but the cost of doing so is almost invariably higher than meeting the Code requirements at the time of construction.

A1.6 Orientation and shape

A1.6.1
The proposed building model shall have the same shape and orientation as the proposed building.

A1.6.2
The reference building shall have the same number of storeys, floor area for each storey, orientation, and three dimensional form as the proposed building. Each floor shall be orientated exactly as the proposed building. The geometric form shall be the same as the proposed building.

A1.7 Climate data

A1.7.1
Both the proposed building and the reference building shall be modelled using the same climate data. The analysis shall use the closest climate data available for the location in which the building project is to be constructed. The climate data shall represent an average year for the location.

A1.8 Thermal zones

A1.8.1
The model of the proposed and reference buildings shall be identically and suitably divided into separate thermal zones.

A1.8.2
Spaces that are likely to have significantly different space conditioning requirements shall be modelled as separate zones.

A1.8.3
The model shall have a representation of internal conductive heat flows between thermal zones. The only internal partitions requiring modelling are those between thermal zones.

A1.8.4
Airflow between thermal zones need not be modelled unless desired.

A1.8.5
The conditioned space shall be divided into a minimum of three thermal zones.

A1.9 Unconditioned spaces

A1.9.1
An unconditioned space attached to the building (e.g. conservatory, atrium, car park, storage, plant room etc.) may be considered outside the building thermal envelope providing there is a separating wall between it and the rest of the building. The wall (inclusive of any transparent components) between it and the rest of the building forms part of the building thermal envelope, and in the reference building shall meet the requirements of 3.1.

A1.9.2
An unconditioned space outside the building thermal envelope need not be modelled.

A1.10 Units and group buildings

A1.10.1
Walls and other surfaces that separate occupied units may be assumed to have no heat transfer.

A1.11 Thermal mass

A1.11.1
The thermal mass of the proposed building structure may be modelled as proposed or lightweight. The thermal mass of the reference structure shall be modelled in the same way as the thermal mass of the proposed building.

A1.12 Thermal mass of contents

A1.12.1
The thermal mass of the contents shall be the same for both models, and may be regarded as zero for modelling purposes.

A2 THERMAL ENVELOPE

A2.1 Envelope components

A2.1.1
Every envelope component that separates the conditioned space from outdoors or from an unconditioned space shall be accounted for in the model and should be described in terms of its surface area, orientation, and R-value. Areas of glazing should also have their shading coefficient specified. The thermal mass and/or solar absorption of external surfaces may be specified, but are not required input (refer A2.2.3).

A2.1.2
R-values, other than for glazing, should be calculated as in the rest of this Standard; that is using a standardized surface thermal resistance of 0.03 m^2 °C/W outside and 0.09 m^2 °C/W inside (0.12 m^2 °C/W total), and thermal bridging effects as specified in NZS 4214 except as provided for in A2.1.3. (BRANZ *House Insulation Guide* gives tables of standard construction types calculated in this manner). Glazing R-values should be as specified in Appendix G.

A2.1.3
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 standardized surface resistances. The same method of calculation shall be used for the proposed building and the reference building.

A2.2 Exterior walls

A2.2.1
Exterior walls of the proposed building shall be modelled as proposed.

A2.2.2
Exterior walls for the reference building shall have an R-value equal to the values required by 3.1 and have the same orientation, tilt and area as the proposed building.

A2.2.3
Walls for the reference building and proposed buildings shall have the same solar absorption. In the absence of specific documentation, 0.7 should be used as a default.

A2.2.4
The thermal mass of exterior walls of the proposed building structure may be modelled as lightweight. The thermal mass of the walls of the reference building shall be modelled in the same way as those of the proposed building.

A2.3 Internal walls

A2.3.1
Walls separating different thermal zones or conditioned space and unconditioned spaces of the proposed and reference buildings shall be modelled as proposed. Other internal walls need not be modelled.

A2.3.2
The same internal walls as modelled in the proposed building shall be modelled in the reference building. Other internal walls need not be modelled. In the reference building, the R-values of walls between conditioned and unconditioned spaces shall be those required for the thermal envelope in 3.1.

A2.3.3
The thermal mass of internal walls of the proposed building structure may be lightweight. The thermal mass of the walls of the reference building shall be modelled in the same way as those of the proposed building.

A2.4 Roofs

A2.4.1
The roofs of the proposed building shall be modelled as proposed.

A2.4.2
Except where skylight areas are modified according to A2.7, roofs for the reference building shall have the same area as the proposed building. In all cases the total roof area shall be the same as for the proposed building.

A2.4.3
The roof of the reference building shall have an R-value equal to the value required by 3.1.

A2.4.4
The roofs of the proposed and reference buildings shall have the same solar absorption (0.7 is an acceptable default).

A2.4.5
The thermal mass of the roof of the proposed building structure may be modelled as of lightweight construction. The thermal mass of the roof of the reference building shall be modelled in the same way as those of the proposed building.

A2.5 Floors

A2.5.1
Floors for the proposed building shall be modelled as proposed.

