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NZS 4218:1996

NZS 4218:1996

NZS 4218:1996

ENERGY EFFICIENCY –

HOUSING AND

SMALL BUILDING ENVELOPE

Superseding NZS 4218P:1977

Pr GG

COMMITTEE REPRESENTATION

This Standard was prepared by the Energy Efficiency – Housing and Small Building Envelope Committee (P4218) for the Standards Council established under the Standards Act 1988.

The committee consisted of representatives of the following:
Architectural Aluminium Association New Zealand
Auckland Manufacturers Association
Building Research Association of New Zealand
Building Officials Institute of New Zealand
Energy Efficiency and Conservation Authority
Forest Research Institute
New Zealand Claddings Institute
New Zealand Institute of Architects
New Zealand Manufacturers Federation
New Zealand Master Builders Federation
The Cement and Concrete Association of New Zealand
Victoria University of Wellington

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CONTENTS **PAGE**

Figure

RELATED DOCUMENTS

Reference is made in this Standard to the following:

NEW ZEALAND STANDARDS

NZS 4214:1977	Methods of determining the total thermal resistances of parts of buildings
NZS 4243:1996	Energy efficiency – large buildings
NZS 4303:1990	Ventilation for acceptable indoor air quality

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 (Rev 1993).

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.

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.

NEW ZEALAND LEGISLATION

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

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* issued free of charge to committee and subscribing members of Standards New Zealand.

FOREWORD

NZS 4218:1996 *Energy efficiency – Housing and small building envelope,* supersedes NZS 4218P:1977 *Minimum thermal insulation require-ments for residential buildings.*

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 Standard recognizes the two methods of construction "Non-solid" and "Solid" that are similar to the former Type A and Type B, specified in NZS 4218P:1977.

NZS 4218:1996 provides methods for compliance, glazing consid-eration, and recognition of climate zoning as opposed to the single climatic zone in the former Standard.

The insulation requirements are based on an economic cost benefit analysis (refer "A Sensible Step to Building Energy Efficiency" listed under "Other Publications"). The minimum insulation levels in this Standard are the least cost option for the building owner based on current knowledge of insulation, current and forecast energy costs, and heating behaviour.

Energy efficient buildings provide comfort and health benefits to the nation, and the building occupier, by reducing overall energy con-sumption whilst retaining or improving on the existing levels of service. These benefits are particularly marked in the colder zones.

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.

NEW ZEALAND STANDARD

ENERGY EFFICIENCY – HOUSING AND 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 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.

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.

