BUILDING PERFORMANCE

Consultation document

Building Code update 2021

Issuing and amending acceptable solutions and verification methods

6 APRIL 2021

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Foreword from the Manager Building Performance and Engineering

The New Zealand Building Code (and its associated documents), along with the Building Act 2004, are the primary legislation governing building work in New Zealand. The Ministry of Business, Innovation and Employment (MBIE) is committed to updating the Building Code and its documents so we can keep pace with innovation, current construction methods and the needs of our modern society.

To achieve this, MBIE holds an annual consultation in April to get feedback on proposed changes, and updates are published in November each year.

Right now, MBIE's priorities in the building and construction sector continue to be supporting the construction of quality medium and higher density housing; reducing carbon emissions in the sector; and improving the ability of buildings to withstand the future effects of climate change.

The changes you'll see proposed in this year's consultation reflect these priorities and support both the Building for Climate Change (BfCC) and Higher Density 8 (HD8) programmes of work.

The BfCC programme was set-up to reduce emissions from both constructing and operating buildings, and to make sure buildings are being built with the future effects of climate change in mind.

In the first step to support the priorities of the BfCC programme, we're proposing options that will make it easier to heat and cool buildings. To do this, we're proposing to increase the number of climate zones in New Zealand from three to six, and to increase the minimum insulation requirements, so that buildings have the right level of insulation for where they're located.

We've heard what you've told us in previous consultation processes, that insulation values are too low, and we're ready to make changes. Now we want you to let us know how far you want these changes to go, how fast you want them to come into force and how we might progressively phase in these changes. Your feedback is important, so we can get this right.

The HD8 programme is looking at eight clauses in the Building Code over the next five years to see how these clauses can be improved to better support higher density housing. The goal is to support higher-density housing while ensuring they are safe, healthy and durable homes that people want to live in.

As part of the HD8 programme of work, this year we're proposing changes to clarify requirements for natural light in apartment buildings and to adopt new methods to demonstrate compliance.

Some of these changes will require upfront investments, which will provide ongoing savings and health benefits from day one. These changes will have long term benefits for you and your whānau, and can be achieved without a large increase in cost. It may require NZ to rethink how we build – considering less floor area and a smaller footprint, or a less unique design. We are also confident that the sector will respond to the challenge, and come up with innovative ways to keep costs down, while providing warmer, drier, healthier homes that are energy efficient.

We acknowledge that increasing insulation levels will only take us so far, and other house features also need to be improved. This is just the first step – further changes are coming that will look at more holistic ways to decrease emissions, and to ensure New Zealand's houses are warm enough to live in comfortably and support good health. These changes will be critical to ensure the health, wellbeing and the environment for future generations and the country as a whole.

Please take the time to let us know your thoughts. You can provide feedback by following the instructions on MBIE's Have Your Say webpage.

Dave Robson
Manager, Building Performance and Engineering

Contents

Proposals

Appendices

Seeking feedback on the Building Code update

In this consultation, we seek your feedback on the following seven proposals:

- › Proposal 1. Energy efficiency for housing and small buildings
- › Proposal 2. Energy efficiency for large buildings
- › Proposal 3. Energy efficiency for heating, ventilation and air conditioning (HVAC) systems in commercial buildings
- › Proposal 4. Natural light for higher-density housing
- › Proposal 5. Weathertightness testing for higher-density housing
- › Proposal 6. Standards referenced in B1 Structure
- › Proposal 7. Editorial changes to Acceptable Solution B1/AS1

Each acceptable solution outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of demonstrating compliance with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Standards referenced in these proposals are available for inspection free of charge from MBIE, 15 Stout Street, Wellington (please ring 0800 242 243 to arrange an appointment). New Zealand Standards are available to purchase from Standards New Zealand, 15 Stout Street, Wellington or online at www.standards.govt.nz. Other standards and documents are available as follows:

- › BRANZ publications can be accessed for free from www.branz.co.nz
- › Energy Efficiency (Energy Using Products) Regulations 2002 can be accessed for free from www.legislation.govt.nz
- › The International Energy Agency BESTEST can be accessed for free from www.nrel.gov
- › Publications from the European Union can be accessed for free from eur-lex.europa.eu
- › The New Zealand Geotechnical Society publication “Guideline for the field descriptions of soils and rocks in engineering purposes” can be accessed for free from www.nzgs.org
- › Publications from the American National Standards Institute and Air-Conditioning, Heating and Refrigeration Institute (AHRI) can be purchased from webstore.ansi.org
- › Publications from the Cooling Technology Institute can be purchased from www.coolingtechnology.org
- › Publications from the Construction Industry Research and Information Association can be purchased from www.bsria.com
- › Publications from the International Commission on Illumination can be purchased from www.cie.co.at.

How to provide feedback

We invite you to submit feedback on the Building Code update by 5pm, Friday 28 May 2021.

› You can provide your feedback by completing a survey online

› Or, you can download a form at www.mbie.govt.nz and send it to us by email or post.

- **email to:** buildingfeedback@mbie.govt.nz, with subject line Building Code consultation 2021
- **post to:** Ministry of Business, Innovation and Employment, 15 Stout Street, Wellington 6011
  or: Ministry of Business, Innovation and Employment, PO Box 1473, Wellington 6140

Your feedback will contribute to further development of the Building Code.

It will also become official information, which means it may be requested under the Official Information Act 1982 (OIA).

The OIA specifies that information is to be made available upon request unless there are sufficient grounds for withholding it. If we receive a request, we cannot guarantee that feedback you provide us will not be made public. Any decision to withhold information requested under the OIA is reviewable by the Ombudsman.

New look for Building Code documents

The Ministry of Business, Innovation and Employment (MBIE) is committed to ongoing improvement of our acceptable solution and verification method documents by making them easier to use, understand and access.

The first step is to release the new look for E2/VM2, G7 Natural Light and H1 Energy Efficiency documents during the consultation and seek your feedback on the look of the new documents. Instead of one big document, we have split out the acceptable solutions and verification methods into separate documents to make them more manageable.

Along with the improved visual elements, some key features of these documents include:

- a consistent set of heading and numbering formats across all documents; and
- moving references and definitions into standardised appendices at the end of the document; and
- ensuring that all documents start with a consistent statement of their role in the Building regulatory system and the scope of buildings and designs they can be used for; and
- enhanced features such as coloured graphics, hyperlinks and icons; and
- the use of a single column format for text, tables and figures.

Once the consultation has finished, all your feedback will be reviewed before we make a decision on whether to publish these documents in the new look or not. More information will follow the close of the consultation.

If you want to provide feedback on the new look, you can do this by either including feedback in the online survey or by emailing us at buildingfeedback@mbie.govt.nz

1. Energy efficiency for housing and small buildings

To make buildings warmer, drier, healthier and more energy efficient, we are considering options to increase the minimum insulation levels for roof, windows, walls and floors for new housing and small buildings. The options for minimum insulation levels vary across the country so that homes in the coldest parts of New Zealand will need more insulation than those in the warmest parts.

1.1. Reasons for the change

Buildings need to have adequate insulation in roofs, windows, walls and floors to keep people warm, dry and healthy and to make sure that energy is being used efficiently. Insulation can make it easier to heat a home in the winter and cool a home in the summer helping to reduce the amount of energy used in all parts of the country.

In past consultations, MBIE has heard that the existing insulation values required for housing are too low and have not kept pace with other parts of the world with similar climates. The current requirements for the minimum thermal insulation in new housing in New Zealand were set in 2008 and lag behind other countries with similar climates. The World Health Organization recommends maintaining an indoor temperature of 18°C to keep people warm in the winter. With the current insulation requirements, it is expensive to heat and cool homes. This puts unnecessary demand on the electricity grid and, in turn, creates avoidable greenhouse gas emissions. As well, the current minimum insulation requirements provide little protection of people against extreme temperature events (both hot and cold) which are forecasted to become more likely as a result of climate change.

Part of the problem with the existing requirements is the use of three climate zones to divide up the country. These zones attempt to group similar weather and temperatures together and are used to set how much insulation is required for a building in each zone. Yet, New Zealand has diverse climates – from subtropic in Northland to sub Antarctic in Invercargill. The current climate zones are too simple. For example, currently the South Island is only one climate zone which means a home in Queenstown need only have the same amount of insulation as one in Nelson. New Zealanders experience different weather and temperatures depending on where they live and the requirements need to better reflect this.

The New Zealand Government's response to climate change works on ways to cut emissions and adapt to the effects of climate change that are coming. Increasing the level of insulation in buildings represents the first step in the Building for Climate Change programme of work which will continue to transform housing and construction for New Zealanders.

It is now time to demand a higher level of energy efficiency from our homes and increase the minimum levels of insulation. Help us prepare for what will be needed as part of a wider response to climate change and ensure new homes in New Zealand are built for current expectations of warm and comfortable homes.

1.2. Proposed changes

It is proposed to issue new editions of Acceptable Solution H1/AS1 and Verification Method H1/VM1 to:

› Lift minimum levels of insulation to make homes more comfortable and easier to heat and cool.

› Introduce a new climate zone map to better recognise variations in climate around New Zealand, and reflect this in the proposed requirements.

› Limit the scope of the current documents to housing and small buildings[1] and issue new documents for large buildings. Details of the new documents (H1/AS2 and H1/VM2) are discussed in Proposal 2.

[1] A small building is defined within the applicable requirements as those with an occupied space up to 300 m^2. Housing of any size (including multi-unit apartment buildings) is included in Proposal 1. Both housing and small buildings have similar heating and cooling characteristics.

The proposed new editions of Acceptable Solution H1/AS1 and Verification Method H1/VM1 in a new document format are provided in Appendix A.

1.3. Options

1.3.1. Performance level

MBIE has considered the following options to increase the minimum thermal insulation requirements against the status quo:

- **Option 1. Halfway to international standards** – Increase the minimum insulation to a level that is approximately half of that from other parts of the world with similar climates. This represents a modest increase in insulation levels versus the current minimum settings and would still leave New Zealand considerably behind other countries. This would have the least amount of upfront construction costs.
- **Option 2. Comparable to international standards** – Increase the minimum insulation to a level that is comparable with other parts of the world with similar climates. This represent a moderate level of change versus the current requirements and would significantly reduce energy demands for heating and cooling.
- **Option 3. Going further than international standards** – This is the greatest level of increase proposed. This would put New Zealand's minimum insulation levels ahead of other parts of the world with similar climates. It would have the greatest impact on current construction requirements and the biggest reductions in energy use.

For this proposal, MBIE does not have a recommended option and, as part of this consultation, is seeking feedback to establish how far you want these changes to go, how fast to adopt new minimum requirements and how we might progressively phase in any changes. Option 1 and 2 are easier to implement quickly while Option 3 is likely to require progressive phasing to make the change.

Each level of change comes with its own costs and benefits. Better insulation in buildings is expected to save on the energy required to heat and cool a building throughout its life and result in lower power bills. It is also expected that this will require additional investment in the upfront cost of construction for new buildings. MBIE have taken this into consideration when formulating the options and are targeting higher requirements in the areas of the country that will receive the most benefit.

Further analysis of the options is provided in Section 1.4.

1.3.2. Climate zones

The recommended level of insulation for each option varies for each part of the country. As part of this proposal, MBIE is expanding the number of climate zones used in the insulation requirements[2] from 3 to 6. This will allow the insulation requirements to better reflect the different temperatures experienced in each zone.

The six climate zone boundaries are based on climatic data and also take into consideration territorial authority (local government) boundaries. A description of the new climate zones is provided in Table 1.1 and illustrated in Figure 1.1.

Further details of which region sits in which zone is provided in a table of values in the new proposed H1/AS1 and H1/VM1 in Appendix A.

Through a sensitivity analysis, it was determined that these six zones provide the most reasonable groupings for the different areas of the country and different building types. These six zones are used throughout the rest of the proposal in the comparison to the status quo.

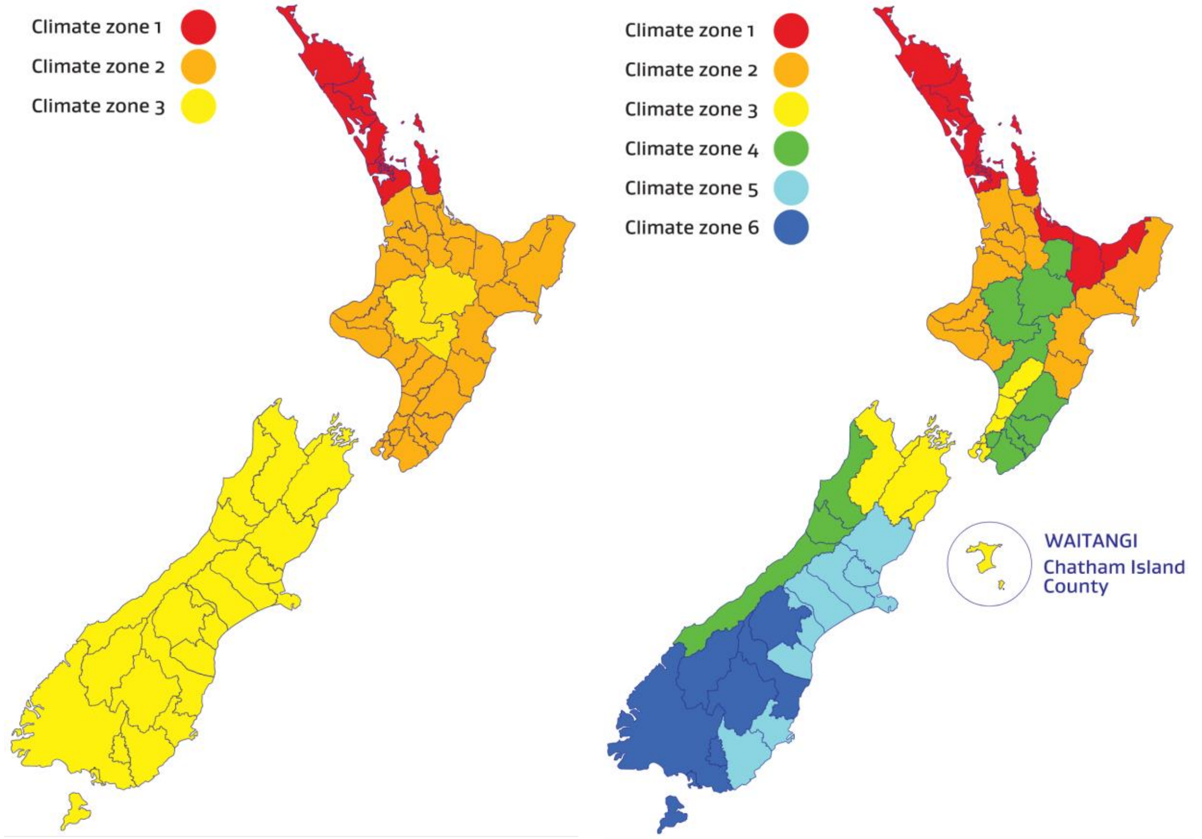
[2] The current climate zones used to determine the level of insulation are referenced in the standards NZS 4218: 2009 "Thermal insulation – Housing and small buildings" and NZS 4243.1: 2007 "Energy efficiency – Large buildings – Part 1 Building thermal envelope".

TABLE 1.1: New climate zones for New Zealand for determining the level of insulation in buildings

←Coldest - Warmest→

Climate zone	Description	Approximate NZ population (%)
1	Northland, Auckland, Coromandel and Bay of Plenty	43%
2	Hamilton, East Coast and New Plymouth	16%
3	Manawatu, Horowhenua, Wellington, Nelson, Marlborough and the Chatham Islands	15%
4	Central Plateau, Wairarapa and the West Coast	6%
5	Canterbury and coastal Otago	16%
6	Inland Otago, Southland and Stewart Island	4%

FIGURE 1.1: Existing and proposed climate zones for New Zealand



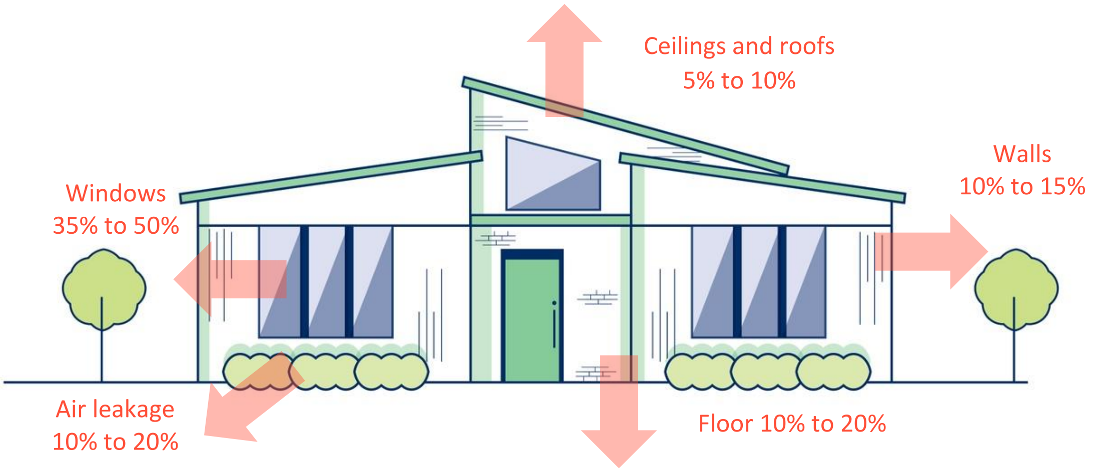
(a) Existing three climate zones in New Zealand (b) Proposed six climate zones for New Zealand

1.3.3. Insulation levels for different building elements

Different building elements will gain and lose heat differently as illustrated in Figure 1.2.

Improving the roof insulation is one of the easiest ways of improving the overall energy efficiency performance of houses. However, windows lose the most heat and have a much lower thermal performance than insulated roofs, walls, or floors. They also cause a house to heat up in the summer when the sun shines through them. Because of this, the performance of windows can significantly affect the energy performance of a building for heating and cooling. Different floor types will perform differently depending on how they are constructed. For example, concrete slab foundations and pile foundations lose heat in different ways. As different portions of a house are insulated, the balance of losses will adjust. To achieve adequate thermal performance of an entire home, the insulation value of all of these elements needs to be considered to achieve the right balance.

FIGURE 1.2: Typical heat losses in the winter for a standalone home insulated to the current requirements[3]



The effectiveness of thermal insulation is measured in terms of thermal resistance or R-values (measured in $m^2 \cdot K/W$). The proposed R-values for each option are shown in the graphs for:

› Roof insulation in Figure 1.3A

› Windows in Figure 1.3B

› Wall insulation in Figure 1.3C

› Underfloor insulation in Figure 1.3D

These graphs include a comparison to other parts of the world that have similar climates to New Zealand[4]. For energy efficiency in housing and small buildings, the most important factor in each climate is the amount of heating required to maintain minimum indoor temperatures. For this comparison,

› Climate zone 1 (Auckland) is similar to Adelaide, Australia

› Climate zone 2 (Napier) is similar to Melbourne, Australia and Santa Maria, California

› Climate zone 3 (Wellington) is similar to Hobart, Australia

› Climate zone 4 is similar to Canberra, Australia

› Climate zone 5 (Christchurch) is similar to London, England

› Climate zone 6 (Queenstown) is similar to Dublin, Ireland

› Cardiff, Wales sits between Christchurch (Climate Zone 5) and Queenstown (Climate zone 6)

Further analysis of the R-values for each building element and the costs and benefits of these options is provided in Section 1.4.

[3] BRANZ, "House insulation guide (5th edition)", 1 July 2014

[4] The similarity in climates was determined based on a comparison of the heating degree days and cooling degree days. The heating degree day is calculated by number of days the region has temperature below 18°C x the degrees below 18°C. Similarly, cooling degree day is calculated based on the number of days with a temperature above 18°C.

FIGURE 1.3A: Roof insulation – Proposed options compared to other parts of the world

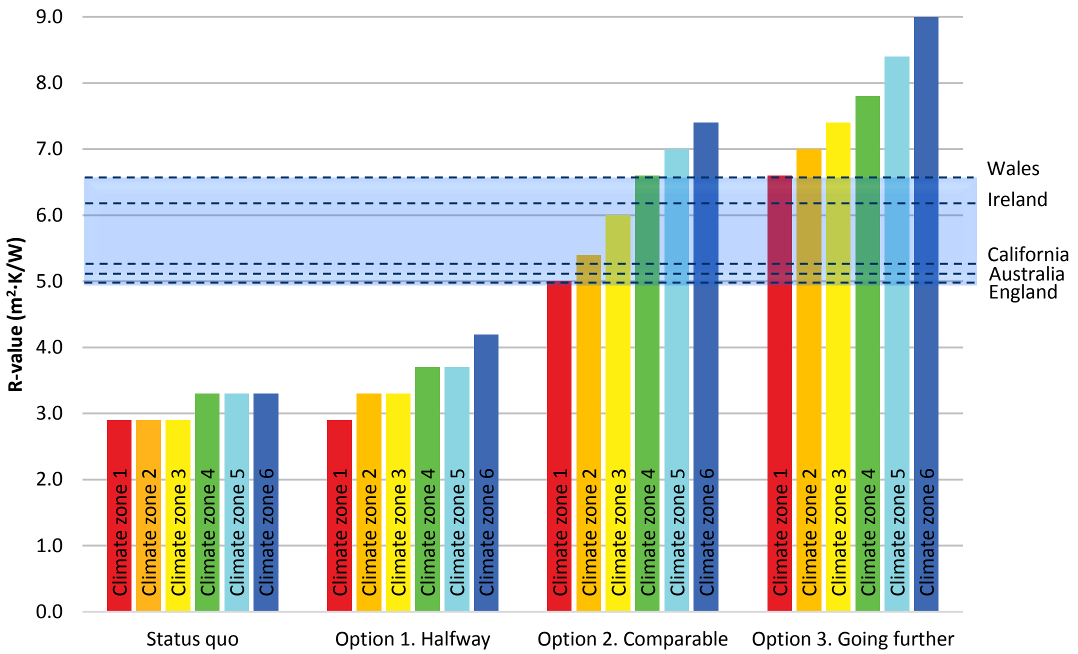


FIGURE 1.3B: Windows – Proposed options compared to other parts of the world

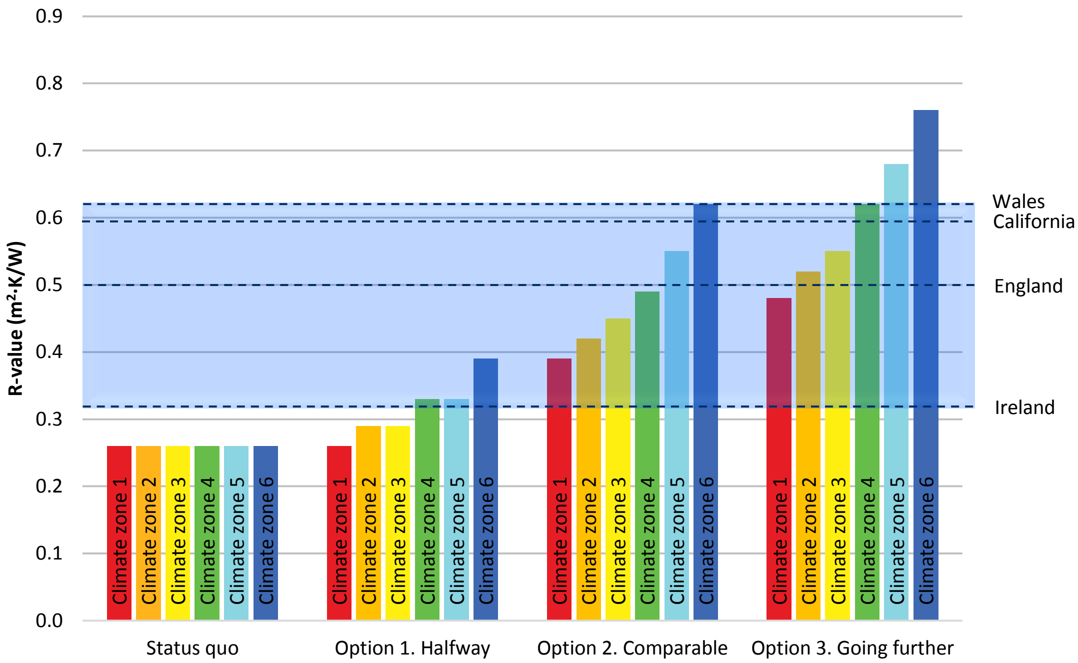


FIGURE 1.3C: Wall insulation – Proposed options compared to other parts of the world