A2.5.2
Floors for the reference building shall have the same area as those in the proposed building but shall be modelled with an R-value according to 3.1.

A2.5.3
Floors for the reference building shall be of the same type as for the proposed building. For example, floors in contact with the ground may not be substituted with suspended floors, or vice versa.

A2.5.4
Carpets and other floor coverings must be the same in both the proposed and reference buildings and must be modelled if present. Any thermal resistance provided by carpets must be in addition to the R-values required by 3.1.

A2.6 Vertical glazing

A2.6.1
Vertical glazing of the proposed building shall be modelled as proposed.

A2.6.2
The total area of glazing in the reference building shall equal the lesser of the total area of glazing in the proposed building or 30 % of the total wall area of the building envelope.

A2.6.3
The glazing R-values in table 4, for glazing up to 30 % of the total wall area, apply to the glazing in the reference building.

A2.6.4
Glazing in the reference building shall be distributed so that the area of glazing as a percentage of the total wall area is the same for each of the four wall directions specified in Appendix H.

A2.7 Skylights
Skylights of the proposed building shall be modelled as proposed.

NOTE – A total area of skylights of less than 0.6 m^2 may be ignored for calculation purposes.

A2.8 External doors

A2.8.1
The distribution of doors in the reference building shall be identical to the distribution of doors in the proposed building.

A2.8.2
The opaque parts of doors with an opening area less than 3 m^2 shall have an R-value of 0.18 in the reference building. For doors in the reference building with an opening area greater than 3 m^2, the opaque parts shall have an R-value equal to the wall R-value as specified in table 1 or table 2.

A2.9 Shading

A2.9.1
Exterior attached shading such as fins and overhangs should be modelled as suggested in the proposed building but need not be modelled in the reference building.

A2.9.2

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

A2.10 Incidental shading

Incidental shading shall be the same for the reference building and the proposed building. Shading by permanent structures and terrain that have a significant effect on the building shall be taken into account. A permanent structure is one that is likely to remain for the life of the proposed building design. No account shall be taken of trees or vegetation.

A2.11 Infiltration

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

A2.12 Internal air flows

Interzone air flow does not require modelling.

A2.13 Internal doors

Internal doors need not be modelled.

A3 LIGHTING

A3.1

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

A4 INTERNAL LOADS

A4.1 Domestic hot water

No input required other than default power density for an internal cylinder (see table A1); hot water systems shall not be modelled.

A4.2 Occupants and plug loads

A4.2.1

Table A1 gives values for the maximum likely rates of heat release into a building from occupants and plug loads. These are modified by the factors from the relevant part of table A2 to provide default values for heat release at different times of day. These values should be used unless other suitable parameters specific to the building's use can be shown to be more appropriate. These internal loads are to be the same for both the proposed and reference buildings. All internal gains are regarded as sensible heat.

A4.2.2

Spaces defined as unconditioned shall be assigned zero internal gains.

A4.3 Process loads

A4.3.1

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

A4.3.2

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.

A5 CONDITIONING SYSTEM MODELLING

A5.1
This Standard has no requirements for the performance of heating, cooling and ventilating equipment. Thus no credit can be given for a high performance system, and no requirements are made of systems. Equipment shall be modelled in an identical manner in both models. Sizing is the only feature that may be changed in response to load requirements.

NOTE – Future revisions of this Standard may include requirements for plant and the subsequent credit for high performance equipment.

A5.2
The type of plant in the proposed building should represent the type of system proposed. Where such a model is unavailable, the closest that is available should be used.

A5.3
Plant type shall be the same for both the reference building and proposed building. All devices that supply space heating or ventilation shall be accounted for. Assumptions made shall be clearly and fully stated. The program shall be suitable for the type of system proposed.

A5.4
Sizing of plant (for modelling purposes) shall be according to the automatic sizing if this feature is provided by the software. Alternatively, the plant should be of sufficient capacity to meet loads without incurring significant energy penalty due to prolonged part load operation.

A5.5
Modelling shall use reasonable assumptions as to equipment performance and control.

A5.6
Sufficient information shall be input to describe the proposed building's plant to permit modelling by the program.

A5.7 Ventilation

A5.7.1
The fresh air ventilation rate and schedule shall be the same for both the proposed building and the reference building.

A5.7.2
Constant ventilation may be modelled.

A5.7.3
The minimum ventilation rate should be according to NZS 4303.

A5.7.4
Ventilation may be provided mechanically or by natural means.

A5.8 Control temperatures

A5.8.1
In all cases temperatures modelled shall be the same for the proposed building and the reference building.

A5.8.2
A minimum temperature of 18 ºC from 07:00 – 23:00 hours and 16 ºC overnight is required to be modelled in all domestic situations. Higher temperatures can be modelled if desired.

A5.8.3
This specification does not deal specifically with internal conditions, and it is for the designer to judge what are appropriate comfort conditions. It is advisable that the designer considers the maximum acceptable temperature and checks that this is not exceeded. Often a temperature of between 20 ºC and 24 ºC is used for air-conditioned domestic and commercial buildings during occupancy.