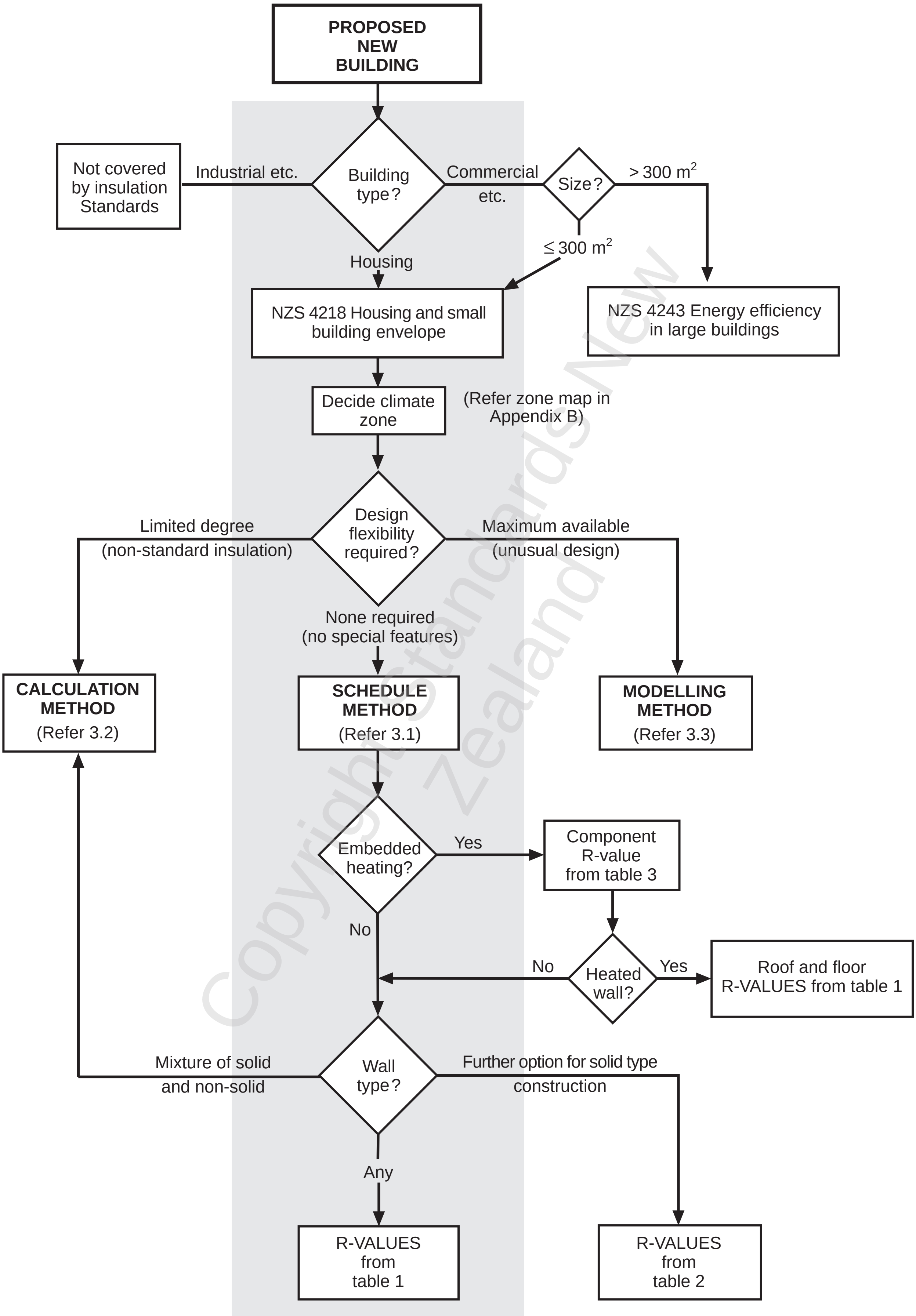

Figure 1 – Decision flowchart

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.

GLAZING AREA. The total area of glazing (including skylights) and 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 6 people, dwelling or hut).

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).

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

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 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 ($m^2 \cdot {}^\circ C/W$).

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 60º 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 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 ($m^2 \cdot {}^oC/W$).

TOTAL WALL AREA. For the purposes of calculation, the total wall area is deemed to be the wall area plus the glazing area. (See also wall area).

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 60º.

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

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 level of insulation required by this Standard will give economic benefits in comparison with an uninsulated building. Higher levels of insulation provide further benefit.

1.3.2

Methods of measuring the thermal resistance of building envelope components, and the 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

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 sub-floor 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 minumum R-values for solid construction.

Table 1 – Minimum R-values for schedule method

Building thermal envelope component	Minimum R-values m²•°C/W	
	Climate zones 1 & 2	Climate zone 3
Roof	R 1.9	R 2.5
Wall	R 1.5	R 1.9
Floor	R 1.3	R 1.3

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) Glazing above 30 % of wall area may very likely lead to solar overheating and excessive heat loss. Use of the calculation method or modelling method is advised for over 30 % glazing.

(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.

Table 2 – Solid construction – alternative minimum R-values for schedule method

Building thermal envelope component	Minimum R-values $m^2 \bullet {}^oC/W$	
	Climate zones 1 & 2	Climate zone 3
Roof	R 3.0	R 3.0
Wall	R 0.6	R 1.0
Floor	R 1.3	R 1.3

NOTE –

(1) The R-values given in this table may be those applicable to the reference building as described in this Standard.

(2) Climate zone boundaries are shown in Appendix B.

(3) Glazing above 30 % of wall area may lead to solar overheating and excessive heat loss. Use of the Calculation Method or Modelling Method is advised for over 30 % glazing.

(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.