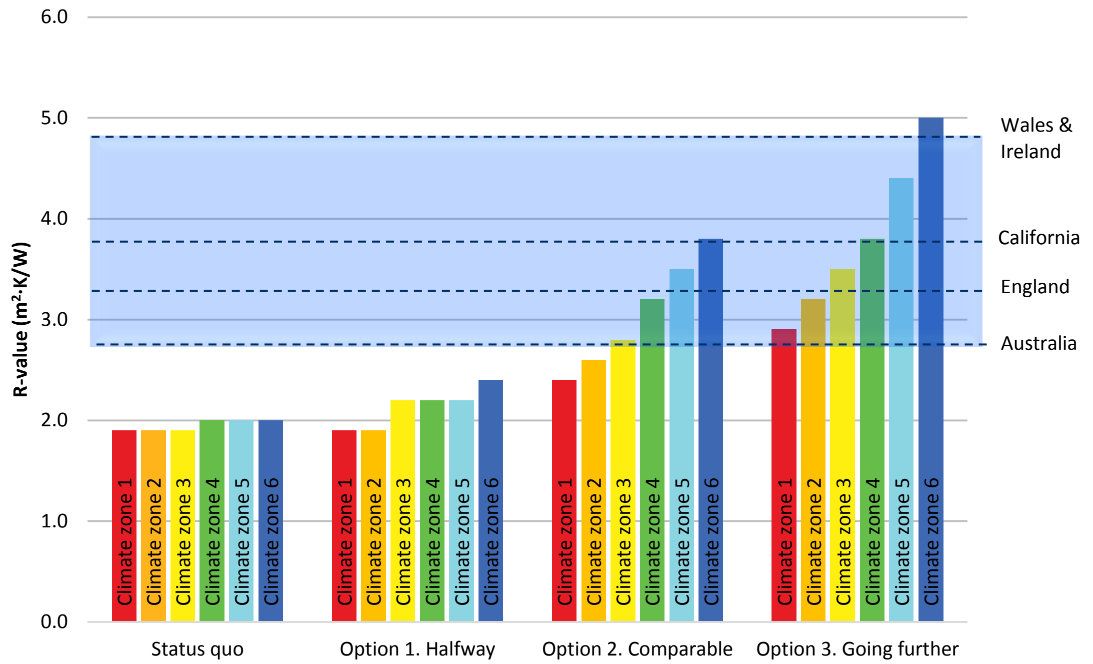
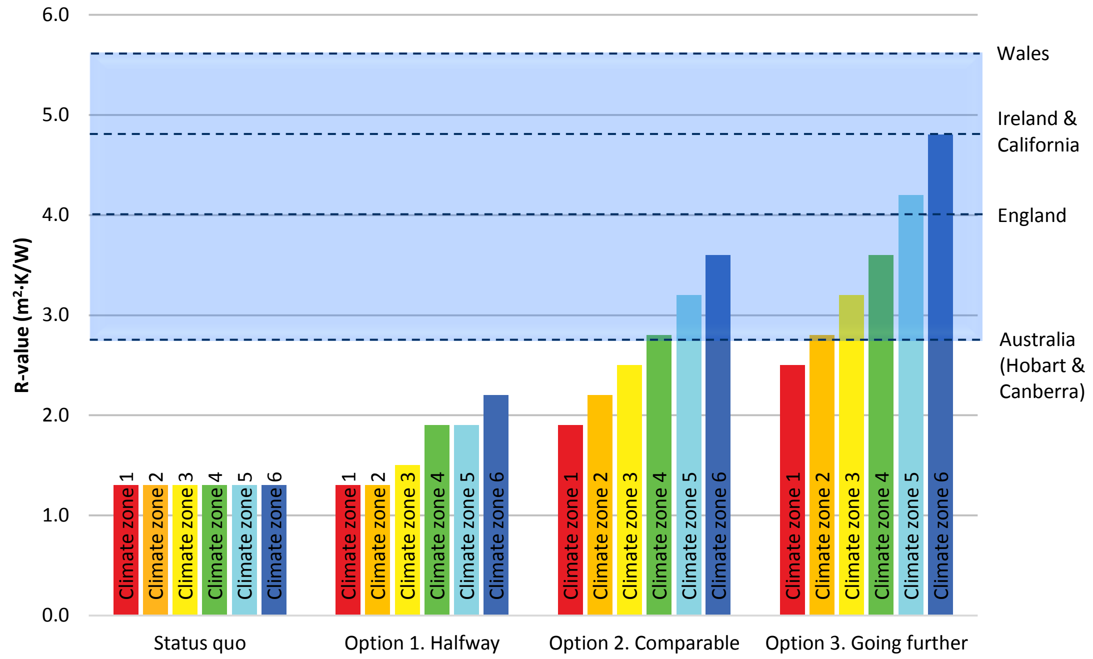


FIGURE 1.3D: Underfloor insulation – Proposed options compared to other parts of the world



1.4. Analysis of the options

1.4.1. Summary of the analysis

An overview of the energy savings and upfront investment for each climate zone is shown in Figure 1.4. A summary of the analysis is provided in Table 1.. Further details of the analysis is provided in the following sections.

FIGURE 1.4: Heating and cooling energy savings for each climate zone

CLIMATE ZONE 1

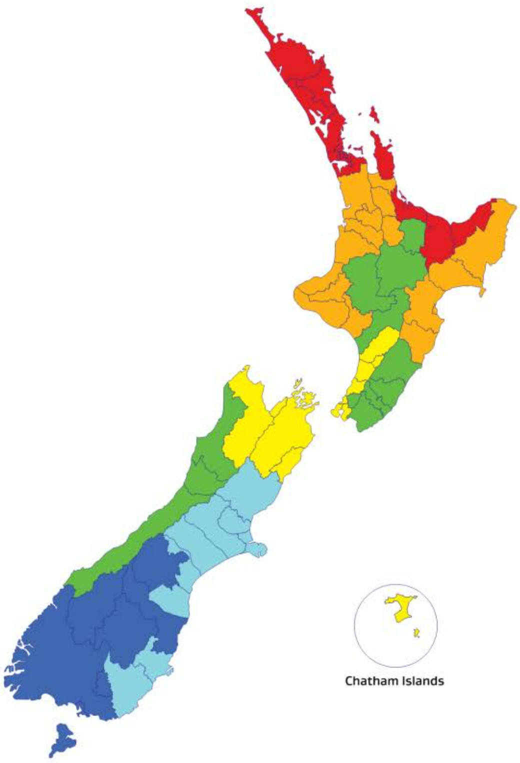
Option		
1	Energy savings	–
	Investment	–
2	Energy savings	36%
	Investment	↑3.2%
3	Energy savings	46%
	Investment	↑4.1%

CLIMATE ZONE 2

Option		
1	Energy savings	12%
	Investment	↑0.4%
2	Energy savings	41%
	Investment	↑3.9%
3	Energy savings	51%
	Investment	↑4.7%

CLIMATE ZONE 3

Option		
1	Energy savings	21%
	Investment	↑1.9%
2	Energy savings	50%
	Investment	↑4.3%
3	Energy savings	64%
	Investment	↑5.8%



CLIMATE ZONE 4

Option		
1	Energy savings	22%
	Investment	↑2.8%
2	Energy savings	49%
	Investment	↑4.4%
3	Energy savings	64%
	Investment	↑7%

CLIMATE ZONE 5

Option		
1	Energy savings	21%
	Investment	↑2.3%
2	Energy savings	57%
	Investment	↑4.6%
3	Energy savings	64%
	Investment	↑10.4%

CLIMATE ZONE 6

Option		
1	Energy savings	27%
	Investment	↑3.7%
2	Energy savings	58%
	Investment	↑5.8%
3	Energy savings	68%
	Investment	↑12.1%

Option 1: Halfway to international standards

Option 2 Comparable to international standards

Option 3 Going further than international standards

Notes: The energy savings relate to the reduction in heating and cooling energy use compared to current insulation requirements.

The investment relates to the increase in the cost of construction and does not include the land costs.

TABLE 1.2: Summary of the analysis for each option for the level of insulation in housing and small buildings

Option	Direct costs in comparison to status quo
Status quo	The current minimum requirements were set in 2008. These levels are lower than other parts of the world with similar climates. There are ongoing operational costs to heat and cool homes with the current requirements. Inefficient use of energy puts unnecessary demand on the national grid and does not align with the current direction of the Government's Building for Climate Change objectives.
Option 1: Halfway to international standards	This represents the smallest level of change proposed versus the current minimum requirements and would still have a considerable lag behind other countries. With this option, there is no change proposed for Climate zone 1. For a typical single-storey 4 bedroom home, this option would reduce the heating and cooling energy use by 12% to 27% in Climate zones 2 to 6 over the life of the building with an upfront investment of 0.4% to 3.7% ($1,800 to $16,000)[(1)]. The design and construction requirements are achievable with existing building products and construction methods that are well established in New Zealand. A long transition period would not typically be necessary to adopt this option.
Option 2 Comparable to international standards	This option proposes to lift insulation levels to comparable international minimum requirements. This option achieves greater reductions in energy use than Option 1 and provides improvements for occupant comfort and health outcomes across the country. For a typical single-storey 4 bedroom home, this option would reduce the heating and cooling energy use by 36% to 58% in Climate zones 1 to 6 over the life of the building with an upfront investment of 3.2% to 5.8% ($15,000 to $25,000)[(1)]. The increase in required performance impacts the design and construction in the coldest parts of the country primarily for windows and walls. A longer transition period would be expected to adapt to the changes.
Option 3 Going further	This option introduces the greatest increase of minimum insulation levels and would exceed the insulation requirements of some other countries with comparable climates. This would achieve the greatest reduction in energy use of each of the options, along with the best improvements in occupant comfort. For a typical single-storey 4 bedroom home, this option would reduce the heating and cooling energy use by 46% to 68% in Climate zones 1 to 6 over the life of the building with an upfront investment of 4.1% to 12% ($19,000 to $50,000)[(1)]. Achieving the highest insulation requirements would require a change in direction from the current ways of designing and constructing buildings in New Zealand. Other methods of construction used overseas would be required. Other methods would also be required to achieve compliance with B1 Structure, E2 External moisture, E3 Internal moisture, and G4 Ventilation. A longer transition period and a phased approach to implement these changes would be expected so that MBIE could develop new acceptable solutions for these parts of the Building Code and for the building and construction sector in New Zealand to adapt to the changes.

Note:

(1) The range of increases considers regional variations in construction costs and the insulation levels for different climate zones. Construction costs are based on a single-storey four bedroom house, built as a light timber frame building designed to NZS 3604: 2011 "Timber framed buildings" on a concrete slab foundation using readily available insulation and construction products.

1.4.2. Objectives of the proposal

The primary objective of this proposal is to lift minimum levels of insulation to increase the energy efficiency of housing and small buildings. This contributes to achieving Objective H1.1 of the Building Code, Functional requirement H1.2(a) and Performance criteria H1.3(a). These clauses of the Building Code state:

Objective **H1.1** The objective of this provision is to facilitate efficient use of energy	**Limits on application** Objective H1.1 applies only when the energy is sourced from a *network utility operator* or a depletable energy resource.
Functional requirement **H1.2** Buildings must be constructed to achieve an adequate degree of energy efficiency when that energy is used for— (a) modifying temperature, modifying humidity, providing ventilation, or doing all or any of those things; or	Requirement H1.2(a) does not apply to *assembly service buildings*, *industrial buildings*, *outbuildings*, or *ancillary buildings*
Performance **H1.3** The *building* envelope enclosing spaces where the temperature or humidity (or both) are modified must be constructed to— (a) provide *adequate thermal resistance*	

In addition, it is intended that this change will provide a first step of the Building for Climate Change programme of work which will look at further measures to reduce emissions from both constructing and operating buildings.

1.4.3. Methodology and assumptions

To determine the R-value options, dynamic thermal modelling was undertaken. The computer modelling used standards assumptions for modelling specified in NZS 4218: 2009 “Thermal insulation - Housing and small buildings” with the exception of heating and cooling set points and schedules, which were defined as 18°C and 25°C respectively, 24 hours per day 365 days per year.

The computer modelling was first used to examine the heating and cooling energy use in 18 New Zealand climates zones identified by NIWA.[5] This was used to create the six climate zones in the proposal. Further thermal modelling examined the impact of a range of roof, window, external wall, and floor options on heating and cooling energy in order to determine the R-values.

Costs for construction materials are based on the use of *QV costbuilder*[6] which is a transparent online database. It should be noted that prices for construction materials may vary significantly in practice due to such things as discounts for the scale of construction.

[5] An overview of New Zealand’s climate is available online from NIWA here: https://niwa.co.nz/education-and-training/schools/resources/climate/overview
[6] QV costbuilder – Construction cost data is available from www.qvcostbuilder.co.nz

1.4.4. R-values of individual building elements

1.4.4.1. Roofs

The proposed options for roof insulation are provided in Table 1.3.

TABLE 1.3: Roof insulation – Proposed R-values for each option

Options	Climate zone					
	1					6
Status quo	R2.9		R2.9/3.3[1]		R3.3	
Option 1. Halfway to international standards	R2.9	R3.3↑		R3.7↑		R4.2↑
Option 2. Comparable to international standards	R5.0↑	R5.4↑	R6.0↑	R6.6↑	R7.0↑	R7.4↑
Option 3. Going further than international standards	R6.6↑	R7.0↑	R7.4↑	R7.8↑	R8.4↑	R9.0↑

Note:

(1) The proposed climate zones 3 and 4 include parts of the existing climate zones 2 and 3 which have slightly different R-value requirements for walls and roof. Therefore, two R-values are specified here for the 'Status quo'.

These R-values represent a range from one layer up to two layers of standard insulation. Analysis has shown that doubling roof insulation is a cost effective option throughout New Zealand. Options 2 and 3 reflect this by proposing insulation levels that are approximately twice current levels for Climate zones 1 to 4. In Climate zones 5 and 6, even higher levels of insulation are proposed to optimise heating and cooling energy efficiency for the colder winter temperatures in these regions.

In buildings with a roof space, the thicker roof insulation could generally be accommodated without any significant changes to the roof framing. However, where there are space restrictions, a thinner higher performing insulation material could be used along the edges of the roof space.

For skillion roofs or low-pitched roofs, achieving the increased roof R-values may require higher performing insulation products or potentially changes to the roof construction if using traditional insulation products. Currently, construction details in Acceptable Solution E2/AS1 do not provide solutions for 'warm roofs' that have an insulation layer above the roof framing to help achieve the higher insulation levels in skillion roofs.

1.4.4.2. Windows

The proposed options for windows are provided in Table 1.4.

TABLE 1.4: Windows – Proposed R-values for each option

Options	Climate zone					
	1					6
Status quo	R0.26					
Option 1. Halfway to international standards	R0.26	R0.29↑		R0.33↑		R0.39↑
Option 2. Comparable to international standards	R0.39↑	R0.42↑	R0.45↑	R0.49↑	R0.55↑	R0.62↑
Option 3. Going further than international standards	R0.48↑	R0.52↑	R0.55↑	R0.62↑	R0.68↑	R0.76↑

Because both the window frames and type of glass used can significantly affect the way a window performs, there are many options that can be used to achieve the proposed R-values. This includes higher performing double glazing and triple glazing windows. MBIE have proposed a range of R-values that would allow different materials to be used to achieve the right performance. Some examples of how these R-values can be achieved:

› R0.26 (status quo) is achievable using double glazing with standard clear glass in conventional window joinery.

› R0.39 to R0.55 is achievable with double glazing, but would usually require glass with a low emissivity (low E) coating and may also require upgrading aluminium joinery to include thermal breaks. Currently, the window and door details in Acceptable Solution E2/AS1 used for weathertightness compromise the thermal performance of some types of thermally broken aluminium joinery by allowing cold air to bypass the thermal breaks.

› R0.62 can be achieved with high-performance double glazing with a low emissivity (low E) coating and timber or uPVC joinery. It can also be achieved using an entry-level triple glazed window with thermally-broken aluminium joinery and glass that has a low emissivity (low E) coating.

› R0.76 is not easily achievable with aluminium joinery, but can be achieved using triple glazing in uPVC or timber joinery. Triple glazing will require additional structure to support the weight of windows in order to comply with Building Code clause B1 Structure.

1.4.4.3. Walls

The proposed options for wall insulation are provided in Table 1.5.

TABLE 1.5: Wall insulation – Proposed R-values for each option

Options	Climate zone					
	1	2	3	4	5	6
Status quo	R1.9		R1.9/2.0(1)		R2.0	
Option 1. Halfway to international standards	R1.9	R2.2↑			R2.4↑	
Option 2. Comparable to international standards	R2.4↑	R2.6↑	R2.8↑	R3.2↑	R3.5↑	R3.8↑
Option 3. Going further than international standards	R2.9↑	R3.2↑	R3.5↑	R3.8↑	R4.4↑	R5.0↑

Note:

(1) Each of the proposed new climate zones 3 and 4 include parts of the existing climate zones 2 and 3 which have slightly different R-value requirements for walls and roof. Therefore, two R-values are specified here for the 'Status quo'.

Some examples of how these R-values can be achieved:

› R1.9 and R2.0 (status quo) is achievable using standard 94 mm wall framing, with slightly better performing insulation products required for R2.0.

› R2.2 to R2.8 wall R-values could be achieved by increasing the wall thickness to accommodate thicker and better performing insulation. For example, the depth of the wall framing could be increased to 140 mm.

› R3.2 to R5.0 wall R-values may require additional changes to reduce cold bridging. For example, this could be achieved by placing additional insulation on the interior or exterior side of the framing, or by using a staggered stud wall system. Currently, design details in Acceptable Solution E2/AS1 do not provide solutions for 'warm walls' that have an additional insulation layer on the exterior side of the wall framing.

1.4.4.4. Underfloor insulation

The proposed options for underfloor insulation are provided in Table 1.6.

For these options, MBIE has considered a number of common construction types, but also included insulation levels that could be achieved using construction techniques that are common overseas.

TABLE 1.6: Underfloor insulation – Proposed R-values for each option

Options	Climate zone					
	1	2	3	4	5	6
Status quo	R1.3					
Option 1. Halfway to international standards	R1.3	R1.3	R1.9↑	R1.9↑	R2.2↑	
Option 2. Comparable to international standards	R1.9↑	R2.2↑	R2.5↑	R2.8↑	R3.2↑	R3.6↑
Option 3. Going further than international standards	R2.5↑	R2.8↑	R3.2↑	R3.6↑	R4.2↑	R4.8↑

Some examples of how these R-values can be achieved:

› R1.3 would not usually require concrete slabs on ground to be insulated, but would require suspended floors to have insulation.

› R1.9 could be achieved by insulating concrete slabs on ground either around their perimeter edge, or underneath.

› R2.2 to R4.8 floors would require concrete slabs on ground to be insulated both around their perimeter edge and above or underneath.

› For suspended floors, the R1.9 to R3.6 R-values would simply require higher performing insulation to be fitted, without any other construction changes.

› R3.6 to R4.8 could also be achieve using higher performing insulation products or alternative construction detailing.

1.4.4.5. Embedded heating systems – where building elements are specifically heated

The provisions in H1/AS1 and H1/VM1 also include specific requirements for building elements that include embedded heating systems (such as underfloor heating). The R-values for these elements are proposed to increase at a similar rate as standard roof, wall, and floors elements. The proposed options for building elements with embedded heating systems are provided in Table 1.7.

TABLE 1.7: Building elements with embedded heating systems – Proposed R-values for each option

Options	Building element	Climate zone					
		1					6
Status quo	Heated ceiling	R3.5			R4.0		
	Heated wall	R2.5			R2.6		
	Heated floor	R1.9					
Option 1. Halfway to international standards	Heated ceiling	R3.5	R4.0↑	R4.0↑	R4.4↑	R4.4↑	R5.0↑
	Heated wall	R2.5↑	R2.5↑	R2.9↑	R2.9↑	R2.9↑	R3.1↑
	Heated floor	R1.9↑	R1.9↑	R2.2↑	R2.8↑	R2.8↑	R3.2↑
Option 2. Comparable to international standards	Heated ceiling	R6.0↑	R6.5↑	R7.2↑	R7.9↑	R8.4↑	R8.9↑
	Heated wall	R3.1↑	R3.4↑	R3.6↑	R4.2↑	R4.6↑	R4.9↑
	Heated floor	R2.8↑	R3.2↑	R3.7↑	R4.1↑	R4.7↑	R5.3↑
Option 3. Going further than international standards	Heated ceiling	R7.9↑	R8.4↑	R8.9↑	R9.4↑	10.1↑	R10.8↑
	Heated wall	R3.8↑	R4.2↑	R4.6↑	R4.9↑	R5.7↑	R6.5↑
	Heated floor	R3.7↑	R4.1↑	R4.7↑	R5.3↑	R6.1↑	R7.0↑

1.4.5. Costs and benefits

The expected savings in heating and cooling energy and the associated investment in upfront construction for each zone are provided in Table 1.8. Compared to current insulation settings, upfront investments provide long term cost savings for heating and cooling energy for the life of the building and make it easier for New Zealanders to keep their homes warm, dry and healthy.

TABLE 1.8: Heating and cooling energy savings for each option and the associated investment in new buildings[1]

Options	Climate zone					
	1					6
Option 1. Halfway to international standards						
Ongoing annual energy savings	N/A[2]	12%	21%	22%	21%	27%
Upfront construction investment cost	N/A[2]	0.4% ($1,760)	1.9% ($8,400)	2.8% ($11,300)	2.3% ($10,700)	3.7% ($15,300)
Option 2. Comparable to international standards						
Ongoing annual energy savings	36%	41%	50%	49%	57%	58%
Upfront construction investment cost	3.2% ($14,700)	3.9% ($16,800)	4.3% ($18,700)	4.4% ($18,200)	4.6% ($21,400)	5.8% ($24,200)
Option 3. Going further than international standards						
Ongoing annual energy savings	46%	51%	64%	64%	64%	68%
Upfront construction investment cost	4.1% ($18,900)	4.7% ($20,500)	5.8% ($25,100)	7.0% ($28,700)	10.4% ($48,200)	12.1% ($50,100)

Notes:

(1) Energy savings and construction investment costs are based on currently available materials and construction methods. The costing model uses a single-storey four bedroom house, built as a light timber frame building designed to NZS 3604: 2011 "Timber framed buildings" on a concrete slab foundation. It is anticipated that as the supply of new materials increases and more efficient construction techniques are adopted these costs are likely to decrease.

(2) No change is proposed for Climate zone 1 with this option.