A5.8.4
Occupancy for commercial buildings should be 10 hours per day, 5 days per week, unless a different schedule can be justified as a likely schedule for the foreseeable life of the building.

A6 REFERENCE BUILDING

A6.1 Schedules

The default power densities for internal gains from occupants and plug loads are shown in table A1.

Table A1 – Default power densities for internal gains from occupants and plug loads

Building type	Occupancy (W/m^2)	Plug load (W/m^2)
Assembly	14.5	2.7
Health/institutional	3.6	10.7
Hotel/motel	2.9	2.7
Office	2.7	8.1
Car parking	NA	NA
Restaurant	7.3	1.1
Retail	2.4	2.7
School	9.7	5.4
Warehouse	0.1	1.1
Housing	See note	24.5

NOTE – Housing modelling assumptions:
DHW contribution (per household for 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 A2.

Table A2 – Default schedules for occupancy and plug loads – percentage of maximum load or percentage of power density

Assembly

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

Housing

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

Table A2 – Default schedules for occupancy and plug loads – percentage of maximum load or percentage of power density (continued)

Office

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

	12 am-8 am	8 am-11 am	11 am-6 pm	6 pm-10 pm	10 pm-12 am
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

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

School

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

	12 am–8 am	8 am–11 am	11 am–6 pm	6 pm–10 pm	10 pm–12 am
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

A7 INFORMATION AND DOCUMENTATION

A7.1 Supporting documentation

A7.1.1
All analyses submitted shall be accompanied by an energy analysis comparison report. The report shall provide:

(a) The name of the modeller;

(b) Full reference on the modelling programme;

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

A7.1.2
The report for the reference building and the proposed building shall separately identify, if possible, the calculated annual energy consumption for space heating, space cooling, and ventilation / fans. If cooling will not be provided in the building, cooling loads are not required to be modelled or reported. Where ventilation is proposed to be non-mechanical, modelling and reporting are not required. These energy consuming features shall be summed for each building and the results compared.

APPENDIX B
CLIMATE ZONES

(Normative)

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

B2
Zone 1 comprises the Coromandel District, Franklin District and all districts north of these.

B3
Zone 2 comprises the remainder of the North Island excluding Taupo District, Ruapehu District and the northern part of the Rangitikei District.

B4
Zone 3 comprises the remainder of the country i.e. Taupo District, Ruapehu District, northern part of the Rangitikei District, South Island and all other islands not in Zone 1.

Figure B1 – Climate zones

APPENDIX C
HEAT LOSS EQUATION TABLES

(Normative)

Table C1 – Reference heat loss equations – non-solid construction

Area of glazing	Climate zone	Reference building heat loss equation
≤ 30 % of total wall area	1	$HL_{Reference} = \frac{A_{Roof}}{1.9} + \frac{A_{Wall}}{1.5} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.15}$
	2	$HL_{Reference} = \frac{A_{Roof}}{1.9} + \frac{A_{Wall}}{1.5} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.15}$
	3	$HL_{Reference} = \frac{A_{Roof}}{2.5} + \frac{A_{70\,\%\text{ of total wall area}}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{30\,\%\text{ of total wall area}}}{0.26}$
> 30 % of total wall area	1	$HL_{Reference} = \frac{A_{Roof}}{1.9} + \frac{A_{Wall}}{1.5} + \frac{A_{Floor}}{1.3} + \frac{A_{30\,\%\text{ of total wall area}}}{0.15} + \frac{A_{Glazing} - A_{30\,\%\text{ of total wall area}}}{0.22}$
	2	$HL_{Reference} = \frac{A_{Roof}}{1.9} + \frac{A_{Wall}}{1.5} + \frac{A_{Floor}}{1.3} + \frac{A_{30\,\%\text{ of total wall area}}}{0.15} + \frac{A_{Glazing} - A_{30\,\%\text{ of total wall area}}}{0.26}$
	3	$HL_{Reference} = \frac{A_{Roof}}{2.5} + \frac{A_{Wall}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{30\,\%\text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\,\%\text{ of total wall area}}}{0.31}$

Table C2 – Reference heat loss equations – solid construction

Area of glazing	Climate zone	Reference building heat loss equation
≤ 30 % of total wall area	1	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{0.6} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.15}$
	2	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{0.6} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.15}$
	3	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{70\text{ \% of total wall area}}}{1.0} + \frac{A_{Floor}}{1.3} + \frac{A_{30\text{ \% of total wall area}}}{0.26}$
> 30 % of total wall area	1	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{0.6} + \frac{A_{Floor}}{1.3} + \frac{A_{30\text{ \% of total wall area}}}{0.15} + \frac{A_{Glazing} - A_{30\text{ \% of total wall area}}}{0.22}$
	2	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{0.6} + \frac{A_{Floor}}{1.3} + \frac{A_{30\text{ \% of total wall area}}}{0.15} + \frac{A_{Glazing} - A_{30\text{ \% of total wall area}}}{0.26}$
	3	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{1.0} + \frac{A_{Floor}}{1.3} + \frac{A_{30\text{ \% of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\text{ \% of total wall area}}}{0.31}$