3.1.5
Table 3 applies to building envelope components that contain embedded heating systems.

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

Building thermal envelope component	Minimum values for climate zones 1, 2 & 3 $m^2 \cdot {}^oC/W$
Heated ceiling (R_{OUT})	R 3.0
Heated wall (R_{OUT})	R 2.2
Heated floor (R_{OUT})	R 1.7

where:

$R_{IN}/R_{OUT} \leq 0.1$

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, 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 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:

$HL_{Proposed} \leq HL_{Reference}$ .... (Equation 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 from table 1, or 2 as appropriate, and the defined R-values in table 4.

Table 4 – Reference building – glazing R-values

Building thermal envelope component	**R-value** $m^2 \cdot {}^oC/W$
Glazing area ≤ 30 % of total wall area	0.18
Glazing area >30 % of total wall area	0.33
Doors	0.18
Skylights (if ≥ 0.6 m^2)	0.18

NOTE –
(1) The minimum R-values for glazing shall be accepted as 0.18 and 0.33 for single and double glazing respectively except where a higher R-value can be demonstrated by calculation or measurement using NZS 4214 or an internationally accepted computer software program.

(2) The total skylight area may be ignored if less than 0.6 m^2.

3.2.4

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

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

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 glazing area (m^2)

and

R_{Roof}, R_{Wall}, R_{Floor} and $R_{Glazing}$ are the proposed or reference R-values ($m^2 \cdot {}^oC/W$) 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 2 or more methods of construction with different thermal resistances, the corresponding term in the proposed building thermal characteristic shall be expanded to suit.

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

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 2.

For example: R 3.0 $\rightarrow$ minimum possible is R 1.8
R 1.5 $\rightarrow$ minimum possible is R 0.9
R 1.0 $\rightarrow$ 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

For the purposes of calculation, all doors shall be treated as glazed areas (i.e. R-value = 0.18 $m^2 \bullet {}^oC/W$).

3.2.8

For the purposes of calculation, the glazing area 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 evaluated 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 method used shall be satisfactorily evaluated by the International Energy Agency's "Building Energy Simulation Test (BESTEST) and Diagnostic Method". 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;

(j) 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.

A1.9 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 it must 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 shall be as proposed or light weight. The thermal mass of the reference structure may be light weight but must be equal to or less than that 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 must be accounted for in the model and should be described in terms of its surface area, orientation, and R-value. Glazing areas 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 should be calculated as in the rest of this Standard; that is using a standardised surface thermal resistance of 0.03 m^2•ºC/W outside and 0.09 m^2•ºC/W inside (0.12 m^2•ºC/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).

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 standardised surface resistances. The same method of calculation must 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 light weight. The thermal mass of the walls of the reference building must be equal to or less than that 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 light weight. The thermal mass of the walls of the reference building must be equal to or less than that 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 lightweight construction. The thermal mass of the roof of the reference building must be equal to or less than that 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
Glazing in the reference building shall have the same distribution as in the proposed design or shall constitute an equal percentage of gross wall area of the thermal envelope for each wall section modelled.

A2.6.3
Table 4 applies to the glazing in the reference building.

A2.6.4
The total glazing area of reference and proposed building shall be the same.

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 doors in the reference building shall have an R-value of 0.18.

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

A2.10.1
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

A2.11.1
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

A2.12.1
Interzone air flow does not require modelling.

A2.13 Internal doors

A2.13.1
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

A4.1.1
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 must 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 must be accounted for. Assumptions made must 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 °C from 07:00 – 23:00 hours and 16 °C 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. It is noted that a temperature of between 20 °C and 24 °C is often 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

	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

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

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

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

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
Week	5	15	15	5	5
Week	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

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 3 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 (indicative only)

APPENDIX C
HEAT LOSS EQUATION TABLES

(Normative)

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

Climate zone	Glazing area	Reference building heat loss equation (where $A_{glazing(reference)} = A_{glazing(proposed)}$)
1 and 2	≤ 30 % of total wall area	$HL_{Reference} = \frac{A_{Roof}}{1.9} + \frac{A_{Wall}}{1.5} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.18}$
3		$HL_{Reference} = \frac{A_{Roof}}{2.5} + \frac{A_{Wall}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.18}$
1 and 2	> 30 % of total wall area	$HL_{Reference} = \frac{A_{Roof}}{1.9} + \frac{A_{Wall}}{1.5} + \frac{A_{Floor}}{1.3} + \frac{30\text{ \% of total wall area}}{0.18} + \frac{A_{Glass} - (30\text{ \% of total wall area})}{0.33}$
3		$HL_{Reference} = \frac{A_{Roof}}{2.5} + \frac{A_{Wall}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{30\text{ \% of total wall area}}{0.18} + \frac{A_{Glass} - (30\text{ \% of total wall area})}{0.33}$