Investing in better quality buildings now will also come with wider benefits for the health and wellbeing of occupants over their lifetime. Some of these benefits and impacts are difficult to quantify and have been assessed qualitatively. MBIE expects that these changes will:

› Reduce health issues associated with cold homes by:
  - maintaining healthier temperatures inside houses
  - improving occupant thermal comfort as required by Building Code clause G5 Interior environment
  - reducing risk of condensation and mould growth on interior surfaces (including walls and windows) as required by Building Code clause E3 Internal moisture.

› Provide a lower environmental footprint by reducing the energy demand on the national grid.

› Encourage the building and construction sector to invest in new, more innovative materials and designs in order to meet the requirements.

› Decrease the costs of higher performing insulation products overtime as the market adjusts.

› Cause existing manufacturers or importers to diversify their offerings to meet the changes in the market needs. This may also lead to a shortage of higher performing products during the adjustment period.

In addition, the impacts of the changes go beyond H1 Energy Efficiency to other parts of the Building Code. The analysis of the proposed R-values has already included discussion of where designs may need to be altered to meet the requirements of B1 Structure and E2 External moisture. In practice, insulation levels require a balance between the temperature settings, fresh air ventilation, and moisture control. MBIE expects that the other parts of the Building Code that will be impacted from these changes include:

› G4 Ventilation – Increased significance of heat losses from infiltration and ventilation.

› E3 Internal moisture – Altered interstitial moisture conditions inside ceilings/roofs, walls, and floors and issues with thermal bridging of structural components (such as framing).

MBIE will investigate these issues and, where necessary based on the option selected, address these issues in future Building Code updates. A longer transition period (24 months or more) provides time to do that before the proposed H1 insulation changes come into effect.

1.4.6. Other changes within H1/AS1 and H1/VM1

To support options to change the insulation levels, there are a number of other changes to H1/AS1 and H1/VM1 as part of this proposal. These changes are required to maintain the consistency and clarity of the requirements for compliance and include:

› Issuing H1/AS1 and H1/VM1 as new editions with a revised introduction and document structure.

› Limiting the scope of H1/AS1 and H1/VM1 to housing and small buildings and issuing a new Acceptable Solution H1/AS2 and Verification Method H1/VM2 for large buildings. Details of H1/AS2 and H1/VM2 are discussed in Proposal 2. The proposed scope of buildings covered by H1/AS1 and H1/VM1 aligns with the existing compliance pathway and requirements found in NZS 4218: 2009 "Thermal insulation – Housing and small buildings".

› Incorporating the relevant requirements from NZS 4218: 2009 "Thermal insulation – Housing and small buildings" directly into H1/AS1 and H1/VM1 and remove the reference of this standard from these documents. This change is required to provide a clear and consistent document and limit the number of modifications that would be required in the citation of the standard in order to adopt the new climate zones and minimum insulation levels. Permission has been obtained from Standards New Zealand to use the content from the standard.

› Removing two existing MBIE guidance documents published in 2008:

- Building Code requirements for house insulation
- Complying with insulation requirements for houses in Northland

These guidance documents refer to the existing performance settings and climate zones and would be superseded by the introduction of the new requirements. The removal of these documents and timing is dependent on the option and the transition period.

› Making editorial changes throughout the document in order to provide consistency and clarity on the application of the requirements.

In addition, it is also proposed to remove the separate minimum insulation levels for high mass walls such as solid timber, concrete or masonry from the acceptable solution. The extent to which high mass walls can help reduce the amount of heating and cooling energy required to maintain comfortable indoor temperatures depends on a number of factors. For example, the density and thickness of the materials that the walls are made from, the size of these walls, whether the insulation is placed on the interior or exterior side of the walls and the extent to which the interior surfaces of the high mass walls are exposed to direct sunlight. Thus, the energy efficiency benefits of homes and buildings with high mass walls are best assessed through computer thermal modelling. Verification Method H1/VM1 provides a better and fairer way to determine how much insulation is required for these types of buildings. Designers of buildings with high mass walls would still have the option of using the simpler compliance methods of H1/AS1 but without any special treatment of buildings with high mass walls.

No other reasonable options were identified for these changes besides maintaining the status quo. The costs and benefits of the changes have been assessed qualitatively. MBIE expects that, in conjunction with the changes to the performance level of insulation, that these changes will provide more consistency and clarity in the understanding and interpretation of the acceptable solution and verification methods. No additional significant impacts or costs have been identified for these changes. In this case, the benefits of the changes exceed the costs.

1.5. Transitions

MBIE does not have a recommended transition period for this proposal and, as part of this consultation, is seeking feedback to establish how fast to adopt new minimum requirements and how they might be progressively phased in. There are three proposed transition periods:

› **Option A. 12 months** – Effective date: 4 November 2021, Cessation date: 3 November 2022

› **Option B. 24 months** – Effective date: 4 November 2021, Cessation date: 2 November 2023

› **Option C. 36 months or more** – Effective date: 4 November 2021, Cessation date: 7 November 2024 or later

Some reasons for a longer or shorter transition period may include:

› the desire for change and demand for higher performing housing and buildings in New Zealand

› the extent of the change (whether Option 1, 2, or 3 for the minimum insulation levels is preferred)

› the ability of the building and construction sector to adapt to other methods of design and construction

› the consequential impacts on other parts of the Building Code (such as E2 External moisture and E3 Internal moisture) and the time required to resolve these issues.

Based on the option for a transitional arrangement selected, existing Acceptable Solution H1/AS1 and Verification Method H1/VM1 will remain in force until the proposed cessation date as shown in Table 1.9.

TABLE 1.9: Proposed transitional arrangements for Acceptable Solution H1/AS1 and Verification Method H1/VM1

Document	Before 4 November 2021	From the effective date To the cessation date
Existing Acceptable Solutions and Verification Methods	If used, will be treated as complying with the Building Code	If used, will be treated as complying with the Building Code
Amended Acceptable Solutions and Verification Methods	Does not apply to Building Consents issued before this date	If used, will be treated as complying with the Building Code

1.6. Questions for the consultation

1-1. Which option do you prefer?

☐ Status quo

☐ Option 1. Halfway to international standards

☐ Option 2. Comparable to international standards

☐ Option 3. Going further than international standards

1-2. For your preferred option, how quickly should this change come into effect?

☐ 12 months

☐ 24 months

☐ 36 months or more

☐ No preference

1-3. If there are factors we should consider to progressively phase in your preferred option, please tell us. These factors may include material availability or affordability, regional differences in the requirements, different building typologies or other considerations.

1-4. Do you support issuing the new editions of H1/AS1 and H1/VM1 as proposed?

1-5. What impacts would you expect on you or your business from the proposed options? These impacts may be economic/financial, environmental, health and wellbeing, or other areas.

1-6. Is there any support that you or your business would need to implement the proposed changes if introduced?

2. Energy efficiency for large buildings

To make buildings warmer, drier, healthier and more energy efficient, we are proposing to increase the minimum insulation levels for roof, windows, walls and floors for large buildings. The proposed minimum insulation levels will vary so that buildings in the coldest parts of New Zealand will need more insulation than those in the warmest parts.

2.1. Reasons for the change

Buildings need to have adequate insulation in roofs, windows, walls and floors to keep people warm, dry and healthy and to make sure that energy is being used efficiently. Insulation can make it easier to heat a building in the winter and cool a building in the summer helping to reduce the amount of energy used in all parts of the country.

In past consultations, MBIE has heard that the existing insulation values are too low and have not keep pace with other parts of the world with similar climates. The current requirements for the minimum thermal insulation in large buildings in New Zealand have not been updated since 1996 and lag behind other countries with similar climates. While the energy use of a large building has been decreasing annually by 0.5% to 1% over the last decade, this is offset by the increases in the size of buildings which have gone up by 2.5% per year in the same time period.[7] This puts unnecessary demand on the electricity grid and creates avoidable greenhouse gas emissions.

The existing requirements divide the country into three climate zones. These zones attempt to group similar weather and temperatures together and are used to set how much insulation is required for a building in each zone. Yet, New Zealand has diverse climates – from subtropic in Northland to sub Antarctic in Invercargill. The current climate zones are too simple. For example, currently the South Island is only one climate zone which means a building in Nelson need only have the same amount of insulation as one in Queenstown. New Zealanders experience different weather and temperatures depending on where they live and the requirements need to better reflect this.

The New Zealand Government's response to climate change works on ways to cut emissions and adapt to the effects of climate change that are coming. Increasing the level of insulation in buildings represents the first step in the Building for Climate Change programme of work which will continue to transform housing and construction in New Zealand.

It is now time to demand a higher level of energy efficiency from our buildings and increase the minimum levels of insulation. Help us prepare for what will be needed as part of a wider response to climate change and ensure new buildings in New Zealand and reduce their energy demand on the national grid.

2.2. Proposed changes

It is proposed to issue a new Acceptable Solution H1/AS2 and Verification Method H1/VM2 to:

› Lift minimum levels of insulation for large buildings[8] to make them more comfortable and easier to heat and cool.

› Introduce a new climate zone map to better recognise variations in climate around New Zealand, and reflect this in the proposed requirements.

› Provide a clear compliance pathway for these buildings by separating the requirements for large buildings into their own acceptable solution and verification method.

[7] IEA, "Tracking Buildings 2020", June 2020. Available online from: https://www.iea.org/reports/tracking-buildings-2020

[8] A large building is defined with the applicable requirements as those with an occupied space of 300 m^2. However, housing of any size (including multi-unit apartment buildings) are covered in Proposal 1.

The proposed new editions of Acceptable Solution H1/AS2 and Verification Method H1/VM2 in the new document format are provided in Appendix A.

2.3. Options

2.3.1. Performance level

MBIE has considered three options to increase the minimum thermal insulation against the status quo:

› **Option 1. 10% reduction in energy use for heating and cooling** – Increase the minimum level of insulation to a level that results in an approximate 10% reduction in the total energy required to heat and cool buildings. This represents the smallest level of change proposed versus the current minimum settings and would still have a considerable lag behind other countries.

› **Option 2. 20% reduction in energy use for heating and cooling** – Increase the minimum level of insulation to a level that results in an approximate 20% reduction in the total energy required to heat and cool buildings. This option is a more assertive step towards reducing energy use in buildings. A 20% reduction represents the largest reduction that can be made while still using conventional design and construction methods. However, it is still below the level of insulation and energy efficiency required in other countries.

› **Option 3. 25% reduction in energy use for heating and cooling** – Increase the minimum level of insulation to a level that results in an approximate 25% reduction in the total energy required to heat and cool buildings. This would result in insulation levels that are comparable to other parts of the world with similar climates and will likely require adoption of other construction methods that are not common in New Zealand.

For this proposal, MBIE does not have a recommended option and, as part of this consultation, is seeking feedback to establish how far you want these changes to go, how fast to adopt new minimum requirements and how we might progressively phase in any changes. Option 1 and 2 are more like to be feasible for shorter term changes while Option 3 is likely to require more consideration on phases for a progressive approach.

Each level of change comes with its own costs and benefits. Better insulation in buildings is expected to save on the energy required to heat and cool a building throughout its life and result in lower power bills. It is also expected that this will require additional investment in the upfront cost of construction for new buildings. MBIE have taken this into consideration when formulating the options and are targeting higher requirements in the areas of the country that will receive the most benefit.

Further analysis of the options is provided in Section 1.4.

2.3.2. Climate zones

A discussion of the existing and new climate zones that form part of this proposal is provided in Proposal 1 in Subsection 1.3.2.

It is proposed that the requirements for large buildings use the same six climate zones as those for housing and small buildings in order to provide consistency and clarity on the application of the requirements.

Further details of which region sits in which zone is provided in a table of values in the new proposed H1/AS2 and H1/VM2 in Appendix A.

2.3.3. Insulation levels for different building elements

Compared to housing and small buildings, larger buildings require more active cooling in summer to maintain comfortable indoor temperatures, while also still requiring heating in winter. As well, for larger buildings the relative importance of different building elements for controlling heat gains and losses greatly depends on the individual geometry and orientation of a building. For example, high-rise buildings have large external wall and window areas and are sensitive to the heat gains and losses through these elements. On the other hand, large single-storey retail stores require more consideration of the roof insulation.

Windows have a much lower thermal performance than insulated roofs, walls, or floors. Windows also allow a building to heat up in the summer through solar gain. The performance of windows can significantly affect the energy performance of a building. Similarly, different floor types will perform differently depending on how they are constructed. For example, concrete slab foundations and pile foundations lose heat in different ways. To achieve adequate thermal performance of an entire building, consideration of the insulation value of all of these buildings elements is required to achieve the right balance.

The effectiveness of thermal insulation is measured in terms of thermal resistance or R-values (measured in $m^2 \cdot K/W$). The R-values for each option are shown in the graphs for:

› Roof insulation in Figure 2.1A
› Windows in Figure 2.1B
› Wall insulation in Figure 2.1C
› Underfloor insulation in Figure 2.1D

These graphs include a comparison to other parts of the world that have similar climates to New Zealand.[9] For this comparison,

› Climate zone 1 (Auckland) is similar to Adelaide, Australia
› Climate zone 2 (Napier) is similar to Melbourne, Australia and Santa Maria, California
› Climate zone 3 (Wellington) is similar to Hobart, Australia
› Climate zone 4 is similar to Canberra, Australia
› Climate zone 5 (Christchurch) is similar to London, England
› Climate zone 6 (Queenstown) is similar to Dublin, Ireland
› Cardiff, Wales sits between Christchurch (Climate Zone 5) and Queenstown (Climate zone 6)

Further analysis of the R-values for each building element and the costs and benefits of these options is provided in Section 2.4.

[9] For this proposal, the similarity in climates was determined based on a comparison of the heating degree days and cooling degree days. The heating degree day is calculated by number of days the region has temperature below 18°C x the degrees below 18°C. Similarly, cooling degree day is calculated based on the number of days with a temperature above 18°C.

FIGURE 2.1A: Roof insulation – Proposed options compared to other parts of the world

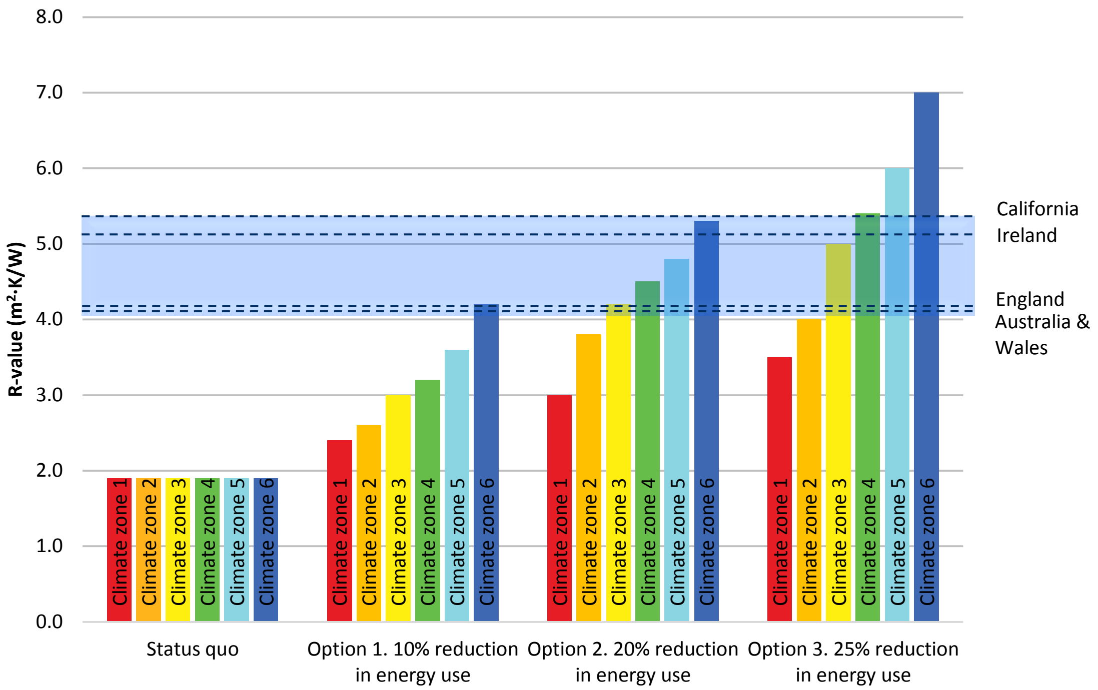
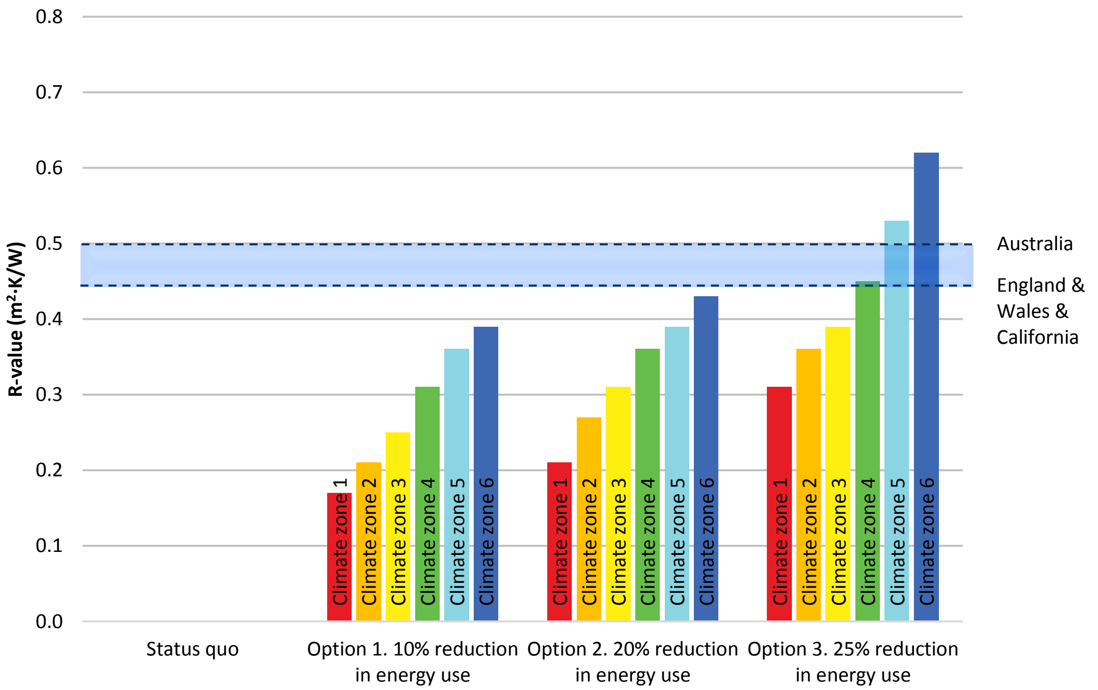


FIGURE 2.1B: Windows – Proposed options compared to other parts of the world



Note: There is currently no minimum requirement for the thermal performance of windows.

FIGURE 2.1C: Wall insulation – Proposed options compared to other parts of the world

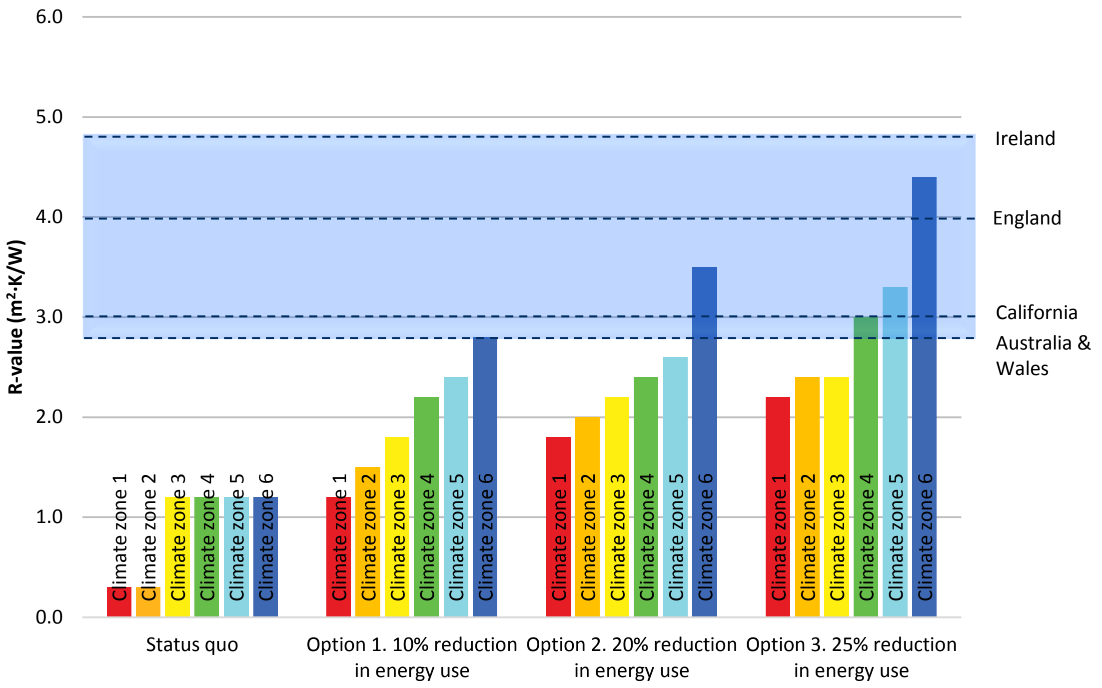
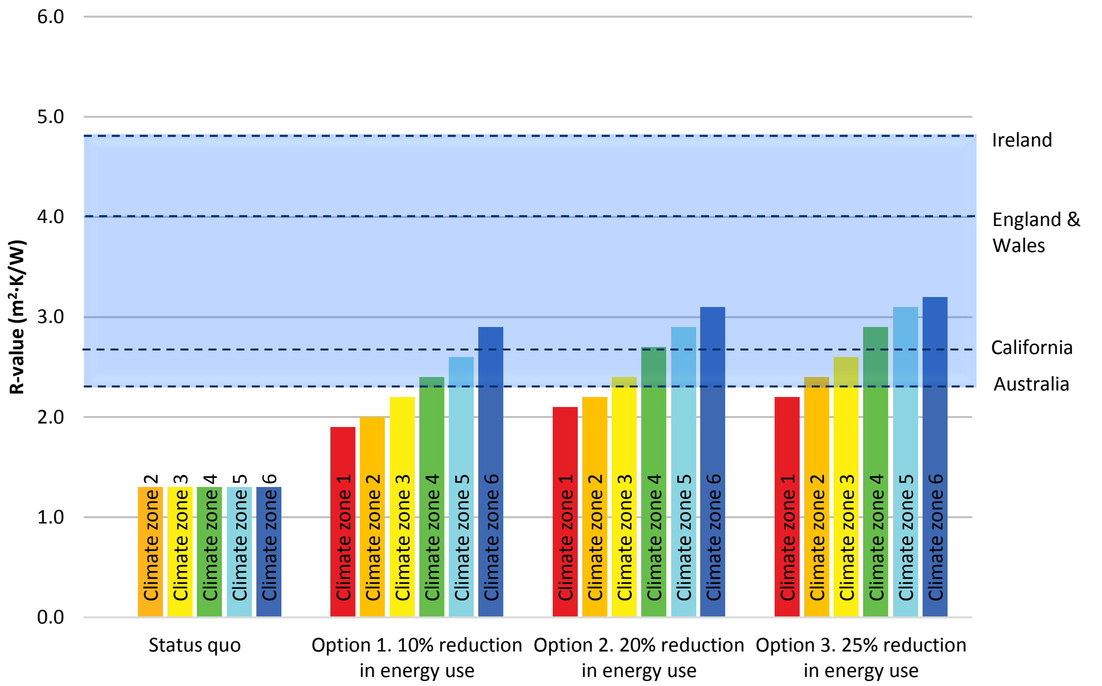


FIGURE 2.1D: Underfloor insulation – Proposed options compared to other parts of the world



Note: There is currently no minimum requirement for Climate zone 1 and 2.