APPENDIX D
WORKED EXAMPLE

(Informative)

D1

The following provides information by way of a worked example, to show how increasing the R-value in one building component allows a decrease in another component. Consider a house in Zone 3 with non-solid construction for walls and roof with a window area of 43 m^2. There is a door opening of 4 m^2 which includes 2 m^2 of glazing. Thus the total glazing is 45 m^2 including the door glazing. The calculation shows the wall R-value is also achieved by the non-glazed portion of the door:

House 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 and roof area:	15 m x 12 m = 180 m^2
Area of glazing:	43 m^2 + 2 m^2 (door) = 45 m^2
% Glazing/wall area:	45 m^2 / 129.6 m^2 = 34.7 %
Wall area:	129.6 m^2 – 45 m^2 = 84.6 m^2
Glazing over 30 % =	45 m^2 – (129.6 m^2 x 30 %) = 6.1 m^2

REFERENCE BUILDING

Using the appropriate equation from table C1 (for Zone 3):

$$HL_{Reference} = \frac{A_{Roof}}{2.5} + \frac{A_{Wall}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{30\,\%\text{ of total wall area}}}{0.26} + \frac{A_{Glazing} - A_{30\,\%\text{ of total wall area}}}{0.31}$$

$$HL_{Reference} = \frac{180}{2.5} + \frac{84.6}{1.9} + \frac{180}{1.3} + \frac{38.9}{0.26} + \frac{6.1}{0.31}$$

$$HL_{Reference} = 72 + 44.5 + 138.5 + 149.6 + 19.7 = 424.3$$

PROPOSED BUILDING (Wall R-value of R1.5 desired)

Assume that the designer is prepared to increase the R-value of the roof, but wishes to use the minimum window R-value. From 3.2.4 and table 1:

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

$$HL_{Proposed} \leq HL_{Reference}$$

$$\frac{180}{R_{Roof}} + \frac{84.6}{1.5} + \frac{180}{1.3} + \frac{45}{0.26} \leq 424.3$$

$$\frac{180}{R_{Roof}} + 56.4 + 138.5 + 173.1 \leq 424.3$$

$$R_{Roof} \geq \frac{180}{56.3}$$

$R_{Roof} \geq 3.2$ (changes from 2.5).

APPENDIX E
BUILDING COMPONENT R-VALUE COMBINATIONS

(Informative)

E1

Table E1 provides examples of acceptable building component combinations for a building of a specific plan with an area of glazing less than or equal to 30 % of the total wall area.

Table E1 – Building component R-value combinations

Non-solid wall	**Climate zone 1**				**Climate zone 2**				**Climate zone 3**				
				IGU				**IGU**	**IGU**			**Slab floor**	
Roof	1.9	2.5	3.0	1.5	1.9	2.5	3.0	1.5	2.5	2.8	1.8	1.5	4
Non-solid wall	1.5	1.2	1.0	1.0	1.5	1.2	1.0	1.0	1.9	1.6	1.5	2.2	1.9
Floor	1.3	1.3	1.3	1.0	1.3	1.3	1.3	1.0	1.3	1.3	1.3	1.8	2
Glazing	0.15	0.15	0.15	0.26	0.15	0.15	0.15	0.26	0.26	0.26	0.31	0.26	0.15
Solid wall													
Roof	3.0	2.1	1.8*	1.8*	3.0	2.1	1.8*	1.8*	3	3.2	1.8	1.8	3
Solid wall	0.6	0.7	0.8	0.6	0.6	0.7	0.8	0.6	1	0.9	1.3	1	1.4
Floor	1.3	1.3	1.3	1.0	1.3	1.3	1.3	1.0	1.3	1.3	1.3	1.3	2
Glazing	0.15	0.15	0.15	0.26	0.15	0.15	0.15	0.26	0.26	0.26	0.26	0.31	0.15

NOTE –

(1) This table provides a selection of examples using the calculation method (section 3.2) for a single storey 150 m^2 house with 25 % area of glazing assuming a wall height of 2.4 m; total wall area of 118 m^2; area of glazing of 29.5 m^2 (i.e.<30 %).

(2) Calculations based on other house designs will result in different R-values.

(3) Other combinations of roof, wall, floor and glazing R-values are possible.

(4) Designers should be aware of the minimum R-values for housing under NZBC Clause E3 – Internal Moisture.

* Clause 3.2.6 limits the reduction in the R-value required in tables 1 or 2 (except for the R-values of glazing) to not greater than 40 %. Values marked * are adjusted to meet this requirement.