Table C2 – Reference heat loss equations – solid construction

Climate zone	Glazing area	Reference building heat loss equation (where $A_{glazing(reference)} = A_{glazing(proposed)}$)
1 and 2	≤ 30 % of total wall area	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{0.6} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.18}$
3		$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{1.0} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.18}$
1 and 2	> 30 % of total wall area	$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{0.6} + \frac{A_{Floor}}{1.3} + \frac{30\ \%\ \text{of total wall area}}{0.18} + \frac{A_{Glass} - (30\ \%\ \text{of total wall area})}{0.33}$
3		$HL_{Reference} = \frac{A_{Roof}}{3.0} + \frac{A_{Wall}}{1} + \frac{A_{Floor}}{1.3} + \frac{30\ \%\ \text{of total wall area}}{0.18} + \frac{A_{Glass} - (30\ \%\ \text{of total wall area})}{0.33}$

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:

Length 15 m Width 12 m Height 2.4 m

R-values (from tables 1 and 4): Roof = 2.5 Wall = 1.9 Floor = 1.3 Glazing = 0.18

Assume a wall R-value of R 1.5 is desired (in lieu of R 1.9 as per table 1)

Floor area	180 m^2
Total wall area	129.6 m^2
Glazing area	38 m^2
Wall area	91.6 m^2

REFERENCE BUILDING
Using the appropriate value from table C1 (glazing area less than 30 %)

$$HL_{Reference} = \frac{A_{Roof}}{2.5} + \frac{A_{Wall}}{1.9} + \frac{A_{Floor}}{1.3} + \frac{A_{Glazing}}{0.18}$$

$$= \frac{180}{2.5} + \frac{91.6}{1.9} + \frac{180}{1.3} + \frac{38}{0.18}$$

$$= 72 + 48.2 + 138.5 + 211.1 = 469.8$$

PROPOSED BUILDING (Wall R-value of R1.5 desired)
Assume that the designer is prepared to increase R-value of roof. From 3.2.4 and table 1:

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

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

$$\frac{180}{R_{Roof}} + \frac{91.6}{1.5} + \frac{180}{1.3} + \frac{30}{0.18} \leq 469.8$$

$R_{Roof} \geq$ 3.0 (increases 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 a glazing area less than or equal to 30 % of the total wall area.

Table E1 – Building component R–value combinations

Non-solid wall	**Climate zones 1 & 2**			**Climate zone 3**				
							Double glazing	Slab floor
Roof	1.9	2.5	3.0	2.5	2.9	2.3	1.5*	1.5
Non-solid wall	1.5	1.2	1.0	1.9	1.6	2.2	1.3	2.2
Floor	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.8
Glazing	0.18	0.18	0.18	0.18	0.18	0.18	0.33	0.18
Solid wall								
Roof	3.0	2.1	1.8*	3.0	2.3	1.9	2.3	2.7
Solid wall	0.6	0.7	0.8	1.0	1.2	1.5	0.6	0.8
Floor	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.8
Glazing	0.18	0.18	0.18	0.18	0.18	0.18	0.33	0.18

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 % glazing assuming a wall height of 2.4 m ; total wall area of 118 m^2; glazing area of 29 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 to not greater than 40 %. Values marked "*" are adjusted to meet this requirement.