2.4. Analysis of the options

2.4.1. Summary of the analysis

A summary of the analysis is provided in Table 2.1.

Further details of the analysis is provided in the following sections.

TABLE 2.1: Summary of the analysis for each option for the level of insulation in large buildings

Option	Direct costs in comparison to status quo
Status quo	The current minimum requirements were set in the mid 1990s. These levels are lower than other parts of the world with similar climates. Inefficient use of energy puts unnecessary demand on the national grid and does not align with the current direction of the Government's Building for Climate Change objectives.
Option 1. 10% reduction in energy use for heating and cooling	This represents the smallest level of change proposed versus the current minimum requirements and is still considerably lower than other parts of the world with similar climates. To achieve a 10% reduction in energy use to heat and cool buildings, this option would require an upfront investment of 2% to 8% (\$26 to \$105/m^2) for a typical retail building[(1)]. The requirements proposed under this option are achievable with existing building products and construction methods that are well established in New Zealand. A long transition period would not typically be necessary to adopt this option.
Option 2. 20% reduction in energy use for heating and cooling	This option achieves more significant reductions in heating and cooling demand and makes noticeable improvements in occupant comfort and running costs. However, the insulation levels for this option are still below the minimum requirements in other countries with similar climates. To achieve a 20% reduction in energy use to heat and cool buildings, this option would require an upfront investment of 3% to 15% (\$50 to \$215/m^2) for a typical retail building[(1)]. As such, the requirements are achievable with existing building products and construction methods in this country. A long transition period would not typically be necessary to adopt this option.
Option 3. 25% reduction in energy use for heating and cooling	This option proposes to lift insulation levels to those comparable with international minimum requirements. This would achieve greater reductions in heating and cooling demand and make good improvements in occupant comfort and optimise operational efficiencies and running costs. To achieve a 25% reduction in energy use to heat and cool buildings, this option would require an upfront investment of 5% to 27% (\$76 to \$381/m^2) for a typical retail building[(1)]. The increase in required performance may require an adjustment of the existing design and construction methods used in New Zealand. A longer transition period and a phased approach to implement these changes would be expected to adapt to these changes.

Note:

(1) The range of increases considers regional variations in construction costs and the insulation levels for different climate zones. Construction costs are based on a typical retail supermarket building. Retail buildings represent the largest percentage of the building types considered in this proposal. The costs are averaged across the floor area to get the \$/m^2 rate. Other configurations may have slightly different cost increases.

2.4.2. Objectives of the proposal

The primary objective of this proposal is to lift minimum levels of insulation to make buildings more comfortable, easier and more affordable to heat and cool consistently to healthy and comfortable levels, and use less energy. This contributes to achieving Objective H1.1 of the Building Code, Functional requirement H1.2(a) and Performance criteria H1.3(a). These clauses of the Building Code state:

Objective		**Limits on application**
H1.1	The objective of this provision is to facilitate efficient use of energy	Objective H1.1 applies only when the energy is sourced from a *network utility operator* or a depletable energy resource.
Functional requirement		
H1.2	Buildings must be constructed to achieve an adequate degree of energy efficiency when that energy is used for— (a) modifying temperature, modifying humidity, providing ventilation, or doing all or any of those things; or	Requirement H1.2(a) does not apply to *assembly service buildings*, *industrial buildings*, *outbuildings*, or *ancillary buildings*
Performance		
H1.3	The *building* envelope enclosing spaces where the temperature or humidity (or both) are modified must be constructed to— (a) provide *adequate thermal resistance*	

In addition, it is intended that this change will provide a first step in the Building for Climate Change programme of work which will look at further measures to reduce emissions from both constructing and operating buildings.

2.4.3. Methodology and assumptions

To analyse the R-value options, dynamic thermal modelling of representative example buildings was undertaken for four building types representing different building typologies and different energy use profiles. Different typologies are used to determine the sensitivity of the analysis so that the final results were representative of a wide variety of structures. These representative dwelling types included:

- › **Office** – A 5 storey mid-rise office building. It is tall and narrow and has a large proportion of facade to footprint and therefore greater energy losses. The office was assumed to be only occupied during normal working hours during the day.
- › **Retail** – A single storey big box retail store with a large footprint. With this configuration, the heat losses through the roof become more significant.
- › **School** – A single storey school with group classrooms. Like offices, a school is only occupied during a short portion of the day.
- › **Healthcare** – A 2 storey low-rise building with clinics occupied 24/7. Healthcare facilities have higher energy demands.

The computer modelling used standards assumptions for modelling specified in NZS 4243.1: 2007. Heating and cooling setpoints were defined as 21°C and 23°C respectively during occupied hours (except for schools).

Dynamic thermal modelling of these building types was first used to examine the heating and cooling energy use in 18 New Zealand climates zones identified by NIWA.[10] This was used to create the six climate zones in the proposal. Further thermal modelling examined the impact of a range of roof, window, external wall, and floor options on heating and cooling energy in order to determine the R-values. Although the heating load dominated the research undertaken for large buildings, cooling loads have also been considered in the options.

[10] An overview of New Zealand's climate is available online from NIWA here: https://niwa.co.nz/education-and-training/schools/resources/climate/overview

Costs for construction materials are based on quantity surveyor estimates. Finished building costs on a per meter-squared basis are based on values from *QV costbuilder*[11] which is a transparent online database. It should be noted that prices for construction materials may vary in practice due to such things as discounts for the scale of construction.

2.4.4. R-values of Individual building elements

2.4.4.1. Roofs

The proposed options for roof insulation are provided in Table 2.2.

TABLE 2.2: Roof insulation – Proposed R-values for each option

Options	Climate zone					
	1					6
	R1.9					
	R2.4↑	R2.6↑	R3.0↑	R3.2↑	R3.6↑	R4.2↑
	R3.0↑	R3.8↑	R4.2↑	R4.5↑	R4.8↑	R5.3↑
	R3.5↑	R4.0↑	R5.0↑	R5.4↑	R6.0↑	R7.0↑

In buildings with a roof space, the thicker roof insulation could generally be accommodated without any significant changes to the roof framing. However, where there are space restrictions, a thinner higher performing insulation material could be used along the edges of the roof space.

For skillion roofs or low-pitched roofs, achieving the increased roof R-values may require higher performing insulation products or potentially changes to the roof construction if using traditional insulation products.

2.4.4.2. Windows

The proposed options for windows are provided in Table 2.3.

TABLE 2.3: Windows – Proposed R-values for each option

Options	Climate zone					
	1					6
Status quo	0.0(1)					
Option 1. 10% reduction in energy use for heating and cooling	R0.17↑	R0.21↑	R0.25↑	R0.31↑	R0.36↑	R0.39↑
Option 2. 20% reduction in energy use for heating and cooling	R0.21↑	R0.27↑	R0.31↑	R0.36↑	R0.39↑	R0.43↑
Option 3. 25% reduction in energy use for heating and cooling	R0.31↑	R0.36↑	R0.39↑	R0.45↑	R0.53↑	R0.62↑

Note: (1) There is currently no minimum requirement for the thermal performance of windows.

Because both the window frames and type of glass used can significantly affect the way a window performs, there are many options that can be used to achieve the proposed R-values. This includes higher performing double glazing and high efficiency triple glazing windows. MBIE have proposed a range of R-values that would allow different materials to be used to achieve the right performance.

[11] QV costbuilder – Construction cost data is available from www.qvcostbuilder.co.nz

2.4.4.3. Walls

The proposed options for wall insulation are provided in Table 2.4.

TABLE 2.4: Wall insulation – Proposed R-values for each option

Options	Climate zone					
	1	2	3	4	5	6
Status quo	R0.3/R1.2[(1)]	R1.2				
Option 1. 10% reduction in energy use for heating and cooling	1.2↑	1.5↑	1.8↑	2.2↑	2.4↑	2.8↑
Option 2. 20% reduction in energy use for heating and cooling	1.8↑	2.0↑	2.2↑	2.4↑	2.6↑	3.5↑
Option 3. 25% reduction in energy use for heating and cooling	2.2↑	2.4↑	2.7↑	3.0↑	3.3↑	4.4↑

Note:

(1) The proposed new climate zone 1 include parts of the existing climate zones 1 and 2 which have different R-value requirements for walls and floors. Therefore, two R-values are specified here for the 'Status quo'.

2.4.4.4. Underfloor insulation

The proposed options for underfloor insulation are provided in Table 2.5.

TABLE 2.5: Underfloor insulation – Proposed R-values for each option

Options	Climate zone					
	1	2	3	4	5	6
Status quo	0.0/R1.3[(1)]		R1.3			
Option 1. 10% reduction in energy use for heating and cooling	1.9↑	2.0↑	2.2↑	2.4↑	2.6↑	2.9↑
Option 2. 20% reduction in energy use for heating and cooling	2.1↑	2.2↑	2.4↑	2.7↑	2.9↑	3.1↑
Option 3. 25% reduction in energy use for heating and cooling	2.2↑	2.4↑	2.6↑	2.9↑	3.1↑	3.2↑

Note:

(1) The proposed new climate zone 1 include parts of the existing climate zones 1 and 2 which have different R-value requirements for walls and floors. Therefore, two R-values are specified here for the 'Status quo'.

2.4.4.5. Embedded heating systems – where building elements are specifically heated

The provisions in H1/AS2 and H1/VM2 also include specific requirements for building elements that include embedded heating systems (such as underfloor heating). The R-values for these elements are proposed to increase at a similar rate as standard roof, wall, and floors elements. The proposed options for building elements with embedded heating systems are provided in Table 2.6.

TABLE 2.6: Building elements with embedded heating systems – Proposed R-values for each option

Options	Building element	Climate zone					
		1					6
Status quo	Heated roof	R3.0					
	Heated wall	R2.2					
	Heated floor	R1.7					
Option 1. 10% reduction in energy use for heating and cooling	Heated roof	R3.6↑	R3.9↑	R4.5↑	R4.8↑	R5.4↑	R6.3↑
	Heated wall	R1.8↑	R2.3↑	R2.7↑	R3.3↑	R3.6↑	R4.2↑
	Heated floor	R2.9↑	R3.0↑	R3.3↑	R3.6↑	R3.9↑	R4.4↑
Option 2. 10% reduction in energy use for heating and cooling	Heated roof	R4.5↑	R5.7↑	R6.3↑	R6.8↑	R7.2↑	R8.0↑
	Heated wall	R2.7↑	R3.0↑	R3.3↑	R3.6↑	R3.9↑	R5.3↑
	Heated floor	R3.2↑	R3.3↑	R3.6↑	R4.1↑	R4.4↑	R4.7↑
Option 3. 25% reduction in energy use for heating and cooling	Heated roof	R5.3↑	R6.0↑	R7.5↑	R8.1↑	R9.0↑	R10.5↑
	Heated wall	R3.3↑	R3.6↑	R4.1↑	R4.5↑	R5.0↑	R6.6↑
	Heated floor	R3.3↑	R3.6↑	R3.9↑	R4.4↑	R5.0↑	R4.8↑

2.4.5. Costs and benefits

The expected savings in heating and cooling energy and the associated investment in upfront construction for each zone are provided in Table 2.7. Compared to current insulation settings, upfront investments provide long term cost savings for heating and cooling energy for the life of the building.

Investing in better quality buildings now will come with wider benefits for the health and wellbeing of occupants over their lifetime. Some of these benefits and impacts are difficult to quantify and have been assessed qualitatively. MBIE expects that these changes will:

› Reduce health issues associated with cold buildings by
  - maintaining healthier temperatures inside buildings
  - improving occupant thermal comfort as required by Building Code clause G5 Interior environment
  - reducing risk of condensation and mould growth on interior surfaces (including walls and windows) as required by Building Code clause E3 Internal moisture.

› Provide a lower environmental footprint by reducing the energy demand on the national grid.

› Encourage the building and construction sector to invest in new, more innovative materials and designs in order to meet the requirements.

› Decrease the costs of higher performing insulation products and construction methods overtime as the market adjusts.

› Encourage existing manufacturers or importers to diversify their offerings to meet the changes in the market needs. This may also lead to a shortage of higher performing products during the adjustment period.

In addition, the impacts of the changes go beyond H1 Energy Efficiency to other parts of the Building Code. The analysis of the proposed R-values has already included discussion of where designs may need to be altered to meet the requirements of B1 Structure and E2 External moisture. In practice, insulation levels require a balance between the temperature settings, fresh air ventilation, and moisture control. MBIE expects that the other parts of the Building Code that will be impacted from these changes include:

› G4 Ventilation – Increased significance of heat losses from infiltration and ventilation

› E3 Internal moisture – Altered interstitial moisture conditions inside ceilings/roofs, walls, and floors and issues with thermal bridging of structural components (such as framing).

MBIE will investigate these issues and, where necessary based on the option selected, address these issues in future Building Code updates. A longer transition period (24 months or more) provides time to do that before the proposed H1 insulation changes come into effect.

TABLE 2.7: Increases in construction costs for the proposed options for different building types

Building type	Climate zone					
	1					6
Option 1. 10% reduction in energy use for heating and cooling – Increases in construction costs[1]						
Office – A 5 storey mid-rise office building	0.4% ($8/m²)	2.0% ($39/m²)	2.4% ($48/m²)	4.3% ($87/m²)	5.3% ($120/m²)	6.8% ($140/m²)
Retail – A single storey big box retail store with a large footprint	1.7% ($26/m²)	3.3% ($45/m²)	3.6% ($50/m²)	5.3% ($75/m²)	6.2% ($97/m²)	7.5% ($110/m²)
School – A single storey school with group classrooms	0.9% ($30/m²)	2.8% ($82/m²)	3.4% ($98/m²)	5.7% ($170/m²)	8.1% ($230/m²)	8.7% ($250/m²)
Healthcare – A 3 storey low-rise building with clinics occupied 24/7	0.3% ($15/m²)	1.0% ($41/m²)	1.2% ($48/m²)	1.9% ($81/m²)	2.5% ($110/m²)	3.0% ($120/m²)
Option 2. 20% reduction in energy use for heating and cooling – Increases in construction costs[1]						
Office – A 5 storey mid-rise office building	2.1% ($48/m²)	2.4% ($49/m²)	4.3% ($87/m²)	7.1% ($140/m²)	6.3% ($140/m²)	8.2% ($160/m²)
Retail – A single storey big box retail store with a large footprint	3.3% ($50/m²)	3.9% ($54/m²)	5.5% ($76/m²)	14% ($200/m²)	13% ($200/m²)	15% ($220/m²)
School – A single storey school with group classrooms	2.9% ($98/m²)	3.5% ($100/m²)	5.7% ($170/m²)	11% ($330/m²)	12% ($330/m²)	13% ($370/m²)
Healthcare – A 3 storey low-rise building with clinics occupied 24/7	1.1% ($48/m²)	1.2% ($50/m²)	2.0% ($81/m²)	3.9% ($160/m²)	3.6% ($160/m²)	4.5% ($180/m²)
Option 3. 25% reduction in energy use for heating and cooling – Increases in construction costs[1]						
Office – A 5 storey mid-rise office building	3.9% ($87/m²)	6.1% ($120/m²)	7.7% ($160/m²)	7.7% ($160/m²)	11% ($260/m²)	14% ($280/m²)
Retail – A single storey big box retail store with a large footprint	5.0% ($76/m²)	7.1% ($98/m²)	15% ($210/m²)	15% ($210/m²)	20% ($320/m²)	27% ($380/m²)
School – A single storey school with group classrooms	4.9% ($170/m²)	7.8% ($230/m²)	12% ($350/m²)	12% ($350/m²)	20% ($560/m²)	21% ($630/m²)
Healthcare – A 3 storey low-rise building with clinics occupied 24/7	1.8% ($81/m²)	2.7% ($110/m²)	4.3% ($170/m²)	4.1% ($170/m²)	6.1% ($27/m²)	7.7% ($310/m²)

Note:

(2) Construction costs are based on a typical building and averaged across the floor area to get the $/m² rate. Other configurations may have slightly different cost increases.

2.4.6. Other changes within H1/AS2 and H1/VM2

To support the changes to the insulation level, there are other new items for H1/AS2 and H1/VM2 as part of this proposal. These changes are required to maintain the consistency and clarity of the requirements for compliance and includes:

› Incorporating the relevant requirements from NZS 4243.1:2007 "Energy efficiency – Large buildings – Part 1 Building thermal envelope" directly into H1/AS2 and H1/VM2 and remove the reference of this standard from these documents. This change is required in order to limit the number of modifications that would be required in the citation of the standard in order to adopt the new climate zones and minimum insulation levels. Permission has been obtained from Standards New Zealand to use the content from the standard

› Making editorial changes to the existing text found in H1/AS1, H1/VM1, and NZS 4243.1 throughout the document in order to provide consistency and clarity on the applications of the requirements.

No other reasonable options were identified for these changes besides maintaining the status quo. The costs and benefits of the changes have been assessed qualitatively. MBIE expects that, in conjunction with the changes to the performance level of insulation, these changes will provide more consistency and clarity in the understanding and interpretation of the acceptable solution and verification method. No additional significant impact or costs have been identified for these changes. In this case, the benefits of the change exceed the costs.

2.5. Transitions

MBIE does not have a recommended transition period for this proposal and, as part of this consultation, is seeking feedback to establish how fast to adopt new minimum requirements and how they might be progressively phased in. There are three proposed transition periods:

› **Option A. 12 months** – Effective date: 4 November 2021, Cessation date: 3 November 2022

› **Option B. 24 months** – Effective date: 4 November 2021, Cessation date: 2 November 2023

› **Option C. 36 months or more** – Effective date: 4 November 2021, Cessation date: 7 November 2024 or later

Some reasons for a longer or shorter transition period may include:

› the desire for change and demand for higher performing buildings in New Zealand

› the extent of the change (whether Option 1, 2, or 3 for the minimum insulation levels is preferred)

› the ability of the building and construction sector to adapt to other methods of design and construction

› the consequential impacts on other parts of the Building Code (such as E2 External moisture and E3 Internal moisture) and the time required to resolve these issues.

Based on the option for a transitional arrangement selected, the existing Acceptable Solution H1/AS1 and Verification Method H1/VM1 will remain in force until the proposed cessation date as shown in Table 2.8.

TABLE 2.8: Proposed transitional arrangements for Acceptable Solution H1/AS2 and Verification Method H1/VM2

Document	Before 4 November 2021	From the effective date To the cessation date
Existing Acceptable Solutions and Verification Methods	If used, will be treated as complying with the Building Code	If used, will be treated as complying with the Building Code
New Acceptable Solutions and Verification Methods	Does not apply to Building Consents issued before this date.	If used, will be treated as complying with the Building Code

2.6. Questions for the consultation

2-1. Which option do you prefer?

- ☐ Status quo
- ☐ Option 1. 10% reduction in energy use for heating and cooling
- ☐ Option 2. 20% reduction in energy use for heating and cooling
- ☐ Option 3. 25% reduction in energy use for heating and cooling

2-2. For your preferred option, how quickly should this change come into effect?

- ☐ 12 months
- ☐ 24 months
- ☐ 36 months or more
- ☐ No preference

2-3. If there are factors we should consider to progressively phase in your preferred option, please tell us. These factors may include material availability or affordability, regional differences in the requirements, different building typologies or other considerations.

2-4. Do you support issuing the new editions of H1/AS2 and H1/VM2 as proposed?

2-5. What impacts would you expect on you or your business from the proposed options? These impacts may be economic/financial, environmental, health and wellbeing, or other areas.

2-6. Is there any support that you or your business would need to implement the proposed changes if introduced?

3. Energy efficiency for heating, ventilation and air conditioning (HVAC) systems in commercial buildings

Currently, there is no acceptable solution or verification method issued for the energy efficiency of heating, ventilation and air conditioning (HVAC) systems in commercial buildings (Clause H1.3.6 of the Building Code). We are proposing to issue a new Verification Method H1/VM3 will establish a baseline and standardised procedures that will help building designers and building consent authorities demonstrate and verify the compliance of this clause.

3.1. Reasons for the change

There is currently no acceptable solution or verification method to demonstrate compliance with H1.3.6. This clause requires HVAC systems in commercial buildings to be located, constructed, installed and able to be maintained to limit energy use. HVAC systems in commercial buildings modify temperature, modify humidity, and provide ventilation (or any combination of those as required by the intended use of the space). HVAC systems are one of the biggest energy users in commercial buildings and have a significant impact on a building's greenhouse gas emissions and energy costs. Improving the energy efficiency of HVAC systems can also improve New Zealand's energy resilience and reduce the need for electricity infrastructure upgrades.

MBIE issued guidance in 2009 to assist with demonstrating compliance with clause H1.3.6 on an alternative solution basis.[12] The existing guidance is not mandatory for people to use or for building consent authorities to accept and it is now out of date. As such, it does not provide a clear pathway for demonstrating compliance for a building consent application. This can cause confusion on what a suitably energy efficient design looks like and has resulted in inconsistencies in the level of performance for different buildings. A solution is required to address this.

MBIE is looking at steps that can be taken now in the Building Code that will align with future objectives and initiatives of the Building for Climate Change.[13] Establishing a baseline for the energy efficiency of HVAC systems is one of the first steps that can support this.

3.2. Proposed changes

It is proposed to issue a new Verification Method H1/VM3 to create consistency in the industry for demonstrating compliance for the energy efficiency of HVAC systems in commercial buildings (Building Code clause H1.3.6).

The proposed Verification Method H1/VM3 is provided for review in Appendix A.

3.3. Options

For this proposal, MBIE considered the following four options against the status quo:

› **Option 1: Update the existing guidance for the energy efficiency to include new material** – This option considers a revision of the existing MBIE guidance "Guidelines for energy efficient heating, ventilation and air conditioning (HVAC) systems".

[12] The existing MBIE "Guidelines for energy efficient heating, ventilation and air conditioning (HVAC) systems" can be viewed here: https://www.building.govt.nz/building-code-compliance/h-energy-efficiency/h1-energy-efficiency/guidance-for-energy-efficient-hvac-systems/

[13] The Climate Change Response (Zero Carbon) Amendment Act 2019 requires New Zealand to reduce net emissions of all greenhouse gases (except biogenic methane) to zero by 2050 and requires the Government to develop and implement policies for climate change mitigation. To help achieve this, MBIE's Building for Climate Change programme aims to transform the building and construction sector and regulatory system.

This guidance document is not an acceptable solution and verification method, and was issued under section 175 of the Building Act. This option was not suitable as it does not meet the regulatory needs to provide a compliance pathway that can be used consistently to demonstrate compliance with H1.3.6.

› **Option 2: Identify existing international frameworks and adopt those as an acceptable solution or verification method** – This option was not considered to be reasonable as no international documents were found for use in the New Zealand context without modification to suit the regulatory needs.

› **Option 3: Issue a verification method based on energy modelling and limits for HVAC system energy use** – This option was not considered to be reasonable as it was identified there is a skills shortage in designers and building consent authorities to undertake and review this type of modelling. As such the road to implementation would be too long and conflict with other steps along the Building for Climate Change programme. A shorter term solution is desired to meet the objectives of this proposal.

› **Option 4: Issue a simplified verification method based on existing MBIE guidelines and international frameworks (Recommended)** – This option considers issuing a simplified verification method based on the existing MBIE guidance document and equivalent international documents. This option was recommended by MBIE in order to maintain up-to-date information to meet the regulatory requirements and to provide a shorter path until it could be implemented.

Based on these options, only option 4 provides a reasonable option for further analysis.