APPENDIX F
MEASUREMENT DETAILS

(Informative)

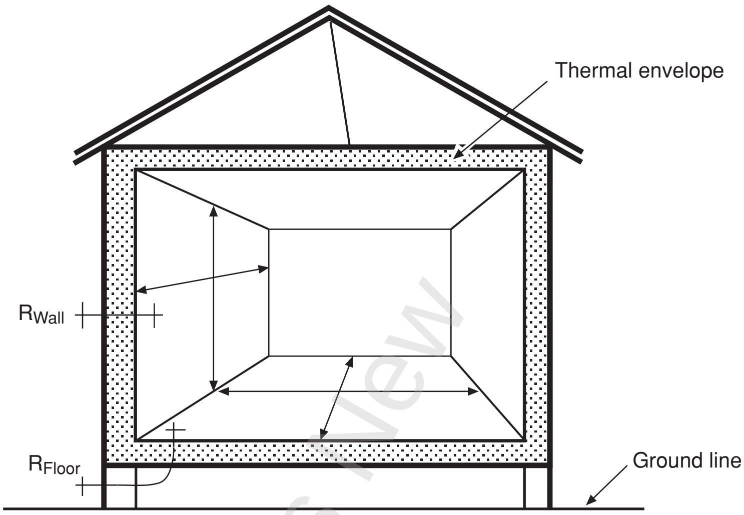

Figure F1 – Floor and wall area measurements and R-value locations

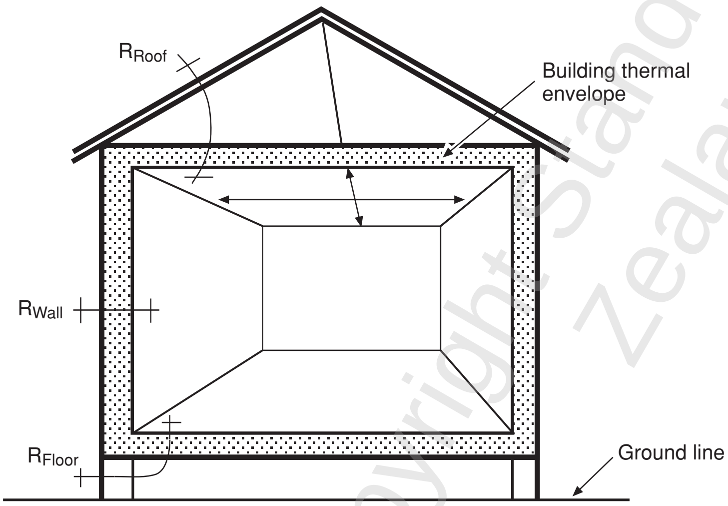

Figure F2 – Roof area measurements

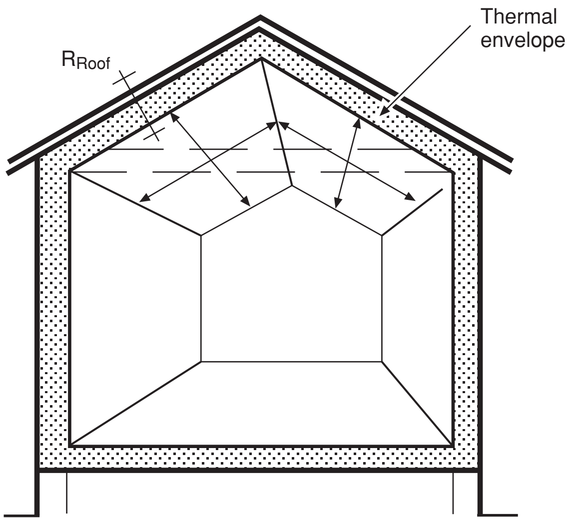

Figure F3 – Roof area measurements

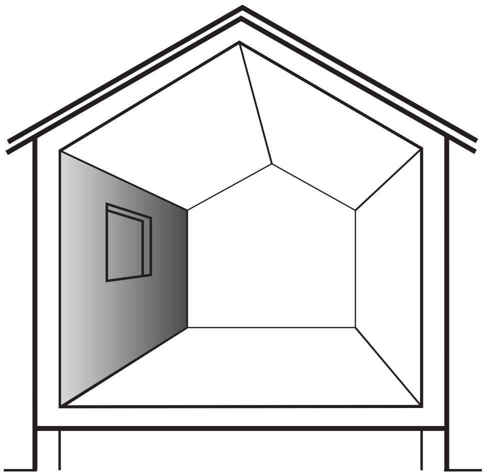

Figure F4 – Total wall area

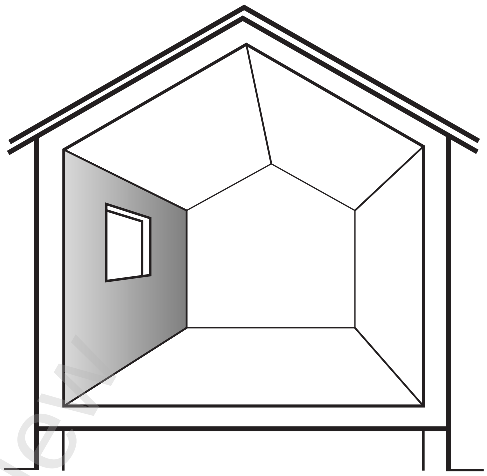

Figure F5 – Wall area

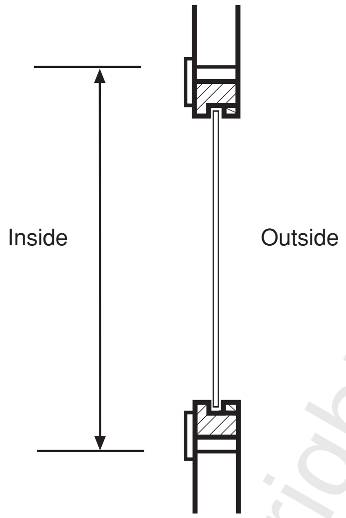

Figure F6 – Window measurement – single window

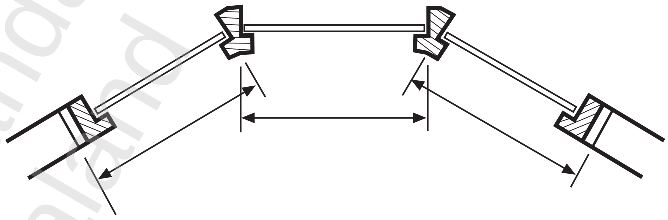

Figure F7 – Bow or bay window measurement

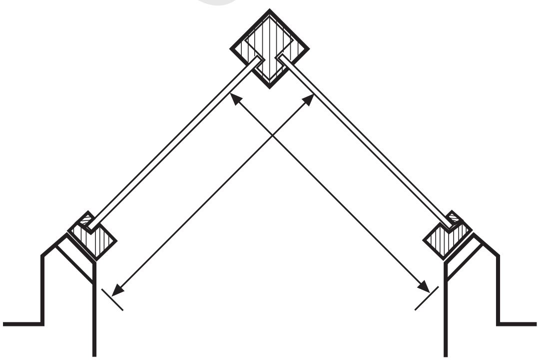

Figure F8 – Rooflight measurement

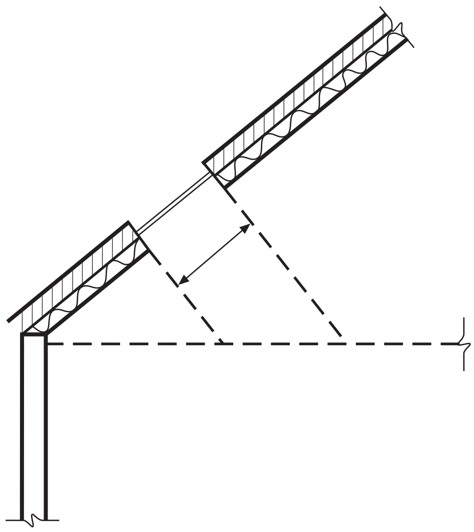

Figure F9 – Skylight measurement

APPENDIX G
GLAZING AND THE WINDOW EFFICIENCY RATING SCHEME (WERS)

(Normative)

G1 GENERAL

The thermal performance of a window must take account of both the glazing material and the frame material in order to provide the true thermal resistance (R-value) of the building element.

The thermal performance of glass 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_{cog}) and total thermal resistance (R_{total}) values are dissimilar. For large windows the centre of glass (R_{cog}) will have more bearing on the overall performance than in a small window, which is dominated by the frame performance.

G2 PERFORMANCE TABLES

Tables G1 and G2 are modified WERS star rating tables that show both the R_{total} and U_{total} along with the U_{cog} so that designers have a guide to the total performance of a window given the U_{cog} for any glass type. The Shading Coefficient (SC_{cog}) is given for the same purpose when comparing the solar control or summer cooling performance of the window.

G3 WERS