APPENDIX F
MEASUREMENT DETAILS

(Informative)

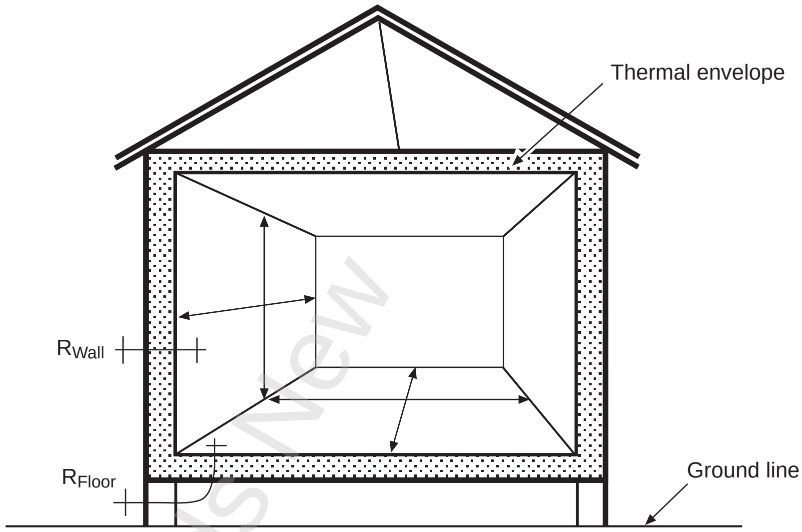

Figure F1 – Floor and wall area measurements and R-value locations

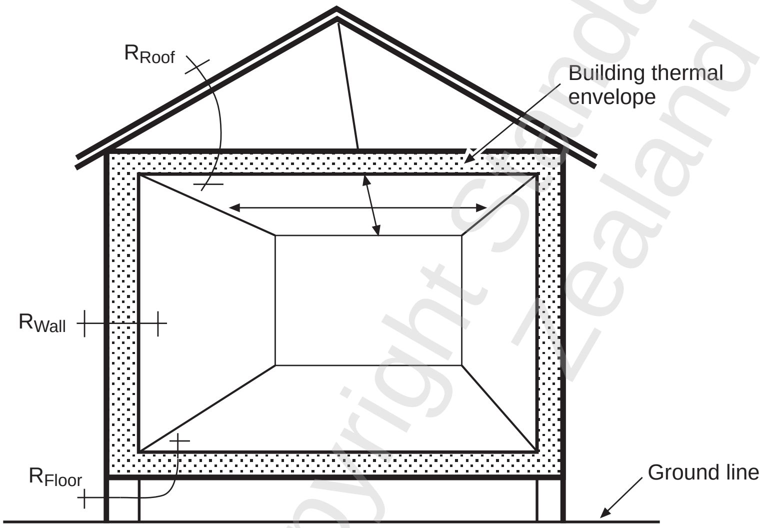

Figure F2 – Roof area measurements

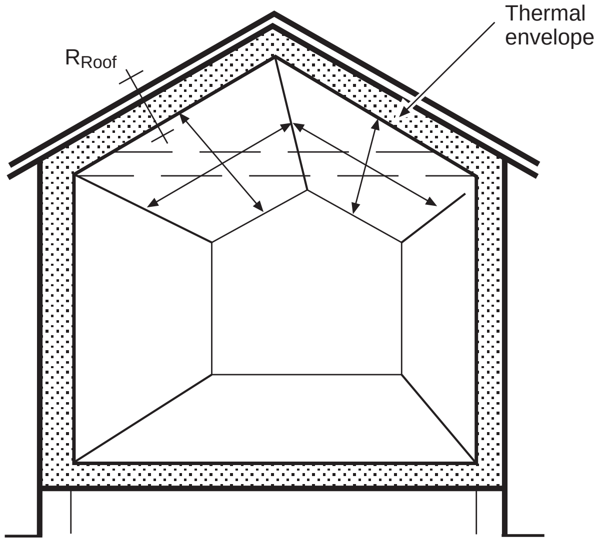

Figure F3 – Roof area measurements

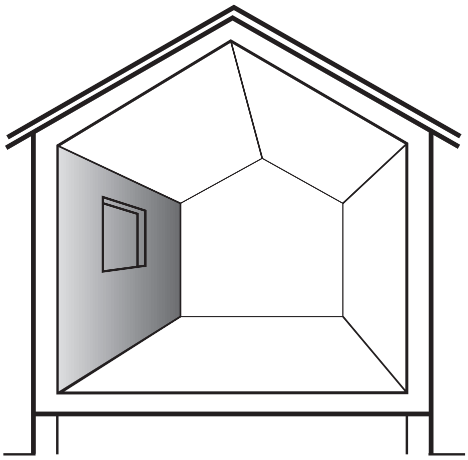

Figure F4 – Total wall area

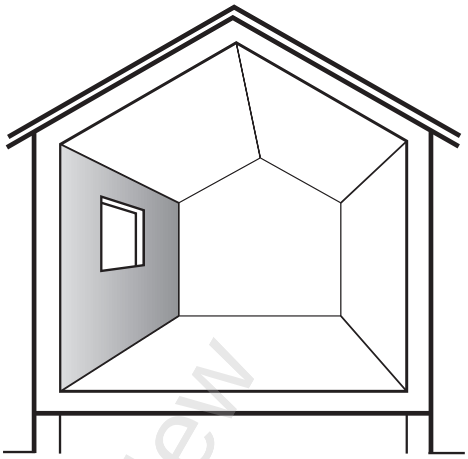

Figure F5 – Wall area

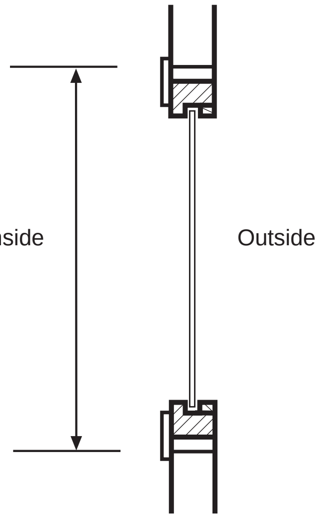

Figure F6 – Window measurement – single window

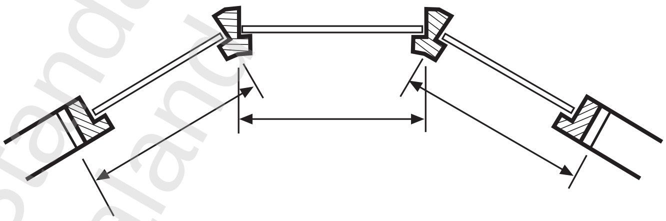

Figure F7 – Bow or bay window measurement

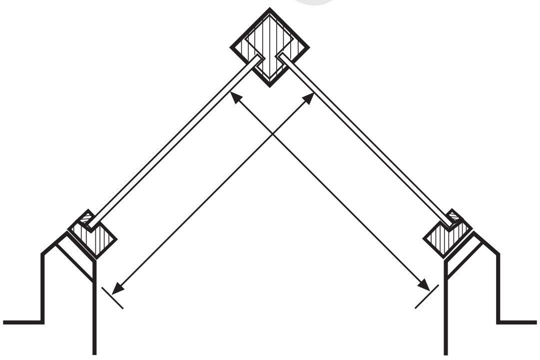

Figure F8 – Rooflight measurement

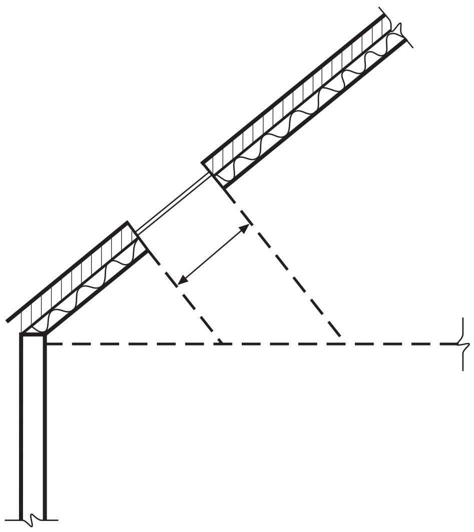

Figure F9 – Skylight measurement

APPENDIX G
GLAZING

(Informative)

G1
Glazing areas of small buildings that exceed 30 % of the wall area may produce adverse effects. This could be caused by excessive localised cooling, associated draughts, and excessive solar gain. This results in occupant discomfort, and increased energy use and costs.

G2
Effects can be reduced by maintaining the average R-value for the building; for example by introducing double glazing that typically has R-values around 0.33 compared with 0.18 for single glazing.

G3
If a large glazing area is considered during the design of a small building, it is recommended that the designer investigate the effects on the building energy use and comfort. The modelling method in this Standard is an investigative tool and may show that benefits can be gained from correct orientation and the addition of fixed external shading or other similar features.

NOTES