3.4. Analysis of the proposed changes

3.4.1. Objectives of the proposal

The primary objective of this proposal is to introduce a deemed to comply method for the energy efficiency of HVAC systems in commercial buildings. This contributes to achieving Objective H1.1 of the Building Code, Functional requirement H1.2(a) and Performance criteria H1.3.6. These clauses of the Building Code state:

Objective		**Limits on application**
H1.1	The objective of this provision is to facilitate efficient use of energy	Objective H1.1 applies only when the energy is sourced from a *network utility operator* or a depletable energy resource.
Functional requirement		
H1.2	Buildings must be constructed to achieve an adequate degree of energy efficiency when that energy is used for— (a) modifying temperature, modifying humidity, providing ventilation, or doing all or any of those things; or	Requirement H1.2(a) does not apply to *assembly service buildings*, *industrial buildings*, *outbuildings*, or *ancillary buildings.*
Performance		**Limits on application**
H1.3.6	HVAC systems must be located, constructed, and installed to— (a) limit energy use, consistent with the intended use of space; and (b) enable them to be maintained to ensure their use of energy remains limited, consistent with the intended use of space.	Performance H1.3.6 applies only to *commercial buildings.*

H1.3.6 is limited to HVAC systems in commercial buildings. A commercial building is defined in Building Code clause A1 Classified Uses as:

5.0 Commercial
5.0.1 Applies to a *building* or use in which any natural resources, goods, services or money are either developed, sold, exchanged or stored. Examples: an amusement park, auction room, bank, car-park, catering facility, coffee bar, computer centre, fire station, funeral parlour, hairdresser, library, office

(commercial or government), Police station, post office, public laundry, radio station, restaurant, service station, shop, showroom, storage facility, television station or transport terminal.

In addition, it is intended that this change will provide a first step the Building for Climate Change programme of work which will look at further measures to reduce emissions from both constructing and operating buildings.

3.4.2. Methodology

MBIE sought advice on the recommended option with a panel of external industry building service experts and from the Code Advisory Panel.[14] Based on internal analysis and advice received, MBIE have formulated an approach based on the relevant requirements for energy efficiency from the Australian National Construction Code which have been modified, with permission from the Australian Building Codes Board, to suit the requirements of the New Zealand Building Code and fit into the New Zealand context. It was found that other existing documents from other parts of the world were either unnecessarily complex or that designers in New Zealand would be unfamiliar with their approaches and requirements.

The proposed verification method includes minimum requirements for the following aspects relevant to limiting the energy use of HVAC systems commonly installed in commercial buildings:

- Controls to ensure HVAC systems can be commissioned so they do not operate unnecessarily.
- Minimum energy efficiency requirements for the main energy using components of HVAC systems: fans, pumps, space heaters, chillers, unitary air-conditioning equipment and heat rejection equipment.
- Features to reduce energy losses in the system, including pipe and ductwork insulation and ductwork sealing.
- Facilities to enable energy monitoring so systems that require maintenance can be identified.
- Access to HVAC system equipment that will require commissioning, maintenance and replacement.

The listed features cover the most important aspects corresponding to the requirements from Building Code clause H1.3.6. They are also consistent with the aspects covered by the Australian National Construction Code for HVAC system energy efficiency.

3.4.3. Other changes as part of this proposal

To support the introduction of H1/VM3, there are other changes required as part of this proposal. This includes:

- Referencing the following standards and documents as part of the new verification method H1/VM3
  - AS/NZS 3823.1.2: 2012 Performance of electrical appliances – Airconditioners and heat pumps – Ducted airconditioners and air-to-air heat pumps - Testing and rating for performance
  - AS/NZS 4859.1: 2018 Thermal insulation materials for buildings – General criteria and technical provisions
  - AS/NZS 5263.1.2: 2000 Gas appliances – Gas fired water heaters for hot water supply and/or central heating
  - AS 1668.2: 2012 The use of ventilation and airconditioning in buildings – Mechanical ventilation in buildings (Incorporating Amendment Nos 1 and 2)[15]
  - AS 4254.1&.2: 2012 Ductwork for air handling systems in buildings – Flexible duct & Rigid duct
  - BS 7190: 1989 Method for assessing thermal performance of low temperature hot water boilers using a test rig
  - AHRI 460: 2005 Performance rating of remote mechanical-draft air cooled refrigerant condensers

[14] The Code Advisory Panel is a body of representatives who provide MBIE with strategic and technical advice on the Building Code. The discussion of the proposal for an HVAC VM is recorded in the meeting report from November 2020 available online here: https://www.building.govt.nz/building-code-compliance/code-advisory-panel/cap-november-2020-meeting/

[15] AS 1668.2: 2012 is proposed for reference in Verification Method H1/VM3 for the requirements for demand ventilation control and car park exhaust and ventilation. Acceptable Solution G4/AS1 currently reference a 2002 version of this standard. In order to comply with both G4/AS1 and H1/VM3 documents, both versions of the standard would be required. However, the 2012 version of the standard adds additional requirements and does not conflict with the requirements in the 2002 version. Reference to the 2012 version in G4/AS1 will be considered as part of a future Building Code update.

- AHRI 551/591: 2015 Performance rating of water-chilling and heat pump water-heating packages using the vapour compression cycle.
- ANSI/AHRI 1500: 2015 Performance rating of commercial space heating boilers
- CTI STD 201 RS: 2013 Performance Rating of Evaporative Heat Rejection Equipment
- CTI ATC 105S: 2011 Acceptance Test Code for Closed Circuit Cooling Towers
- CTI 106: 2011 Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers
- Construction Industry Research and Information Association, Safe access for maintenance and repair. Guidance for designers. 2nd edition 2009
- European Union, Commission Regulation (EU) No. 547/2012 and No. 622/2012
- New Zealand Government Energy Efficiency (Energy Using Products) Regulations 2002

The reference documents proposed for this verification method have been selected based on their appropriateness for use in New Zealand. Where possible, a New Zealand standard (or joint AS/NZS standard) have been used. Where no standard existed, other suitable material has been included.

› Removing the existing MBIE guidance document Guidelines for energy efficient heating, ventilation and air conditioning (HVAC) systems. This guidance document would be superseded by the introduction of the new requirements.

3.4.4. Costs and benefits

Costs and benefits of issuing the new verification method were assessed qualitatively. Benefits of the change are hard to quantify. MBIE expects that the proposed new Verification Method H1/VM3 will:

› Provide a pathway to comply with the Building Code clause H1.3.6 with greater consistency, clarity and certainty to designers, builders and consent officers in the building consent process.

› Describe an acceptable minimum level of energy efficiency for HVAC systems in commercial buildings.

› Ensure that HVAC systems can have suitable access for commissioning and maintenance to comply with Building Code clause H1.3.6.

› Be consistent with the current design practice and knowledge of building services engineers and designers and not require significant amounts of training or upskilling to implement in a design.

› Represent a cost-neutral change for the installation of the systems in buildings. It is intended that the measures are a first step as a ‘baseline’ for compliance which all systems should already comply with. That is, it is not expected that these requirements will introduce significant costs to the installation of HVAC systems or construction of most buildings. Some additional costs may be incurred for designers and building consent authorities to document and review the designs for compliance in relation to the verification method for building consent applications. However, the stringency of the requirements are not expected to impose significant costs on buildings.

› Provide a platform that can be potentially extended in the future as part of the implementation of the Building for Climate Change programme.

In this case, the benefits of the change exceed the costs.

3.5. Transitions

Effective date: 4 November 2021

It is proposed that the Verification Method H1/VM3 will be published on and be effective from 4 November 2021. It does not apply to Building Consents issued before this date.

3.6. Questions for the consultation

3-1. Do you support issuing the new H1/VM3 as proposed?

3-2. Do you think the proposed Verification Method H1/VM3 covers all important aspects of energy efficiency of HVAC systems in commercial buildings?
If there are aspects that you think should be included, please tell us.

3-3. What impacts would you expect on you or your business from the new H1/VM3?
These impacts may be economic/financial, environmental, health and wellbeing, or other areas.

3-4. Do you agree with the proposed transition time of 12 months for the new Verification Method H1/VM3 to take effect?

- ☐ Yes, it is about right
- ☐ No, it should be longer (24 months or more)
- ☐ No, it should be shorter (less than 12 months)
- ☐ Not sure/no preference

4. Natural light for higher-density housing

We are proposing to issue new acceptable solutions and verification methods for G7 Natural Light to adopt new compliance pathways for higher-density housing. The new pathways are more suitable for these types of buildings. As a consequence of the change, the scope of the existing documents are proposed to be limited.

4.1. Reasons for the change

The demand for multi-unit homes continues to rise across New Zealand. In recent years, approximately 40% of all homes consented were apartments, townhouse, units, or retirement village units and this is up from 15% in 2010.[16] G7 Natural Light was one aspect of the Building Code identified by MBIE that would strongly benefit from new methods for demonstrating compliance to cope with more complex housing designs.

Natural light is important for people in buildings because it contributes to positive health and wellbeing outcomes including improved quality of life, happiness and productivity[17]. The current requirements do not provide sufficient natural light for all types of buildings and were developed assuming low-rise standalone housing as the predominant way of developing residential buildings. While the current Acceptable Solution G7/AS1 may work adequately for this style of housing, it is not an effective means for the design of higher density housing options including multi-level apartment buildings. Additionally, the existing Verification Method G7/VM1 currently cites a standard from 1984. However, this verification method is not very robust and does not provide a complete compliance pathway for G7.

The existing Acceptable Solution G7/AS1 and Verification Method G7/VM1 were first published in 1992 with minor amendments made in 1995 and 2014. It is now time to bring G7 Natural Light into a modern building and construction setting.

4.2. Proposed changes

It is proposed to issue the new acceptable solutions and verification methods for G7 Natural Light to:

› Adopt new methods to demonstrate compliance for natural light provisions in higher density buildings.

› Limit the scope of the existing acceptable solution and verification method to lower rise and simpler buildings as appropriate.

› Provide a new format for the content of the G7 Natural Light acceptable solutions and verification methods with a new introduction to clarify the scope for their use and a structure consistent with other new acceptable solutions and verification methods.

The proposed new acceptable solutions and verification methods for G7 Natural Light are provided in Appendix B.

4.3. Options

For this proposal, MBIE considered the following three options against the status quo:

› **Option 1: Revise the citation of NZS 6703 to a newer version of a standard**
The current standard referenced in G7/VM1 is NZS 6703: 1984. This has been superseded by three AS/NZS standards. However, none of these contain daylighting provisions for residential buildings as required by G7

[16] Stats NZ, "High-density housing on the rise", October 2019. Available online at: https://www.stats.govt.nz/news/high-density-housing-on-the-rise
[17] Strong, D., "The distinctive benefits of glazing: The social and economic contributions of glazed areas to sustainability in the built environment," 2012. Available online at: https://glassforeurope.com/wp-content/uploads/2018/04/The-distinctive-properties-of-glazing.pdf

Natural Light. The superseding standards do not fill the existing gap in the compliance pathways in New Zealand. No other New Zealand standards were identified and this option was not considered to be reasonable for further analysis.

› **Option 2: Provide new means of compliance for higher density buildings and limit the scope of the existing acceptable solution and verification method (recommended)**

The recommended change is to introduce new compliance pathways for daylight that provide more appropriate solutions for apartments and higher density building types. As part of this option, the existing scope of G7/VM1 and G7/AS1 are limited to certain design applications where they are most appropriate for their use.

› **Option 3: Provide new means of compliance but leave the existing acceptable solution and verification method unchanged**

This option was not considered to be reasonable as there would be overlap in the application of the different compliance pathways and this would likely create confusion as the different methods would provide different levels of performance to the same building types. This option would not adequately support achieving an adequate degree of natural light and awareness of outside as required by G7 Natural Light.

After consideration, MBIE is of the view that only option 2 provides a reasonable option for further analysis.

4.4. Analysis of the proposed changes

4.4.1. Objectives of the proposal

The primary objective of this proposal is to provide more suitable compliance pathways for demonstrating compliance with G7 Natural Light to allow for a higher level of innovative design for higher density housing options. These clauses of the Building Code state:

		Limits on application
Objective		
G7.1	The objective of this provision is to safeguard people from illness or loss of *amenity* due to isolation from natural light and the outside environment.	
Functional requirement		
G7.2	*Habitable spaces* shall provide *adequate* openings for natural light and for a visual awareness of the outside environment.	Requirement G7.2 shall apply only to *housing*, old people's homes and early childhood centres.
Performance		
G7.3.1	Natural light shall provide an *illuminance* of no less than 30 lux at floor level for 75% of the *standard year.*	
G7.3.2	Openings to give awareness of the outside shall be transparent and provided in suitable locations.	

In addition, it is intended that the new compliance pathways will be clear and consistent in the scope of their application and provide solutions for both performance criteria in G7 (illuminance and awareness of the outside environment).

4.4.2. Methodology

To formulate new requirements for the compliance pathways, MBIE investigated a number of daylighting standards and guidelines available from other countries particularly those who are part of the Inter-Jurisdictional Regulatory Collaboration Committee (IRCC).[18] It was found that the Singapore Standards "BCA

[18] Details of the IRCC and member countries can be found on www.ircc.info

Green Mark, technical guide and requirements, green mark for residential buildings, GM RB:2016, Appendix B-B3. Detailed daylighting simulation guidelines" provide an appropriate starting point for developing new requirements for the following reasons:

› The Singapore Standard is a relatively new guide, first published in 2016, then revised version for implementation in 2017, hence aligns with international daylight standards and guides.

› There are a large number of high rise buildings in Singapore and this guideline has proved to be successful and working.

› It includes both a simple and easy to use method for a broad spectrum of designers and a more complicated computer modelling method for lighting designers and practitioners.

› Unlike some international standards, this was published by the Singapore Government Building Construction Authority and better suited for inclusion in building regulations.

The Singaporean standard include a prescribed guidelines for a simplified method that with some modification could be used as an acceptable solution as well as guidelines on daylighting simulation methods that could be modified and published as a verification method. Both methods provide a suitable starting point for demonstrating compliance in New Zealand with G7 Natural Light for high density building options and complicated architectural designs.

Permission was obtained from the Singapore Building Construction Authority to adopt this document and modify the requirement to suit the local New Zealand context.

4.4.3. Proposed compliance pathways for G7 Natural light

The new acceptable solutions and verification methods proposed include the following:

› Acceptable Solution G7/AS1 Natural light for buildings up to 3 storeys excluding those with borrowed daylight

› Acceptable Solution G7/AS2 Natural light for simple buildings excluding those with borrowed daylight

› Verification Method G7/VM1 Natural light for complex buildings excluding those with borrowed daylight

› Verification Method G7/VM2 Natural light for all buildings including those with borrowed daylight

The content of each document is discussed further.

› **Acceptable Solution G7/AS1 Natural light for buildings up to 3 storeys excluding those with borrowed daylight –** This acceptable solution is based on the existing G7/AS1 requirements and is proposed for low density, low rise buildings such as detached buildings and attached side by side multi-unit buildings including townhouses. The scope of the document has also been limited to tighten up the application of the requirements for awareness of the outside environment. Rooms that borrow daylight need to be designed in a holistic way outside of this compliance pathway.

› **Acceptable Solution G7/AS2 Natural light for simple buildings excluding those with borrowed daylight** – This acceptable solution is based on the Singaporean guidelines and is proposed for simple multi-unit apartment designs with vertical external windows and with no internal rooms. The proposed requirements for illuminance include a series of tabulated values that can be used to determine the maximum dimensions of a room based on various factors in the design. It is intended to be used for a broad spectrum of designs. The requirements for awareness of the outside have been reproduced from G7/AS1 to provide a pathway for compliance with the performance criteria in G7.3.2.

› **Verification Method G7/VM1 Natural light for complex buildings excluding those with borrowed daylight –** This verification method is based on the existing G7/VM1 which refers to a method for manual calculation of daylight found in NZS 6703: 1984 Appendix A. This method is no longer common practice and the relevant standard has been superseded by three AS/NZS standards. As part of this consultation, MBIE is considering revoking this verification method as it will be replaced with the modern daylight calculation methods in G7/VM2.

If G7/VM1 were to remain, additional requirements for awareness of the outside environment are needed for the verification method to provide a pathway for compliance with the performance criteria in G7.3.2. It is proposed to reproduce these requirements from G7/AS1.

› **Verification Method G7/VM2 Natural light for all buildings including those with borrowed daylight** – The verification method is based on the Singapore guidelines for computer modelling. It provides the most freedom in the design applications and can be used for all buildings including those that are complex or contain rooms that borrow daylight from other spaces. Knowledge of daylight computer modelling practices are required to use this verification method in design. This type of computer modelling is already common with industry professionals and used to demonstrate compliance on an alternative solution basis. The provisions for awareness of the outside environment have been modified from the existing G7/AS1 requirements in order to cover the applicable designs covered by the document.

These documents continue to apply to residential buildings, old people's homes, and early childhood centres as specified in the limits of application of Building Code clause G7.2.

4.4.4. Costs and benefits

Costs and benefits of the changes were assessed qualitatively. MBIE expects the following from these changes:

› The new compliance pathways will help ensure the objectives of Building Code clause G7 are met for high density residential building typologies. This will contribute to positive health and wellbeing outcomes for occupants in the buildings.

› The compliance pathways will provide a more consistent and standardised approaches for daylighting simulations and compliance with G7. This will help create a more efficient design review process for building consent applications for this approach.

› The use of G7/AS2 and G7/VM2 may result in more clear glazing area than previously designed using the existing acceptable solution and verification method. However, the amount of clear glazing will still only reflect the current minimum requirements of the Building Code.

› Additional education will be required for designers and building consent officers to adjust to the new methods in the acceptable solutions and verification methods and the new scope of application for the existing requirements.

› Additional training/upskilling may be required by designers to be able to apply the computer modelling methods outlined in G7/VM2. Related to this, additional costs may be introduced in the design process for the design of complex buildings to demonstrate their compliance with G7/VM2.

In consideration of these impacts, the benefits of the change exceed the costs.

4.5. Transitions

Effective date: 4 November 2021
Transitional arrangements: 12 months

It is proposed that the existing Acceptable Solution G7/AS1 and Verification Method G7/VM1 will remain in force, as if not amended, for a period of 12 months until 3 November 2022 (the proposed cessation date) as described in Table 4.1.

TABLE 4.1: Proposed transitional arrangements for G7 Natural Light acceptable solutions and verification methods

Document	Before 4 November 2021	From 4 November 2021 (effective date) To 3 November 2022 (cessation date)
Existing Acceptable Solutions and Verification Methods	If used, will be treated as complying with the Building Code	If used, will be treated as complying with the Building Code
Amended or new Acceptable Solutions and Verification Methods	Does not apply to Building Consents issued before this date.	If used, will be treated as complying with the Building Code

4.6. Questions

4-1. Do you support issuing the new G7/AS1, G7/AS2, G7/VM2 as proposed?

4-2. What approach do you think we should take for G7/VM1?

☐ It should be revoked

☐ It should be amended

☐ It should remain as is

☐ Not sure/no preference

4-3. What impacts would you expect on you or your business from the new editions of G7/AS1, G7/AS2, G7/VM1, and G7/VM2?
These impacts may be economic/financial, environmental, health and wellbeing, or other areas.

4-4. Do you agree with the proposed transition time of 12 months for the new G7/AS1, G7/AS2, G7/VM1, and G7/VM2 to take effect?

☐ Yes, it is about right

☐ No, it should be longer (24 months or more)

☐ No, it should be shorter (less than 12 months)

☐ Not sure/no preference

5. Weathertightness testing for higher-density housing

We are proposing to issue a new edition of E2/VM2 to reference BRANZ Evaluation Method EM7 Performance of mid-rise cladding systems (version 3, June 2020). This update version of EM7 is easier for test laboratories, cladding system suppliers, and building designers to use than the previous version. The new version does not significantly change the minimum performance requirements of the test method, and existing tested cladding systems will not need to be retested.

5.1. Reasons for the change

Verification Method E2/VM2 was first issued in June 2019 to provide a compliance pathway for cladding systems installed on buildings up to 25 m in height. This verification method references BRANZ EM7 as part of the testing specification. Since its first publication, EM7 has been revised to improve its usability, clarity, and readability.

Issuing a new edition of E2/VM2 now is part of routine maintenance of the verification method. It ensures that users are provided with the most up-to-date information and removes uncertainty in the consent process as new information is available for use.

Additionally, E2/VM2 was previously released in 2019 with an altered document format on a trial basis for a new look for acceptable solutions and verification methods. Since 2019, MBIE has worked to develop a consistent new look for these documents and is ready to publish E2/VM2 in the new format to provide consistency across the Building Code.

5.2. Proposed changes

It is proposed to issue a new edition of Verification Method E2/VM2 to:

- Reference BRANZ EM7 Performance of mid-rise cladding systems (version 3, June 2020) as a means to demonstrate compliance for cladding systems for buildings up to 25 m in height.
- Provide a new format for the content of E2/VM2 with a new introduction to clarify the scope for its use and a structure consistent with other new acceptable solutions and verification methods.

The proposed new edition of Verification Method E2/VM2 in a new document template is provided in Appendix C.

5.3. Options

For this proposal, MBIE considered the following three options against the status quo:

- **Option 1: Identify alternate test specifications available internationally and cite those documents instead** – This option was not considered to be reasonable as no other suitable standards specific to the context in New Zealand were identified. The proposed reference document cited in this proposal has been published by BRANZ, a New Zealand based independent research and testing organisation, in consultation with other experts in New Zealand.
- **Option 2: Locate the applicable requirements directly into the verification method** – This option was not considered to be reasonable as the material is impractical for direct publication in the verification method.
- **Option 3: Revise the references and citations to reflect the newest versions of the published version (Recommended)** – This option is recommended in order to maintain up-to-date information for the requirements and to reduce confusion and disconnect between industry practice and compliance with the Building Code.

5.4. Analysis of the proposed changes

The primary objective of this proposal is to issue a new edition of E2/VM2 to clarify its application to cladding systems for medium density housing options. This contributes to achieving the Objective E2.1 which states:

Objective

E2.1 The objective of this provision is to safeguard people from illness or injury that could result from external moisture entering the building.

The updated version of EM7 proposed for reference in E2/VM2 was developed by BRANZ as a result of feedback since previous edition. The new version had input from professionals working in the areas of façade design, cladding testing, building science, and building regulation (including MBIE). Key changes addressed by the new version of EM7 from the previous version include:

› improving clarity of conformance criteria for use as a compliance pathway for specific claddings on specific buildings

› removal of some stringent conditions that made the test less usable

› the inclusion of details more relevant to mid-rise construction

› commentary on the use of EM7 test results to support alternative solutions proposals for enhanced cladding systems and/or where additional tests are undertaken.

For more information on the changes, please review BRANZ EM7 (version 3, June 2002) available on www.branz.co.nz.

Costs and benefits of the changes were assessed qualitatively. Along with the new edition of E2/VM2, MBIE expects the following from this change:

› Implementing recommendations for updating EM7 arising from laboratory accreditation assessments will make the test method clearer and easier to use. Clearer provisions in the test method will increase its uptake as a method of demonstrating Building Code compliance.

› The minimum performance requirements of EM7 will not be significantly changed by this update. Cladding systems already certified under the existing test method will not be required to re-test to demonstrate that they meet the minimum performance requirements of the Building Code.

› Test facilities which undertake EM7 testing will need to update their practices to align with the updated test methodology which result in minor one-off costs. Test facilities are not expected to require new technology or equipment to follow the updated test methodology.

› Suppliers of new cladding systems will need to follow the updated EM7 rather than the previous version, but there are only small differences and none are significantly more onerous than the current version of the document. Suppliers of existing cladding systems will not need to change their practices or documentation.

› Designers and building consent authorities will not need to change their practices.