The Window Efficiency Rating Scheme (WERS) is a four category, five star performance rating system for windows and is the official rating system of the Window Association of New Zealand.

The WERS stars for heating and cooling are determined by the use of computer simulated space heating and cooling energy use of an average house, in a representative average location, and subject to the environmental conditions from an average climatic year. Both the thermal insulation value and the solar heat gain coefficient are used to determine the star rating.

The WERS stars for fading are derived directly from the damage weighted fading transmission of the specific glazing used, being frame independent. The condensation stars are derived from computer modelling of the heat flow through the glazing systems, giving the interior surface temperatures rating at the centre of glass, edge of glass and framing separately, at a range of humidities.

Star types are:

(a) Winter heating – effectiveness in reducing heat loss;

(b) Summer cooling – effectiveness in reducing heat gain from the sun;

(c) Condensation – effectiveness in reducing condensation;

(d) Fading – effectiveness in reducing fading of furnishing and carpets.

G4 STANDARD WINDOW

The R-value of a window or door has previously been known as the thermal resistance of the centre of the glass area (R_{cog}). This has ignored the effect of the framing, and the size of the glazing. When the WERS method is used to define glazing R-values, a “Standard Window” is used, of size 1800 mm wide x 1500 mm high with a central mullion and one opening light. The R-value (R_{total}) of the glass and frame is calculated, resulting in typical R-values for standard aluminium joinery of 0.26 and 0.15 m^2 °C /W instead of the traditional values of 0.33 and 0.18 m^2 °C /W.

Table G1 – Climate zones 1 and 2: WERS star rating

Generic windows	SC_{cog}	U_{cog} ($W/m^2\ ^oC$)	Winter heating stars	Summer cooling stars	Condensation stars	Fading stars	$R_{(total)}$ ($m^2\ ^oC/W$)	$U_{(total)}$ ($W/m^2\ ^oC$)
Aluminium frame								
Single clear	0.98	6.26	2	1.5	1	1	0.15	6.7
Single grey tint	0.71	6.23	1	2.5	1	3.5	0.15	6.7
Single advanced tint	0.66	6.23	1	3	1	3	0.15	6.7
Single laminated solar Low E	0.61	3.76	2.5	3.5	0.5	4	0.22	4.6
IGU clear	0.86	2.79	3.5	2	2	2	0.26	3.9
IGU bronze / clear	0.64	2.78	2.5	4.5	2	3.5	0.26	3.9
IGU grey / clear	0.58	2.78	2.5	4	2	3.5	0.26	3.9
IGU grey reflective / clear	0.35	2.77	1.5	5	2	5	0.26	3.9
IGU advanced tint / clear	0.53	2.78	2.5	4.5	2	3.5	0.26	3.9
IGU clear laminated / clear	0.81	2.76	2.5	4	2	4.5	0.26	3.9
IGU clear / Low E	0.8	1.91	4	2.5	2	2.5	0.31	3.2
IGU tint / Low E	0.47	1.9	3	4.5	2	3.5	0.31	3.2
IGU clear / Low E + Argon gas	0.8	1.61	4.5	2.5	2	2.5	0.33	3
Composite frame								
Single clear	0.98	6.26	2	1	1	1	0.15	6.6
Single advanced tint	0.66	6.23	1	3	1	3	0.15	6.6
Single laminated solar Low E	0.61	3.76	2.5	3.5	0.5	4	0.24	4.2
IGU clear	0.86	2.79	4	2	2.5	2	0.26	3.9
IGU advanced tint / clear	0.53	2.78	3	4	2.5	3.5	0.26	3.9
IGU clear / Low E	0.8	1.91	4.5	2	2.5	2.5	0.31	3.2
IGU tint / Low E	0.47	1.9	3	4.5	2.5	3.5	0.31	3.2
IGU clear / Low E + Argon gas	0.8	1.61	5	2	2.5	2.5	0.34	3
Thermally broken aluminium frame								
Single clear	0.98	6.26	2.5	1.5	1	1	0.17	6
Single advanced tint	0.66	6.23	1	3	1	3	0.17	5.9
Single laminated solar Low E	0.61	3.76	2.5	3.5	0.5	4	0.24	4.2
IGU clear	0.86	2.79	3.5	2.5	3	2	0.31	3.2
IGU advanced tint / clear	0.53	2.78	3	4.5	3	3.5	0.31	3.2
IGU clear / Low E	0.8	1.91	4.5	2.5	3	2.5	0.4	2.5
IGU tint / Low E	0.47	1.9	3	5	3	3.5	0.38	2.6
IGU clear / Low E + Argon gas	0.8	1.61	5	2.5	3	2.5	0.43	2.3
PVC or wooden frame								
Single clear	0.98	6.26	2.5	2	1	1	0.19	5.2
Single advanced tint	0.66	6.23	1.5	3.5	1	3	0.19	5.2
Single laminated solar Low E	0.61	3.76	3	4	0.5	4	0.27	3.7
IGU clear	0.86	2.79	4	2.5	4	2	0.36	2.8
IGU advanced tint / clear	0.53	2.78	3	4.5	4	3.5	0.36	2.8
IGU clear / Low E	0.8	1.91	4.5	3	5	2.5	0.48	2.1
IGU tint / Low E	0.47	1.9	3.5	5	5	3.5	0.48	2.1
IGU grey tint laminated / Low E	0.53	1.89	3.5	4.5	5	4.5	0.48	2.1
IGU clear / Low E + Argon gas	0.8	1.61	5	3	5	2.5	0.53	1.9