No significant impact or costs have been identified for issuing the verification method. In this case, the benefits of the change exceed the costs.

5.5. Transitions

Effective date: 4 November 2021
Transitional arrangements: 12 months

It is proposed that the existing Verification Method E2/VM2 will remain in force, as if not amended, for a period of 12 months until 3 November 2022 (the proposed cessation date) as described in Table 5.1.

TABLE 5.1: Proposed transitional arrangements for Verification Method E2/VM2

Document	Before 4 November 2021	From 4 November 2021 (effective date) To 3 November 2022 (cessation date)
Existing Verification Method	If used, will be treated as complying with the Building Code	If used, will be treated as complying with the Building Code
New edition of the Verification Method	Does not apply to Building Consents issued before this date.	If used, will be treated as complying with the Building Code

5.6. Questions for the consultation

5-1. Do you support the issuing the new edition E2/VM2 as proposed to cite BRANZ EM7 version 3?

5-2. What impacts would you expect on you or your business from the new edition of E2/VM2? These impacts may be economic/financial, environmental, health and wellbeing, or other areas.

5-3. Do you agree with the proposed transition time of 12 months for the new Verification Method E2/VM2 to take effect?

- ☐ Yes, it is about right
- ☐ No, it should be longer (24 months or more)
- ☐ No, it should be shorter (less than 12 months)
- ☐ Not sure/no preference

6. Standards referenced in B1 Structure

We are proposed to amend referenced standards in the acceptable solutions and verification methods for clause B1 Structure. The amended references include new versions of AS/NZS 4671, AS/NZS 5131, AS/NZS 2327, the NZGS document "Field Description of Soil and Rock – Guideline for the field descriptions of soils and rocks in engineering purposes". Previous versions of these documents are currently referenced by the acceptable solutions and verification methods.

6.1. Reasons for the change

Referenced standards and documents form an important part of the building regulatory system. They contain necessary details on a repeatable way of doing something which can be used to demonstrate full or partial compliance with the performance requirements of the Building Code.

As building technologies and methods of construction continue to evolve over time, revising the references and their citations is part of routine maintenance of the acceptable solutions and verification methods. This maintenance ensures that users are provided with the most up-to-date information and removes uncertainty in the consent process as new information becomes available for use.

The proposed changes for references and citations for the 2021 consultation were identified for amendment based on:

› the ongoing strategic direction of the Building Code
› contribution to the performance requirements of the Building Code
› the age of the current document
› when the document was available for review in lead up to preparing this consultation document.

There are approximately 350 standards referenced across all acceptable solutions and verification methods. Future updates to the Building Code will continue to identify any standards that need amendments over time.

6.2. Proposed changes

It is proposed to reference the following standards and document for the acceptable solutions and verification methods for B1 Structure:

› AS/NZS 4671: 2019 Steel for the reinforcement of concrete (B1/AS1, B1/AS3, B1/VM1)
› AS/NZS 5131: 2016 Structural Steelwork – Fabrication and Erection (B1/VM1)
› AS/NZS 2327:2017 Composite structures – Composite steel-concrete construction in buildings Amendment 1 (B1/VM1)
› New Zealand Geotechnical Society Inc., "Field Description of Soil and Rock – Guideline for the field descriptions of soils and rocks in engineering purposes", December 2005 (B1/VM1).

6.3. Options

For this proposal, MBIE considered the following three options against the status quo:

Option 1: Identify alternative standards and reference those documents instead

This option was not considered to be reasonable as no other suitable standards specific to the context in New Zealand were identified. The proposed reference documents cited in this proposal have been published as joint New Zealand-Australian standards and by a New Zealand organisation.

Option 2: Insert the applicable requirements directly into the acceptable solutions and verification methods
This option was not considered to be reasonable as the material is too large and impractical for direct publication in the acceptable solutions and verification methods.

Option 3: Revise the references and citations to reflect the newest versions of the published version (Recommended)

This option is recommended in order to maintain up-to-date information for the requirements and to reduce confusion and disconnect between industry practice and compliance with the Building Code.

6.4. Analysis of the proposed changes

6.4.1. Objectives of the proposal

The citation of these standards and document contribute to achieving the Objective B1.1 which states:

Objective

B1.1 The objective of this provision is to:
(a) safeguard people from injury caused by structural failure,
(b) safeguard people from loss of *amenity* caused by structural behaviour, and
(c) protect *other property* from physical damage caused by structural failure.

Analysis of the proposed changes is presented for each standard and document based on a comparison to the status quo. This includes a summary of the key changes from the previous versions. For more information on the requirements, please review the standards and document in full.

6.4.2. AS/NZS 4671: 2019 Steel for the reinforcement of concrete

AS/NZS 4671 is a manufacturing standard that sets out the requirements for steel products that are used as reinforcement within most New Zealand buildings. It is used by manufacturers and suppliers, and is referred to by professional engineers and others. Reinforcement needs to conform to this standard to safeguard people from injury caused by structural failure, safeguard people from loss of amenity caused by structural behaviour, and to protect other property from physical damage caused by structural failure. The 2001 version of this standard is currently referenced within B1/VM1 Paragraph **14.0 Ductile Steel Mesh** with several modifications along with B1/AS2 Paragraph **3.1.8 NZS 3604 Clause 7.5.8.1** and B1/AS3 Paragraph **1.8.5 Reinforcing steel**.

Key changes found in this standard from the previous version are listed below.

- › The new version has incorporated the modifications to the standard that were set out in B1/VM1. The intent of the B1/VM1 modifications has now been directly incorporated into the 2019 version of the standard. As a result, the modifications in B1/VM1 to the citation of the standard are no longer necessary.
- › The new version provides higher reinforcing steel strength grades. There were also extensive revisions to the testing, conformance, and quality requirements to emphasise and improve the long-term quality of the steel products. Higher grades of reinforcing steel provide more certainty for Australian manufacturers exploring the potential benefits offered by higher strength reinforcing steels.
- › The title of the standard has been harmonised with other related international standards.
- › Other minor technical and editorial omissions have been amended in the standard.

MBIE expect that these changes will have the following benefits:
- › The compliance pathway will be clearer as the standard will no longer be cited with modifications to demonstrate compliance with the Building Code.
- › Steel testing laboratories will be able to use the same assessment method for all types of steel which may limit confusion in the industry.

No significant impact or costs have been identified for the adoption of this standard as modifications to the standard were already adopted in 2016 to demonstrate compliance with the Building Code. A transition period of 12 months is expected to be sufficient. Additional costs may be incurred by designers and manufacturers who need to purchase a new copy of the standard or update product literature. In these cases, the benefits of the change exceed any anticipated costs.

The proposed amendments to Verification Method B1/VM1 to cite the standard and explanations for each amendment are provided in Table 6.1.

Table 6.1 Proposed amendments to Verification Method B1/VM1 to cite AS/NZS 4671: 2019

Current Text	Proposed text	Explanation
B1 Structure References		
AS/NZS 4671: 2001 Steel Reinforcing Materials *Amend*: 1	AS/NZS 4671: 2019 Steel for the reinforcement of concrete	It is proposed to amend this reference to the most recent version of this standard.
B1/VM1 Paragraph 14.0 Ductile Steel Mesh		
14.1 Grade 500E welded steel mesh Where Grade 500E welded steel mesh is specified, it shall meet the requirements of AS/NZS 4671 subject to the following modifications. **14.1.1 Laboratory accreditation** **14.1.2 Interpretation and Clarification of AS/NZS 4671** **14.1.3 AS/NZS 4671** **14.1.4 AS/NZS 4671 Clause 9.3 Labelling of reinforcing steel** **14.1.5 AS/NZS 4671 Appendix A** **14.1.6 AS/NZS 4671 Clause B1.1** **14.1.7 AS/NZS 4671 Clause B1.3.1** **14.1.8 AS/NZS 4671 Clause B1.3.5** **14.1.9 AS/NZS 4671 Clause B1 Scope and general** **14.1.10 AS/NZS 4671 Clause B3 (c)** **14.1.11 AS/NZS 4671 Clause B4.1.1 Batch parameters** **14.1.12 AS/NZS 4671 Clause B4.1.2** **14.1.13 AS/NZS 4671 Clause B5** **14.1.15 AS/NZS 4671 Clause B6.1** **14.1.14 AS/NZS 4671 Clause B6** **14.1.16 AS/NZS 4671 Clause B6.2.1** **14.1.17 AS/NZS 4671 Clause B6.3** **14.1.18 AS/NZS 4671 B6.4** **14.1.19 AS/NZS 4671 Clause B7.2** **14.1.20 AS/NZS 4671 Clause B7.3** **14.1.21 AS/NZS 4671 Clause B7.4.1(a)(iii)** **14.1.22 AS/NZS 4671 Clause C2.2.2**	**14.1 Grade 500E welded steel mesh** Where Grade 500E welded steel mesh is specified, it shall meet the requirements of AS/NZS 4671.	It is proposed to amend this text and remove the modifications to the standard. The intent of these modifications have been incorporated into AS/NZS 4671: 2019 are no longer necessary for demonstrating compliance with the Building Code.

6.4.3. AS/NZS 5131: 2016 Structural Steelwork – Fabrication and Erection

AS/NZS 5131: 2016 Structural Steelwork and Erection is used for steel framed buildings or parts of buildings constructed from steel (except for light steel framing). The standard is used by structural engineers designing and supervising the construction of buildings as well as fabricators manufacturing steelwork for buildings and contractors assembling buildings. It is used to meet the objectives of B1 Structure and ensures buildings are safe by providing fabrication and erection methods that reliably achieve the designed capacity of the steel members. It is currently cited in B1/VM1 Paragraph **5.0 Steel**.

Key changes found in this standard from the previous version are listed below.

- The Construction Categories within AS/NZS 5131 relating to quality assurance and traceability processes and have been revised with significant changes to the terminology used (the terms Basic, Partial and Full Traceability have been revised to Lot, Piece-mark and Piece Traceability). This impacts steel framed buildings in New Zealand. However, the impact of these changes to the recommended process are expected to be relatively minor.
- Portions of this joint New Zealand-Australia standard have been revised to include requirements that are only applicable to Australia. Hence, there is no impact for the compliance with the New Zealand Building Code.
- A number of other minor editorial clarifications have occurred in the standard, and several existing errors have been fixed. These are not a critical part of the citation for Building Code compliance.

MBIE expect that these changes will make the compliance pathway clearer for the structural stability and safety of steel construction. No significant impact or costs have been identified for the adoption of this standard. Some minor administrative costs may be introduced as manufacturers update documentation in relation to the quality assurance processes. In this case, the benefits of the change exceed the costs.

The proposed amendments to Verification Method B1/VM1 to cite the standard and explanations for each amendment are provided in Table 6.2.

Table 6.2 Proposed amendments to Verification Method B1/VM1 to cite AS/NZS 5131: 2016 Amend 1

Current Text	Proposed text	Explanation
B1 Structure References		
AS/NZS 5131: 2016 Structural steelwork – Fabrication and erection	AS/NZS 5131: 2016 Structural steelwork – Fabrication and erection Amend: 1	It is proposed to amend this reference to the most recent version of this standard. There are no other amendments required to B1/VM1 and no changes proposed to the modifications of the standard as cited in Paragraph 5.0 Steel.

6.4.4. AS/NZS 2327: 2017 Composite structures – Composite steel-concrete construction in buildings Amendment 1

AS/NZS 2327: 2017 sets out the design, detailing and construction processes for composite steel-concrete members in buildings. Steel-concrete members are widely used, and found in both steel and concrete framed buildings ranging from medium density residential to commercial high-rise and industrial buildings. The standard is relied on by structural engineers and the manufacturers of the products and components that are used to construct steel-concrete composite members. The standard is used to meet the objectives of B1 Structure and is currently cited in B1/VM1 Paragraph **5.1.4A Section 13 Design of composite members and structures**.

This amendment of the standard fixes a number of typographical errors in text and equations. These errors would have been easily identified by engineers using the document and likely result in a design engineer using another method to demonstrate compliance. MBIE expects that correcting these errors will make the standard easier to use and follow. This will benefit the public by ensuring composite members are appropriately designed and the compliance pathway is clear for designers. No new costs have been identified for the use of the amended standard. In this case, the benefits of the change exceed the costs.

The proposed amendments to Verification Method B1/VM1 to cite the standard and explanations for each amendment are provided in Table 6.3.

Table 6.3 Proposed amendments to Verification Method B1/VM1 to cite AS/NZS 5131: 2016 Amend 1

Current Text	Proposed text	Explanation
B1 Structure References		
AS/NZS 2327:2017 Composite structures – Composite steel-concrete construction in buildings	AS/NZS 2327: 2017 Composite structures – Composite steel-concrete construction in buildings Amend: 1	It is proposed to amend this reference to the most recent version of this standard. There are no other amendments required to B1/VM1 to incorporate this change.

6.4.5. Field Description of Soil and Rock – Guideline for the field descriptions of soils and rocks in engineering purposes, New Zealand Geotechnical Society Inc., December 2005

This guideline for soils and rocks is published by the New Zealand Geotechnical Society (NZGS). NZGS represents practitioners in soil mechanics, rock mechanics and engineering geology. They aim to advance the study and application of these areas among engineers and scientists and are well placed to develop guidelines. The previously cited version of the document was issued in 1988. It is currently cited in B1/VM1 Paragraph **11.0 Drains** for the design and installation of buried concrete pipes and is used to modify the requirements of AS/NZS 3725: 2007 "Design for installation of buried concrete pipes". The existing cited version (1988) is no longer available from the NZGS.

Key changes found in the 2005 document from the 1988 version are listed below.

- Defined terms used in communicating soil and rock properties in New Zealand have been revised.
- Typical soil and rock types in New Zealand have been characterised in accordance with internationally agreed methods.
- The rock descriptions have been simplified with revision made to suit the range of rock types normally found in New Zealand.

MBIE expects that referencing the latest version of the guidelines will have no impact on the pipe installation and minimum requirements for the soil materials around the pipes. However, referencing the 2005 version will provide a clearer pathway for compliance since the 1988 version is no longer available. In this case, the benefits of the change exceed the costs.

The proposed amendments to Verification Method B1/VM1 to cite the standard and explanations for each amendment are provided in Table 6.3.

Table 6.4 Proposed changes to Acceptable Solution B1/VM1 to amend standard citations

Current Text	Proposed text	Explanation
B1 Structure References		
New Zealand Geomechanics Society Guidelines for the field descriptions of soils and rocks in engineering use – Nov 1988	New Zealand Geotechnical Society Inc. Field Description of Soil and Rock – Guideline for the field descriptions of soils and rocks in engineering purposes, December 2005	This citation reflects the most recent version of this document. The name of the attributed organisation is proposed to be amended as the name of the society change in 2005.
Verification Method B1/VM1		
11.1 AS/NZS 3725 subject to the following modifications: **Clause 3**… New Zealand Geomechanics Society, Guidelines for the field description of soils and rocks in engineering use." **Clause 4**…. "or the New Zealand Geomechanics Society Guidelines". …	**11.1 AS/NZS 3725** subject to the following modifications: **Clause 3**… New Zealand Geotechnical Society, Field Description of Soil and Rock – Guidelines for the field description of soils and rocks in engineering purposes." **Clause 4**…. "or the New Zealand Geotechnical Society Guidelines".	This text is proposed to be amended to reflect the revised citation of the newest version of the document.

6.5. Transitions

Effective date: 4 November 2021
Transitional arrangements: 12 months

It is proposed that the existing Acceptable Solutions B1/AS1 and B1/AS3 and Verification Method B1/VM1 will remain in force, as if not amended, for a period of 12 months until 3 November 2022 (the proposed cessation date) as described in Table 6.5.

TABLE 6.5: Proposed transitional arrangements for Acceptable Solutions B1/AS1 and B1/AS3 and Verification Method B1/VM1

Document	Before 4 November 2021	From 4 November 2021 (effective date) To 3 November 2022 (cessation date)
Existing Acceptable Solutions and Verification Method	If used, will be treated as complying with the Building Code	If used, will be treated as complying with the Building Code
Amended Acceptable Solutions and Verification Method	Does not apply to Building Consents issued before this date	If used, will be treated as complying with the Building Code

6.6. Questions for the consultation

6-1. Do you support the amendment of B1/AS1, B1/AS3 and B1/VM1 as proposed to include the following referenced standards and document?

› AS/NZS 4671: 2019 Steel for the reinforcement of concrete

› AS/NZS 5131: 2016 Structural Steelwork – Fabrication and Erection

› AS/NZS 2327: 2017 Composite structures – Composite steel-concrete construction in buildings Amendment 1

› Field Description of Soil and Rock – Guideline for the field descriptions of soils and rocks in engineering purposes, New Zealand Geotechnical Society Inc., December 2005

6-2. What impacts would you expect on you or your business from the referencing of these standards and document?
These impacts may be economic/financial, environmental, health and wellbeing, or other areas.

6-3. Do you agree with the proposed transition time of 12 months for the new Acceptable Solutions B1/AS1 and B1/AS3 and Verification Method B1/VM1 to take effect?

☐ Yes, it is about right

☐ No, it should be longer (24 months or more)

☐ No, it should be shorter (less than 12 months)

☐ Not sure/no preference

7. Editorial changes to Acceptable Solution B1/AS1

We are proposed to amend text within Acceptable Solution B1/AS1 to make editorial changes in regards to geotechnical requirements. Editorial changes may include obvious errors in the text, typos, spelling mistakes, incorrect cross-references, changes in the formatting, minor clarifications of text with minor to no impact, or other items related to current document drafting practices.

7.1. Proposed change

The proposed editorial changes to Acceptable Solution B1/AS1 and explanations for each change are provided in Table 7.1.

The scope of these editorial corrections has been limited to the geotechnical requirements in the acceptable solution. For these items, the only practicable option identified is to correct the text as this will provide consistency and clarity in the understanding and interpretation of the acceptable solution.

TABLE 7.1: Proposed editorial changes to Acceptable Solution B1/AS1

Current Text	Proposed text	Explanation
2.1.2 NZS 4229 Foundations where *good ground* has not been established	**2.1.2 NZS 4229 Foundations where good ground has not been established**	This text is proposed to be amended to format it as a heading to maintain consistency with B1/AS1 3.1.14 and 4.1.5.
7.5.13.3 Foundation details **7.5.13.3.1…** **COMMENT:** **Design constraints:** … d) the I_{SS} (soil stability index) ranges attributed to the expansivity classifications as defined in 3.2.4 above have been calculated using the parameters presented in BSR120A and Equation 2.3.1 of AS 2870:2011. …	**7.5.13.3 Foundation details** **7.5.13.3.1…** **COMMENT:** **Design constraints:** … d) the I_{SS} (shrink swell index) ranges attributed to the expansivity classifications as defined in 3.2.4 above have been calculated using the parameters presented in BSR120A and Equation 2.3.1 of AS 2870:2011. …	This text is proposed to be amended in order to maintain consistency with terminology used in the referenced documents BSR120A and AS 2870. The text within the comment box was added to B1/AS1 in Amendment 19 in November 2019. Prior to 2019, the text was previously found in the revoked Simple Housing Acceptable Solution. MBIE has received feedback that the use of different terms between B1/AS1 and BSR120A and AS 2870 causes confusion. Adopting the terminology used by the reference documents provides the most clarity of this text.

7.2. Transitions

Effective date: 4 November 2021
Transitional arrangements: 12 months

It is proposed that the existing Acceptable Solution B1/AS1 will remain in force, as if not amended, for a period of 12 months until 3 November 2022 (the proposed cessation date) as described in Table 7.2.

This transition period of 12 months is proposed so that it may to align with the proposed transition period for new standards to be cited in B1 Structure as discussed in Proposal 6. This is intended to minimise confusion on which documents and what requirements are in effect on what date.

TABLE 7.2: Proposed transitional arrangements for Acceptable Solution B1/AS1

Document	Before 4 November 2021	From 4 November 2021 (effective date) To 3 November 2022 (cessation date)
Existing Acceptable Solution	If used, will be treated as complying with the Building Code	If used, will be treated as complying with the Building Code
Amended Acceptable Solution	Does not apply to Building Consents issued before this date.	If used, will be treated as complying with the Building Code

7.3. Questions for the consultation

7-1. Do you support the amendment of B1/AS1 to address the editorial changes to geotechnical requirements as proposed?

Appendix A. Draft acceptable solution and verification methods for H1 Energy Efficiency

As part of Proposals 1, 2, and 3, there are five draft acceptable solutions and verification methods proposed for H1 Energy Efficiency. These are:

- Acceptable Solution H1/AS1 Energy Efficiency for all housing, and buildings up to 300 m^2
- Verification Method H1/VM1 Energy Efficiency for all housing, and buildings up to 300 m^2
- Acceptable Solution H1/AS2 Energy Efficiency for buildings greater than 300 m^2
- Verification Method H1/VM2 Energy Efficiency for buildings greater than 300 m^2
- Verification Method H1/VM3 Energy Efficiency for HVAC systems in commercial buildings

BUILDING PERFORMANCE

H1 Energy Efficiency

Acceptable Solution H1/AS1

Energy efficiency for all housing, and buildings up to 300 m^2

DRAFT FOR PUBLIC CONSULTATION

FIFTH EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

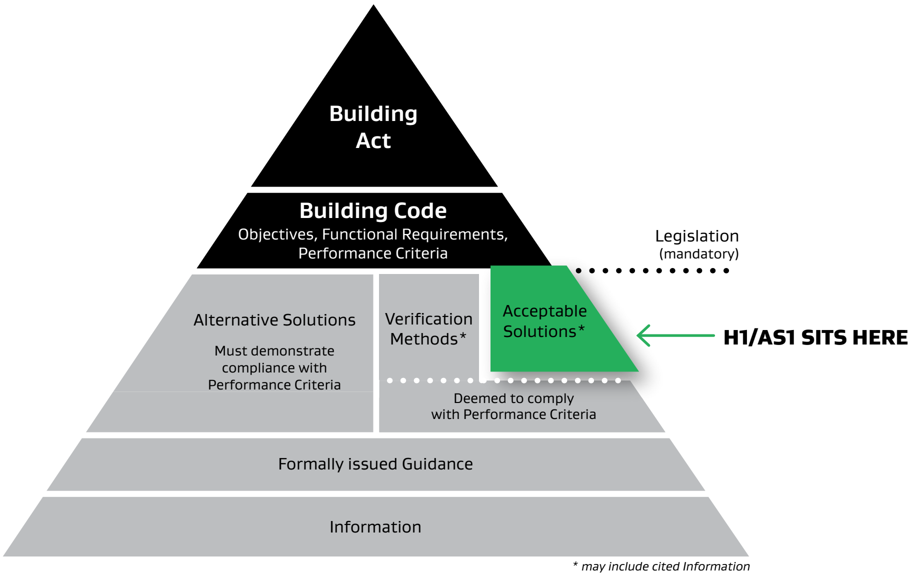
Document status

This document (H1/AS1) is an acceptable solution issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX. The previous Acceptable Solution H1/AS1, as amended, can be used to show compliance until X XXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX.