Table G2 – Climate zone 3: WERS star rating

Generic windows	SC_{cog}	U_{cog} (W/m^2 °C)	Winter heating stars	Summer cooling stars	Condensation stars	Fading stars	$R_{(total)}$ (m^2 °C/W)	$U_{(total)}$ (W/m^2 °C)
Aluminium frame								
Single clear	0.98	6.26	2	1.5	1	1	0.15	6.7
Single grey tint	0.71	6.23	1	3	1	3.5	0.15	6.7
Single advanced tint	0.66	6.23	1	3.5	1	3	0.15	6.7
Single laminated solar Low E	0.61	3.76	2	4	0.5	4	0.22	4.6
IGU clear	0.86	2.79	3.5	2.5	2	2	0.26	3.9
IGU bronze / clear	0.64	2.78	2.5	4.5	2	3.5	0.26	3.9
IGU grey / clear	0.58	2.78	3	4.5	2	3.5	0.26	3.9
IGU grey reflective / clear	0.35	2.77	0.5	5	2	5	0.26	3.9
IGU advanced tint / clear	0.53	2.78	2.5	4.5	2	3.5	0.26	3.9
IGU clear laminated / clear	0.81	2.76	3	4.5	2	4.5	0.26	3.9
IGU clear / Low E	0.8	1.91	4	2.5	2	2.5	0.31	3.2
IGU tint / Low E	0.47	1.9	3	5	2	3.5	0.31	3.2
IGU clear / Low E + Argon gas	0.8	1.61	4.5	2.5	2	2.5	0.33	3
Composite frame								
Single clear	0.98	6.26	2	1	1	1	0.15	6.6
Single advanced tint	0.66	6.23	1	3	1	3	0.15	6.6
Single laminated solar Low E	0.61	3.76	2.5	4	0.5	4	0.24	4.2
IGU clear	0.86	2.79	3.5	2	2.5	2	0.26	3.9
IGU advanced tint / clear	0.53	2.78	3	4.5	2.5	3.5	0.26	3.9
IGU clear / Low E	0.8	1.91	4.5	2.5	2.5	2.5	0.31	3.2
IGU tint / Low E	0.47	1.9	3.5	4.5	2.5	3.5	0.31	3.2
IGU clear / Low E + Argon gas	0.8	1.61	5	2	2.5	2.5	0.34	3
Thermally broken aluminium frame								
Single clear	0.98	6.26	2	1.5	1	1	0.17	6
Single advanced tint	0.66	6.23	1	3.5	1	3	0.17	5.9
Single laminated solar Low E	0.61	3.76	2.5	4	0.5	4	0.24	4.2
IGU clear	0.86	2.79	3.5	2.5	3	2	0.31	3.2
IGU advanced tint / clear	0.53	2.78	3	4.5	3	3.5	0.31	3.2
IGU clear / Low E	0.8	1.91	4.5	3	3	2.5	0.4	2.5
IGU tint / Low E	0.47	1.9	3.5	5	3	3.5	0.38	2.6
IGU clear / Low E + Argon gas	0.8	1.61	5	2.5	3	2.5	0.43	2.3
PVC or wooden frame								
Single clear	0.98	6.26	2.5	2	1	1	0.19	5.2
Single advanced tint	0.66	6.23	1.5	3.5	1	3	0.19	5.2
Single laminated solar Low E	0.61	3.76	3	4	0.5	4	0.27	3.7
IGU clear	0.86	2.79	4	3	4	2	0.36	2.8
IGU advanced tint / clear	0.53	2.78	3	4.5	4	3.5	0.36	2.8
IGU clear / Low E	0.8	1.91	4.5	3	5	2.5	0.48	2.1
IGU tint / Low E	0.47	1.9	3.5	5	5	3.5	0.48	2.1
IGU grey tint laminated / Low E	0.53	1.89	4	5	5	4.5	0.48	2.1
IGU clear / Low E + Argon gas	0.8	1.61	5	3	5	2.5	0.53	1.9

APPENDIX H ORIENTATION

(Normative)

H1 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 H1. The orientations of skylights and other walls, including the glazing they contain, shall be determined in a similar way.

H2 DESCRIPTION OF SECTORS

Orientation sectors specified in figure H1 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).

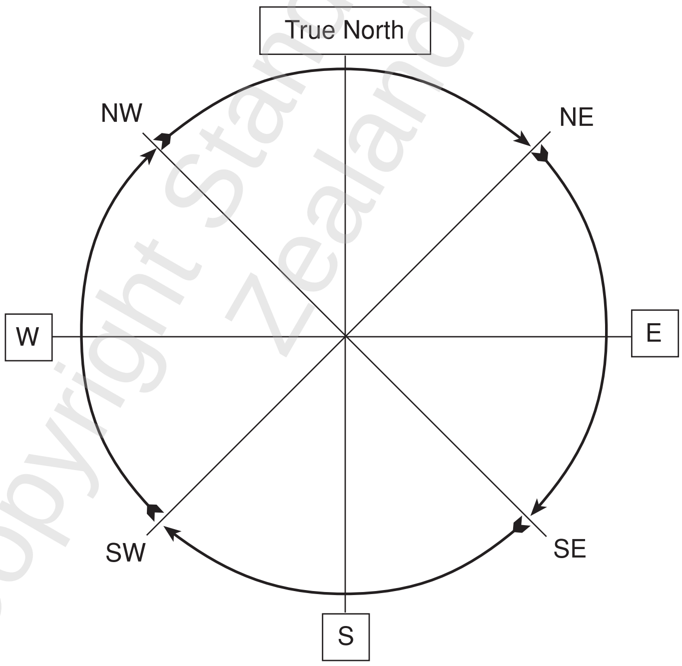

Figure H1 – Orientation sectors

NOTES

Approved by the Standards Council on 20 August 2004 to be a New Zealand Standard pursuant to the provisions of section 10 of the Standards Act 1988.

First published: 20 August 2004

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