Building Code regulatory system

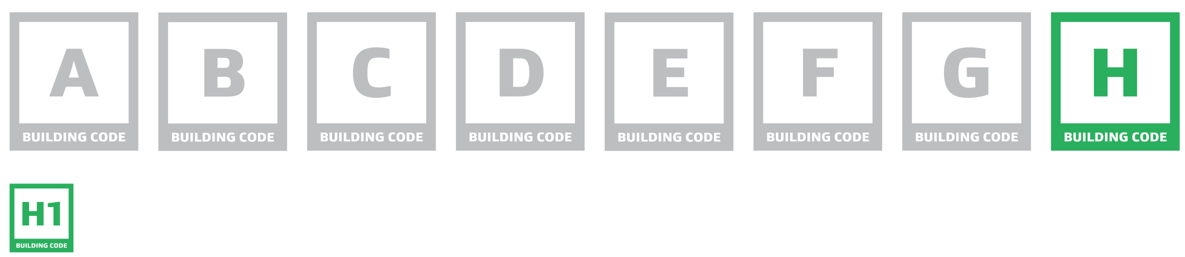
Each acceptable solution outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this acceptable solution relates to is clause H Energy Efficiency. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This acceptable solution is the fifth edition of H1/AS1. The main changes from the previous version are:

- The scope of H1/AS1 has been reduced to cover only housing, and buildings other than housing less than 300 m^2. Requirements applicable to buildings other than housing over 300 m^2 have been combined into the new Acceptable Solution H1/AS2. To reflect the new scope of the documents and the new document layout, a new introduction and scope has been provided in Part 1. General.
- Citation of NZS 4218: 2009 "Thermal insulation - Housing and small buildings" has been removed from the document. The relevant content from this standard has been adopted into H1/AS1 with permission from Standards New Zealand.
- The three-zone climate zone map previously found in NZS 4218 has been updated with a six-zone climate zone map in Appendix C.
- The minimum R-values previously found in NZS 4218 are replaced with new values and new text in Part 2. Building thermal envelope.
- Portions of text have been re-written to enhance clarity in the document and provide consistent language with other acceptable solutions and verification methods.
- Requirements for artificial lighting have been removed from H1/AS1 as these now apply to buildings outside of the new scope of H1/AS1.
- References have been revised to include only documents within the scope of H1/AS1 and have been amended to include the most recent versions of NZS 4246 and ALF in Appendix A.
- The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solutions or verification methods are available from www.building.govt.nz

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This document applies to:

H
a) **housing**; and
b) other *buildings* with a floor area of *occupied space* no greater than 300 m^2.

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> COMMENT: **Housing** includes detached dwellings, multi-unit dwellings such as *buildings* which contain more than one separate household or family, e.g. an apartment *building*, and also group dwellings, e.g. a *wharenui*.

1.1.1.2 For *buildings* that do not meet these characteristics, refer to the Acceptable Solution H1/AS2 or Verification Method H1/VM2 as a means to demonstrate compliance or use an alternative means to demonstrate compliance.

1.1.2 Items outside the scope of this document

1.1.2.1 This acceptable solution does not include the use of foil insulation.

Com 1.1.2.2 For **commercial** *buildings*, this acceptable solution does not include requirements to comply with clause H1.3.6 of the Building Code. For this clause, use Verification Method H1/VM3 or use an alternative means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This acceptable solution is one option that provides a means of establishing compliance with the performance criteria in Building Code clauses H1.3.1, H1.3.3, H1.3.4 and H1.3.5.

1.1.3.2 Options for demonstrating compliance with H1 Energy Efficiency through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.1.3.3 Compliance with Building Code clause H1.3.1(a) (*adequate thermal resistance*) satisfies clause H1.3.2E (*Building Performance Index* or *BPI*).

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> COMMENT:
> 1. The Schedule and Calculation method as described in Part 2 is an acceptable solution for Building Code clause H1.3.1(a) (*adequate thermal resistance*). However, compliance with clause H1.3.2E (*Building Performance Index or BPI*) is not sufficient for demonstrating compliance with clause H1.3.1(a) (*adequate thermal resistance*).
> 2. ALF 4.0, published by BRANZ, calculates the *BPI*. Note that the ALF procedures are intended for detached dwellings and are not suitable for multi-unit dwellings.
> 3. The 20°C stated in the definition of *heating energy* is for calculation purposes only.

TABLE 1.1.3.2: Demonstrating compliance with H1 Energy Efficiency through acceptable solutions and verification methods

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
H1.3.1 (a) and (b) Thermal Envelope	H **Housing** CR **Communal residential** CN **Communal non-residential** (assembly care only) Com **Commercial**	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large *buildings*: H1/AS2 or H1/VM2
H1.3.2E *Building performance index*	H **Housing**	H1/AS1 or H1/VM1
H1.3.3 (a) to (f) Physical conditions	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large buildings: H1/AS2 or H1/VM2
H1.3.4 (a) Heating of hot water	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (b) Storage vessels and distribution systems	Individual storage vessels ≤ 700 L in capacity	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (c) Efficient use of hot water	H **Housing**	H1/AS1
H1.3.5 Artificial lighting	Lighting not provided solely to meet the requirements of Building Code clause F6 in: Com CN **Commercial** and **Communal non-residential** having *occupied space* greater than 300 m²	H1/AS2
H.1.3.6 *HVAC systems*	Com **Commercial**	H1/VM3

1.2 Using this acceptable solution

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

Ind 1.2.1.2 In *buildings* containing both **industrial** and other classified uses, the non-industrial portion shall be treated separately according to its classified use. For example, in a building containing both **industrial** and **commercial** classified uses, the **commercial** area shall meet the relevant energy efficiency requirements of the Building Code.

1.2.2 Determining the area of the building

H 1.2.2.1 For **housing**, use the *floor area* of the building.

1.2.2.2 For *buildings* other than **housing**, calculate the area based on the *occupied space* of the *building*.

1.2.3 Features of this document

1.2.3.1 For the purposes of Building Code compliance, the standards and documents referenced in this acceptable solution must be the editions, along with their specific amendments listed in Appendix A.

1.2.3.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.3.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.3.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses. These requirements are also denoted with classified use icons for:

- H a) **Housing**, and
- CR b) **Communal residential**, and
- CN c) **Communal non-residential**, and
- Com d) **Commercial**, and
- Ind e) **Industrial**, and
- Out f) **Outbuildings**, and
- Anc g) **Ancillary**.

1.2.3.5 Appendices to this acceptable solution are part of, and have equal status to, the acceptable solution. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Building thermal envelope

2.1 Thermal resistance

2.1.1 Demonstrating compliance

H CR CN Com

2.1.1.1 For **housing, communal residential, communal non-residential** assembly care, and **commercial** *buildings,* the *building envelope* shall be provided with *construction* that provides *adequate thermal resistance.* The minimum required *construction R-values* shall be determined through the use of:

a) the Schedule method in Subsection 2.1.2, or

b) the Calculation method in Subsection 2.1.3, or

c) the Modelling method in H1/VM1.

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> COMMENT: To satisfy the Building Code performance requirement E3.3.1 for internal moisture, it may be necessary, depending on the method adopted, to provide more insulation (a greater *R-value*) than that required to satisfy energy efficiency provisions alone.

2.1.1.2 The requirements for the Schedule method and Calculation method are separated based on the relevant climate zone for the *building*. A list of the New Zealand Climate zones is provided in Appendix C.

2.1.1.3 For *building elements* with embedded heating systems, the minimum *construction R-values* shall be determined through the Schedule method. These apply whenever *building elements* that are part of the *thermal envelope* include heating systems and may not be reduced by applying the Calculation method in Subsection 2.1.3.

2.1.1.4 The *construction R-values* of individual *building elements* shall be determined in accordance with Subsection 2.1.4.

2.1.1.5 Insulation materials shall be installed in a way that achieves the intended thermal performance in *buildings* without compromising the durability and safety of insulation or *building elements* and the health and safety of installers and *building* occupants. NZS 4246 sections 5, 6, 7 and 10 provide acceptable methods for installing bulk thermal insulation in light-timber and steel-framed residential *buildings*.

2.1.2 Schedule method

2.1.2.1 The schedule method shall only be used where:

a) The *window area* is 30% or less of the *total wall area*; and

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

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

d) The *door area* is no more than 6 m^2 or 6% of the *total wall area* (whichever is greater); and

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

2.1.2.2 *Building elements* that are part of the *thermal envelope* shall have minimum *construction R-values* no less than those in:

a) For *building elements* that contain embedded heating systems, those in Table 2.1.2.2A; or

b) For *building elements* that do not contain embedded heating systems, those in Table 2.1.2.2B.

2.1.2.3 There are no *R-value* requirements for the door area (the unglazed parts of doors) and for decorative glazing and louvres.

TABLE 2.1.2.2A: **Minimum construction R-values for heated ceilings, walls or floors**

Paragraph 2.1.2.2 a), 2.1.3.1

Building element	Construction R-values (m² K/W)[(1),(2),(3)]					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Heated ceiling	**Refer to the consultation document for the proposed R-values for each element and climate zone**					
Heated wall						
Heated floor						

Notes:

(1) R_{IN}/R-value < 0.1 and R_{IN} is the *thermal resistance* between the heated plane and the inside air.

(2) Floor coverings, for example carpet or cork, will reduce the efficiency of the *heated floor*.

(3) Climate zone boundaries are shown in Appendix C.

TABLE 2.1.2.2B: **Minimum construction R-values for building elements that do not contain embedded heating systems**

Paragraph 2.1.2.2 b), 2.1.3.1

Building element	Construction R-values (m² K/W)[(1)]					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Roof	**Refer to the consultation document for the proposed R-values for each element and climate zone**					
Wall						
Floor						
Windows						
Skylights						

Notes:

(1) Climate zone boundaries are shown in Appendix C.

2.1.3 Calculation method

2.1.3.1 This method compares the proposed *building* with the reference *building* which is insulated in accordance with Table 2.1.2.2A and Table 2.1.2.2B. This method permits *roof*, wall, floor and window insulation combinations which differ from these tables, but the *building* must perform at least as well as the reference *building*.

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

2.1.3.3 *Building elements* that form part of the *thermal envelope* with *construction R-values* different from those in the Schedule method in Subsection 2.1.2 may be used providing the heat loss of the proposed *building* ($HL_{Proposed}$) is less than or equal to the heat loss of the reference *building* ($HL_{Reference}$) for the relevant climate zone and window *area*.

2.1.3.4 $HL_{Reference}$ shall be calculated using the equations in Table 2.1.3.4.

TABLE 2.1.3.4: **Reference building heat loss equations**

Paragraph 2.1.3.4

Window area	Climate zone[1]	Reference building heat loss equation
≤ 30% of *total wall area*	1	$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{R_{roof}} + \frac{A_{70\% \text{ of the total wall area}}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{30\% \text{ of the total wall area}}}{R_{window}}$ **Note: The values of R_{roof}, R_{wall}, R_{floor}, and R_{window} depend on the R-values to be provided in the Schedule method. Refer to the consultation document for the proposed R-values for each element and climate zone**
	2	
	3	
	4	
	5	
	6	
> 30% of *total wall area*	1	$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{R_{roof}} + \frac{A_{wall} + A_{door}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{30\% \text{ of the total wall area}}}{R_{window}} + \frac{A_{window} - A_{30\% \text{ of the total wall area}}}{0.4}$ **Note: The values of R_{roof}, R_{wall}, R_{floor}, and R_{window} depend on the R-values to be provided in the Schedule method. Refer to the consultation document for the proposed R-values for each element and climate zone**
	2	
	3	
	4	
	5	
	6	

Note:

(1) Climate zone boundaries are shown in Appendix C.

2.1.3.5 $HL_{Proposed}$ shall be calculated as the sum of all the *building element* heat losses according to Equation 1.

Equation 1: $$HL_{Proposed} = \frac{A_{roof}}{R_{roof}} + \frac{A_{wall}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{window}}{R_{window}} + \frac{A_{door}}{R_{door}} + \frac{A_{skylight}}{R_{skylight}}$$

where:

A is area of individual elements in the proposed *thermal envelope* (m^2) and

R is the *construction R-value* in the proposed *thermal envelope* ($m^2 \cdot K/W$)

2.1.3.6 If A_{door} is no more than 6 m^2 or 6% of the *total wall area* (whichever is greater) then A_{door} shall be set to zero in Equation 1. If A_{door} is greater than 6 m^2 and 6% of the *total wall area*, then A_{door} shall be set to the difference between A_{door} and the greater of 6 m^2 or 6% of the *total wall area* in Equation 1.

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

2.1.3.8 The *construction R-value* in the proposed *building* for *roofs*, walls, and floors, that form part of the *building thermal envelope* shall be at least 50% of the *construction R-value* of the corresponding *building element* in the reference *building* equation.

2.1.3.9 Where the *construction R-value* of a *building element* is not known, default *construction R-values* of 0.18 $m^2 \cdot K/W$ for an opaque *building element* and 0.15 $m^2 \cdot K/W$ for windows shall be used in the heat loss equation for the proposed *building*.

2.1.4 Determining thermal resistance of building elements

2.1.4.1 Acceptable methods for determining the *thermal resistance* (*R-values*) of *building elements* are contained in NZS 4214.

> COMMENT: The BRANZ House Insulation Guide provides *thermal resistances* of common building components and is based on calculations from NZS 4214.

2.1.4.2 Acceptable methods for determining the *thermal resistance* (*R-values*) of some insulation materials are contained in AS/NZS 4859.1.

2.1.4.3 The *construction R-values* of *building elements* shall be calculated using the typical area as follows:

a) For walls and *roofs*, the *R-value* is of a typical area of the *building element* excluding the effects of openings and corners; and

b) For framed walls, this includes studs, dwangs, top plates, and bottom plates, but excludes lintels, additional studs that support lintels, and additional studs at corners and junctions; and

c) For walls without frames, this excludes any attachment requirements for windows and doors; and

d) For slab floors, the *R-value* is from the inside air to the outside air; and

e) For suspended floors, the *R-value* is of a typical area of the floor excluding the effects of openings and corners; and

f) For windows, refer to R_{window} as specified in Appendix D; and

g) For doors, the *R-value* excludes the door frame, opening tolerances and glazing.

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

2.1.4.5 The *R-value* of an unconditioned air-space between the *thermal envelope* and the *building envelope* may be included in the *construction R-value*. This can include a subfloor, *roof* space, garage, and/or conservatory.

> COMMENT: Garages should form part of the *unconditioned space* of a *building*, that is, they should be outside the *thermal envelope*. Any *building elements* between attached garages and the *conditioned spaces* of a *building* form part of the *thermal envelope* and therefore be insulated.

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

2.1.4.7 Concrete slab-on-ground floors are deemed to achieve a *construction R-value* of 1.3 $m^2{\cdot}K/W$, unless a higher *R-value* is justified by calculation or physical testing.

2.2 Airflow

2.2.1 Control of airflow

H CR CN Com

2.2.1.1 **Housing, communal residential, communal non-residential** assembly care, and **commercial** *buildings* shall have windows, doors, vents or other *building elements* that allow significant movement of air, to be *constructed* in such a way that they are capable of being fixed in the closed position.

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> COMMENT: G4/AS1 provides for the supply of outdoor air for ventilation by way of windows and doors that can be fixed in the open position.

2.3 Solar heat gains

2.3.1 Control of solar heat gains

2.3.1.1 Requirements to account for heat gains from solar radiation are satisfied by complying with the requirements for *thermal resistance* in Section 2.1.

Part 3. Building services

3.1 Hot water systems

3.1.1 Hot water systems for sanitary fixtures and sanitary appliances

3.1.1.1 Hot water systems for *sanitary fixtures* and *sanitary appliances* having a storage water heater capacity of up to 700 litres shall comply with NZS 4305.

COMMENT:

1. NZS 4305 deals with domestic type electrical and gas systems having a storage water heater capacity of up to 700 litres. Larger systems and their associated piping are not controlled by the Building Code.
2. The manufacture and sale of hot water cylinders and gas water heaters are covered by the Energy Efficiency (Energy Using Products) Regulations 2002. The associated NZ Minimum Energy Performance Standards for electric storage water heaters (MEPS as defined in NZS 4606.1 and the relevant NZ section of AS/NZS 4692.2) are equivalent to the requirements in this acceptable solution (see NZS 4305 clause 2.1.1). Electric storage water heaters that do not comply with NZ MEPS do not comply with this acceptable solution.

Appendix A. References

For the purposes of Building Code compliance, the standards and documents referenced in this acceptable solution must be the editions, along with their specific amendments, listed below.

Standards New Zealand		**Where quoted**
NZS 4214: 2006	Methods of determining the total thermal resistance of parts of buildings	2.1.4.1, Definitions 2.1.4.2 Comment
NZS 4246: 2016	Energy efficiency – Installing bulk thermal insulation in residential buildings	2.1.1.5
NZS 4305: 1996	Energy efficiency – domestic type hot water systems	3.1.1.1
NZS 4606:-	Storage water heaters	
Part 1: 1989	General requirements	3.1.1.1 Comment
AS/NZS 4692:-	Electric water heaters	
Part 2: 2005	Minimum Energy Performance Standards (MEPS) requirements and energy labelling	3.1.1.1 Comment
AS/NZS 4859:-	Materials for the thermal insulation of buildings	
Part 1: 2002	General criteria and technical provisions	2.1.4.2

These standards can be accessed from www.standards.govt.nz

BRANZ

ALF 4.0	Annual Loss Factor 4.0, 4th Edition (2018)	Definitions

This document can be accessed from www.branz.co.nz

National Institute of Water and Atmospheric Research Ltd (NIWA)

Temperature Normals for New Zealand 1961-1990 by A I Tomlinson and J Sansom (ISBN 0478083343)	Definitions

This document can be accessed from www.niwa.co.nz

New Zealand Legislation

Energy Efficiency (Energy Using Products) Regulations 2002	3.1.1.1 Comment

This document can be accessed from www.legislation.govt.nz

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Appendix B. Definitions

These definitions are specific to this acceptable solution. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	Means *adequate* to achieve the objectives of the Building Code.
Approved temperature data	Means the temperature data contained in A I Tomlinson and J Sansom, Temperature Normals for New Zealand for period 1961 to 1990 (NIWA, ISBN 0478083343).
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Building element	Any structural or non-structural component or assembly incorporated into or associated with a *building*. Included are *fixtures*, services, *drains*, permanent mechanical installations for access, glazing, partitions, ceilings and temporary supports.
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 performance index (BPI)	In relation to a *building*, means the *heating energy* of the *building* divided by the product of the *heating degrees total* and the sum of the *floor area* and the *total wall area*, and so is calculated in accordance with the following formula: $BPI = \frac{\text{Heating energy}}{\text{Heating degrees total x (floor area + total wall area)}}$
Conditioned space	That part of a *building* within the *building thermal envelope* that may be directly or indirectly heated or cooled for occupant comfort. It is separated from *unconditioned space* by *building elements* (walls, windows, *skylights*, doors, *roof*, and floor) to limit uncontrolled airflow and heat loss.
Construct	In relation to a *building*, includes to design, build, erect, prefabricate, and relocate the *building*.
Construction R-value	The *R-value* of a typical area of a *building element* where: a) For walls and *roofs*, the *R-value* is of a typical area of the *building element* excluding the effects of openings and corners; and b) For framed walls, this includes studs, dwangs, top plates, and bottom plates, but excludes lintels, additional studs that support lintels, and additional studs at corners and junctions; and c) For walls without frames, this excludes any attachment requirements for windows and doors; and d) For slab floors, the *R-value* is from the inside air to the outside air but excludes carpets and other floor coverings; and e) For suspended floors, the *R-value* is of a typical area of the floor but excludes carpets, other floor coverings, and the effects of openings and corners; and f) For windows, the *R-value* includes the effects of both the glazing materials and the frame materials; and g) For doors, the *R-value* is of the door excluding the frame, opening tolerances, and glazing.
Door area (A_{door})	The total area of doors in the *thermal envelope*, including frames and opening tolerances, but excluding all glazing, decorative glazing, and louvres.
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment

Floor area	In relation to a *building*, means the *floor area* (expressed in square metres) of all interior spaces used for activities normally associated with domestic living.
Heated ceiling, wall or floor	Any ceiling, wall or floor incorporating embedded pipes, electrical cables, or similar means of raising the temperature of the ceiling, wall, or floor for room heating.
Heating degrees	In relation to a location and a *heating month*, means the degrees obtained by subtracting from a base temperature of 14°C the mean (calculated using the *approved temperature data*) of the outdoor temperatures at that location during that month.
Heating degrees total	In relation to a location and year, means whichever is the greater of the following: a) the value of 12 and b) the sum of all the *heating degrees* (calculated using the *approved temperature data*) for all of the *heating months* of the year.
Heating energy	In relation to a *building*, means the energy from a *network utility operator* or a depletable resource (expressed in kilowatt-hours, and calculated using ALF 4.0, A tool for determining the Building Performance Index (BPI) of a house design (2018, BRANZ, Ltd) or some other method that can be correlated with that manual) needed to maintain the *building* at all times within a year at a constant internal temperature under the following standard conditions: a) a continuous temperature of 20°C throughout the *building:* b) an air change rate of 1 change per hour or the actual air leakage rate, whichever is the greater: c) a heat emission contribution arising from internal heat sources for any period in the year of 1000 kilowatt-hours for the first 50 m^2 of *floor area*, and 10 kilowatt-hours for every additional square metre of *floor area:* d) no allowance for— i) carpets; or ii) blinds, curtains, or drapes, on windows: e) windows to have a *shading coefficient* of 0.6 (made up of 0.8 for windows and recesses and 0.75 for site shading).
Heating month	In relation to a location, means a month in which a base temperature of 14°C is greater than the mean (calculated using the *approved temperature data*) of the outdoor temperatures at that location during that month.
HVAC system	For the purposes of performance H1.3.6 and in relation to a *building*, means a mechanical, electrical, or other system for modifying air temperature, modifying air humidity, providing ventilation, or doing all or any of those things, in a space within the *building*.
Insulating glass unit (IGU)	Two or more panes of glass spaced apart and factory sealed with dry air or special gases in the unit cavity. (Often abbreviated to IGU or referred to as the unit or double glazing).
Intended use	In relation to a *building*, — a) includes any or all of the following: i) any reasonably foreseeable occasional use that is not incompatible with the intended use; ii) normal maintenance; iii) activities undertaken in response to *fire* or any other reasonably foreseeable emergency; but b) does not include any other maintenance and repairs or rebuilding.

Network utility operator	Means a *person* who— a) undertakes or proposes to undertake the distribution or transmission by pipeline of natural or manufactured gas, petroleum, biofuel, or geothermal energy; or b) operates or proposes to operate a network for the purposes of— i) telecommunications as defined in section 5 of the Telecommunications Act 2001; or ii) radiocommunications as defined in section 2(1) of the Radiocommunications Act 1989; or c) is an electricity operator or electricity distributor as defined in section 2 of the Electricity Act 1992 for the purpose of line function services as defined in that section; or d) undertakes or proposes to undertake the distribution of water for supply (including irrigation); or e) undertakes or proposes to undertake a drainage or sewerage system
Occupied space	Any space within a *building* in which a *person* will be present from time to time during the intended use of the *building*.
Persons	Includes— a) the Crown; and b) a corporation sole; and c) a body of *persons* (whether corporate or unincorporated).
R-value	The common abbreviation for describing the values of both *thermal resistance* and *total thermal resistance*.
Roof	Any roof/ceiling combination where the exterior surface of the *building* is at an angle of 60° or less to the horizontal and has its upper surface exposed to the outside.
Roof area (A_{roof})	The area of the roof that is part of the thermal envelope, excluding the *skylight area*.
Sanitary appliance	An appliance which is intended to be used for *sanitation*, but which is not a *sanitary fixture*. Included are machines for washing dishes and clothes.
Sanitary fixture	Any *fixture* which is intended to be used for *sanitation.*
Sanitation	The term used to describe the activities of washing and/or excretion carried out in a manner or condition such that the effect on health is minimised, with regard to dirt and infection
Shading coefficient	The ratio of the total *solar heat gain coefficient* (SHGC) through a particular glass compared to the total *solar heat gain coefficient* through 3 mm clear float glass.
Skylight	Translucent or transparent parts of the *roof*.
Skylight area ($A_{Skylight}$)	The area of *skylights* that are part of the *roof thermal envelope*, including frames and opening tolerances.
Solar heat gain coefficient (SHGC)	The total solar energy entering a *building* through the glazing, that is, the direct transmission of energy from the sun plus the inwards re-radiation of heat from solar radiation that is absorbed in the glass. The SHGC is also known as the solar factor (SF) or g (*glazing* factor).
Surface (of glass)	The glass surfaces of single glazing and double glazing are numbered from the outside to the inside. The outside face of the outer pane is surface one, the inside face of the outer pane is surface two. In single glazing there are only two surfaces. With double glazing the outer surface of the inner pane is surface three, and the inner surface of the inner pane is surface four.

Definitions

Thermal envelope	The *roof*, wall, window, *skylight*, door, and floor *construction* between *unconditioned spaces* and *conditioned spaces*.
Thermal envelope floor area (A_{floor})	The area of the floor that forms part of the *thermal envelope*.
Thermal resistance	The resistance to heat flow of a given component of a *building element*. It is equal to the air temperature difference (K) needed to produce unit heat flux (W/m^2) through unit area (m^2) under steady conditions. The units are $m^2{\cdot}K/W$.
Total thermal resistance	The overall air-to-air *thermal resistance* across all components of a *building element* such as a wall, *roof,* or floor. (This includes the surface resistances which may vary with environmental changes e.g. temperature and humidity, but for most purposes can be regarded as having standard values as given in NZS 4214.)
Total roof area	The *roof* area (A_{roof}) plus the *skylight area* ($A_{skylight}$)
Total wall area	In relation to a *building,* means the sum (expressed in square metres) of the following: a) the *wall area* of the *building*; and b) the area (expressed in square metres) of all vertical windows in *external walls* of the *building*.
U-value (for windows)	A measure of air-to-air heat transmission (loss or gain) due to the thermal conductance of the window and the difference between indoor and outdoor temperatures. It is calculated as (U-value) where U = 1/R (*thermal resistance*). The units are $W/(m^2{\cdot}K)$.
Unconditioned space	Space within the *building envelope* that is not *conditioned space* (for example, this may include a garage, conservatory, atrium, attic, subfloor, and so on). However, where a garage, conservatory or atrium is expected to be heated or cooled these spaces shall be included in the *conditioned space*.
Wall area	The area of walls that are part of the *thermal envelope*, excluding the *door area* and the *window area*.
Wharenui	A communal meeting house having a large open *floor area* used for both assembly and sleeping in the traditional Māori manner.
Window area (A_{window})	The total area of glazing in the *thermal envelope*, including frames and opening tolerances, glazing in doors, and decorative glazing and louvres, but excluding *skylights*.

Appendix C. New Zealand climate zones

C.1 Climate zones

C.1.1 Climate zone boundaries

C.1.1.1 There are six climate zones. The climate zone boundaries are based on climatic data taking into consideration territorial authority boundaries.

C.1.1.2 A list of the climate zones for each territorial authority is provided in Table C.1.1.2 and illustrated in Figure C.1.1.2. The list in the table takes precedence.

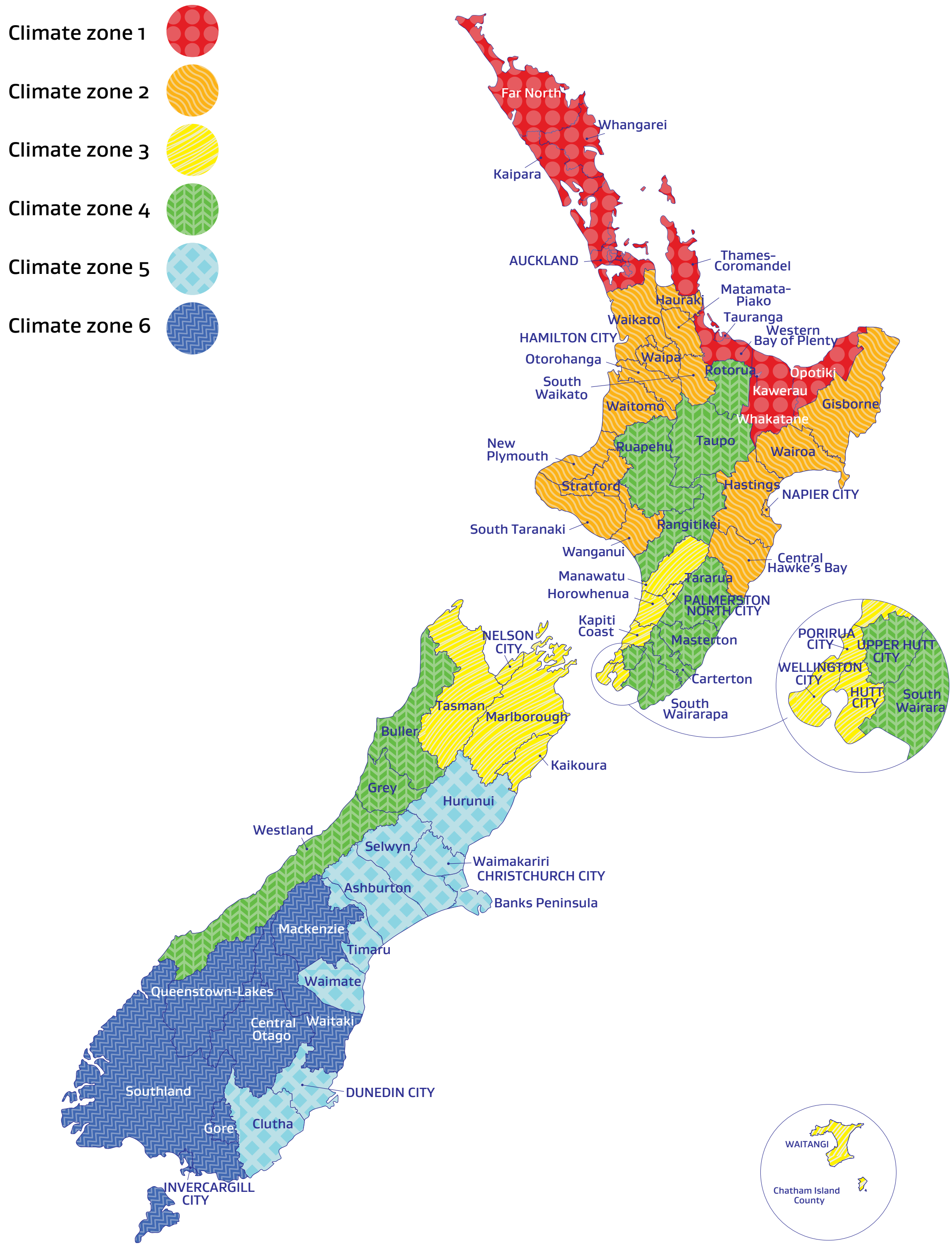
TABLE C.1.1.2: Climate zones by territorial authority

Paragraph C.1.1.2

North Island/Te Ika-a-Māui		South Island/Te Waipounamu	
Territorial authority	Climate zone	Territorial authority	Climate zone
Far North District	1	Tasman District	3
Whangarei District	1	Nelson City	3
Kaipara District	1	Marlborough District	3
Auckland	1	Kaikoura District	3
Thames-Coromandel district	1	Buller District	4
Hauraki District	2	Grey District	4
Waikato District	2	Westland District	4
Matamata-Piako District	2	Hurunui District	5
Hamilton City	2	Waimakariri District	5
Waipa District	2	Christchurch City	5
Otorohanga District	2	Selwyn District	5
South Waikato District	2	Ashburton District	5
Waitomo District	2	Timaru District	5
Taupo District	4	Mackenzie District	6
Western Bay of Plenty District	1	Waimate District	5
Tauranga City	1	Chatham Islands	3
Rotorua District	4	Waitaki District	6
Whakatane District	1	Central Otago District	6
Kawerau District	1	Queenstown-Lakes District	6
Opotiki District	1	Dunedin City	5
Gisborne District	2	Clutha District	5
Wairoa District	2	Southland District	6
Hastings District	2	Gore District	6
Napier City	2	Invercargill City	6
Central Hawke's Bay District	2		
New Plymouth District	2		
Stratford District	2		
South Taranaki District	2		
Ruapehu District	4		
Whanganui District	2		
Rangitikei District	4		
Manawatu District	3		
Palmerston North City	3		
Tararua District	4		
Horowhenua District	3		
Kapiti Coast District	3		
Porirua City	3		
Upper Hutt City	4		
Lower Hutt City	3		
Wellington City	3		
Masterton District	4		
Carterton District	4		
South Wairarapa District	4		

FIGURE C.1.1.2: Map of New Zealand climate zones

Paragraph C.1.1.2



Appendix D. Windows and glazing

D.1 Vertical windows

D.1.1 Construction R-values

D.1.1.1 The *construction R-values* for windows shall include the effects of both the glazing materials and the frame materials, and are defined as R_{window}. R_{window} shall be determined using the method described in Subsection D.1.2, or determined from the performance tables in Subsection D.1.3.

COMMENT:

1. The thermal performance of a window shall take account of both the glazing materials and the frame material in order to provide the true *thermal resistance* (*R-value*, or the reciprocal of this being the thermal transmission or *U-value*) of the window as a 'total product'. The thermal performance of glazing products is measured without the influence of the frame and is normally quoted as centre of glass (COG) *U-values* or *R-values*.
2. The window size and frame material have a major bearing on the *total thermal resistance* of the window as a *building element* and often the centre of glass *R-value* (R_{COG}) and the *total thermal resistance* (R_{Window}) values are dissimilar. For large windows the centre of glass R-value (R_{COG}) will have more bearing on the overall performance than in a small window, which is dominated by the frame performance.
3. The amount of free heat that enters a window from the sun is measured with the *SHGC* or the *shading coefficient* (SC). If the *SHGC* is below 0.69, the solar heat captured in winter may fall below an acceptable level and this should be considered in design.

D.1.2 Calculating window R-values

D.1.2.1 To calculate R_{window} for vertical windows, use a standardised procedure for determining the *R-value* of the glazing and frame based on heat transfer analysis. This shall be based on a generic window of size 1800 mm wide x 1500 mm high with a central mullion and one opening light.

COMMENT:

1. The standard window described in Paragraph D.1.2.1 gives typical R_{window} *R-values* for standard aluminium joinery of 0.15 $m^2·K/W$ for single glazing and 0.26 $m^2·K/W$ for a standard *IGU*, based on a 4 mm glass/12 mm air/4 mm glass combination.
2. The BRANZ website provides information on the glazing systems used for the generic windows, and also has additional information about alternative framing and glazing options.
3. The *R/U-values* of windows *constructed* of different materials vary, as indicated in Table D.1.3.1A, Table D.1.3.1B, Table D.1.3.1C and Table D.1.3.1D.

D.1.3 Performance tables

D.1.3.1 The thermal performance of generic windows (R_{window}) may be determined from:

a) In aluminium frame, Table D.1.3.1A; and

b) In composite aluminium frame, Table D.1.3.1B; and

c) In thermally broken aluminium frame, Table D.1.3.1C; and

d) In PVC/wooden frame, Table D.1.3.1D.

COMMENT:

1. Table D.1.3.1A, Table D1.3.1B, Table D1.3.1C, and Table D.1.3.1D show both R_{window} and U_{window} of window systems with different glass types along with the U_{COG} and R_{COG}, so that designers have a guide to the total performance of a window given the U_{COG} for any glass type.
2. $SHGC_{COG}$ and SC_{COG} are given to allow comparison of the solar control or summer cooling performance of the window. The *shading coefficient* is calculated as SC = SHGC/0.86.
3. Manufacturers should be consulted about the suitability of using single glazed Low E glass. Low E coatings on single glazing can have a lower surface temperature in winter, and so can collect more condensation, which temporarily removes the benefit of the low emissivity surface.

D.2 Skylights

D.2.1 Construction R-values

D.2.1.1 The *construction R-values* for *skylights* ($R_{skylight}$) may be determined using the method described in Subsection D.1.2 by changing the window tilt or slope and thus the heat flow requirements.

D.2.1.2 Alternatively, manufacturer's data for the *construction R-value* may be used. In the absence of this information, $R_{skylight}$ shall be determined from the values of R_{window} from:

a) In aluminium frame, Table D.1.3.1A; and
b) In composite aluminium frame, Table D.1.3.1B; and
c) In thermally broken aluminium frame, Table D.1.3.1C; and
d) In PVC/wooden frame, Table D.1.3.1D.

TABLE D.1.3.1A: **Thermal performance of generic windows in aluminium frame**

Paragraphs D.1.3.1 a), D.2.1.2 a)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in aluminium frame[1]											
101	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.70	0.15
102	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	6.58	0.15
103	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.81	0.21
104	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	5.21	0.19
105	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.68	0.15
106	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.68	0.15
107	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.66	0.15
108	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.68	0.15
109	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	6.65	0.15
Insulating glass units in aluminium frame[2],[3]											
110	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	4.22	0.24
111	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	4.06	0.25
112	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.96	0.25
113	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.90	0.26
114	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.89	0.26
115	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.89	0.26
116	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.89	0.26
117	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.89	0.26
118	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.89	0.26
119	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.90	0.26
120	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.82	0.26
121	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.78	0.26
122	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.78	0.26
123	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	3.28	0.31
124	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	3.44	0.29
125	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	3.27	0.31
126	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	3.27	0.31
127	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	3.14	0.32
128	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	3.09	0.32

Notes:

(1) For single glazing, the Low E coated *surface* is on *surface* 2 inside the *building*.

(2) For an *IGU,* the Low E coating is on *surface* 2 if an outer pane and *surface* 3 of the *IGU* if an inner pane.

(3) The performance of units containing argon gas is based on the cavity having a 90% argon/10% air mix.

TABLE D.1.3.1B: Thermal performance of generic windows in composite aluminium frame

Paragraphs D.1.3.1 b), D.2.1.2 b)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in composite frame(1)											
201	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.58	0.15
202	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	6.46	0.15
203	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.69	0.21
204	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	5.09	0.20
205	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.56	0.15
206	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.56	0.15
207	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.53	0.15
208	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.56	0.15
209	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	6.53	0.15
Insulating glass units in composite frame(2),(3)											
210	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	4.19	0.24
211	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	4.03	0.25
212	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.92	0.25
213	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.86	0.26
214	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.86	0.26
215	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.86	0.26
216	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.85	0.26
217	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.86	0.26
218	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.85	0.26
219	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.86	0.26
220	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.79	0.26
221	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.74	0.27
222	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.74	0.27
223	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	3.24	0.31
224	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	3.41	0.29
225	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	3.24	0.31
226	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	3.24	0.31
227	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	3.10	0.32
228	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	3.06	0.33

Notes:

(1) For single glazing, the Low E coated *surface* is on *surface* 2 inside the *building*.

(2) For an *IGU,* the Low E coating is on *surface* 2 if an outer pane and *surface* 3 of the *IGU* if an inner pane.

(3) The performance of units containing argon gas is based on the cavity having a 90% argon/10% air mix.

TABLE D.1.3.1C: **Thermal performance of generic windows in thermally broken aluminium frame**

Paragraphs D.1.3.1 c), D.2.1.2 c)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in thermally broken aluminium frame[1]											
301	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.04	0.17
302	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	5.92	0.17
303	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.16	0.24
304	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	4.55	0.22
305	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.02	0.17
306	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.02	0.17
307	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.00	0.17
308	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.02	0.17
309	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	5.99	0.17
Insulating glass units in thermally broken aluminium frame[2],[3]											
310	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	3.54	0.28
311	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	3.38	0.30
312	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.28	0.31
313	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.22	0.31
314	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.21	0.31
315	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.21	0.31
316	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.21	0.31
317	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.21	0.31
318	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.20	0.31
319	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.22	0.31
320	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.14	0.32
321	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.10	0.32
322	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.10	0.32
323	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	2.60	0.39
324	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	2.76	0.36
325	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	2.59	0.39
326	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	2.59	0.39
327	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	2.46	0.41
328	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	2.41	0.41

Notes:

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

TABLE D.1.3.1D: **Thermal performance of generic windows in PVC/wooden frame**

Paragraphs D.1.3.1 d), D.2.1.2 d)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in PVC/wooden frame[(1)]											
401	4	Clear	–	–	–	0.85	0.97	5.88	0.17	5.23	0.19
402	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	5.11	0.20
403	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	3.35	0.30
404	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	3.74	0.27
405	5	Grey	–	–	–	0.62	0.71	5.85	0.17	5.21	0.19
406	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	5.21	0.19
407	6	Green	–	–	–	0.61	0.71	5.82	0.17	5.19	0.19
408	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	5.21	0.19
409	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	5.18	0.19
Insulating glass units in PVC/wooden frame[(2),(3)]											
410	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	3.07	0.33
411	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	2.91	0.34
412	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	2.81	0.36
413	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	2.75	0.36
414	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	2.75	0.36
415	5	Bronze	12	4	Clear	0.56	0.64	2.73	0.37	2.75	0.36
416	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	2.74	0.36
417	5	Evergreen	12	4	Clear	0.46	0.54	2.73	0.37	2.75	0.36
418	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	2.74	0.36
419	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	2.75	0.36
420	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	2.67	0.37
421	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	2.63	0.38
422	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	2.63	0.38
423	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	2.13	0.47
424	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	2.29	0.44
425	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	2.13	0.47
426	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	2.13	0.47
427	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	1.99	0.50
428	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	1.95	0.51

Notes:

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

Appendix E. Orientation

E.1 Orientation

E.1.1 Establishing building orientation

E.1.1.1 A *building* wall, including windows it contains, shall be considered to face north if it faces any direction in the north orientation sector of Figure E.1.2.1.

E.1.1.2 The orientations of *skylights* and other walls, including the windows they contain, shall be determined in a similar way.

E.1.2 Description of sectors

E.1.2.1 Orientation sectors are based on true north and are as follows (see Figure E.1.2.1):

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

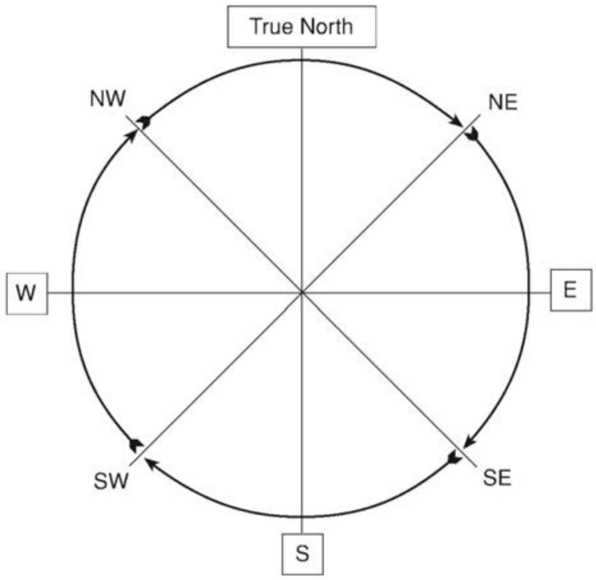
b) East sector lies between north east (45°) and south east (135°); and

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

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

FIGURE E.1.2.1: **Orientation sector map**

Paragraphs E.1.1.1, E.1.2.1



COMMENT: A compass points toward magnetic north. Magnetic north varies from true north by 19.5° in Auckland, 22° in Wellington and 23.5° in Christchurch. In New Zealand magnetic north is always east of true north. It is important that true north is used for the orientation rather than magnetic north. The following website calculates the difference between magnetic north and true north (magnetic declination) www.gns.cri.nz/Home/Our-Science/Land-and-Marine-Geoscience/Earth-s-Magnetic-Field/Declination-around-New-Zealand.

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MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

BP 6458

BUILDING PERFORMANCE

H1 Energy Efficiency

Verification Method H1/VM1

Energy efficiency for all housing, and buildings up to 300 m²

DRAFT FOR PUBLIC CONSULTATION

FIFTH EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

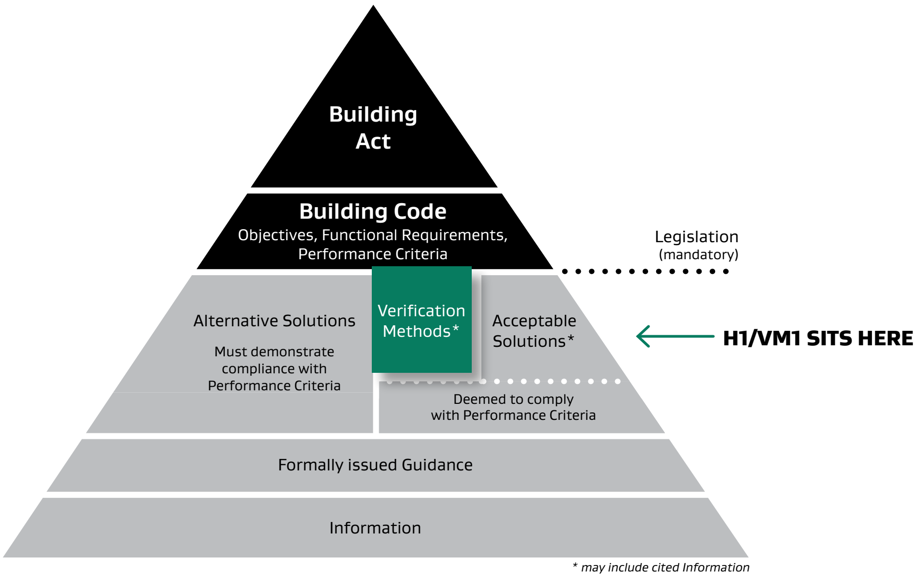
Document status

This document (H1/VM1) is a verification method issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX. The previous Verification Method H1/VM1, as amended, can be used to show compliance until X XXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX.

Building Code regulatory system

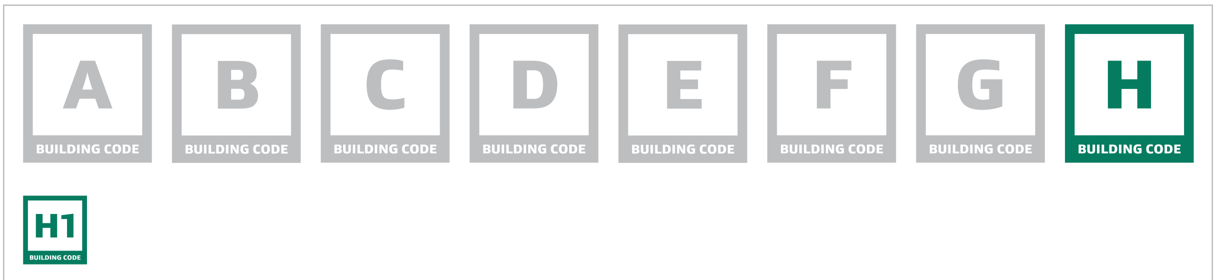
Each verification method outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this verification method relates to is clause H1 Energy Efficiency. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This verification method is the fifth edition of H1/VM1. The main changes from the previous version are:

- The scope of H1/VM1 has been reduced to cover only housing and buildings less than 300 m^2. Requirements applicable for large buildings have been combined into the new Verification Method H1/VM2. To reflect the new scope of the documents and the new document layout, a new introduction and scope has been provided in Part 1. General.
- Citation of NZS 4218: 2009 "Thermal insulation – Housing and small buildings" has been removed from the document. The relevant content from this standard has been adopted into H1/AS1 with permission from Standards New Zealand.
- The three-zone climate zone map previously found in NZS 4218 has been updated with a six-zone climate zone map in Appendix C.
- The minimum R-values previously found in NZS 4218 are replaced with new values and new text in Part 2. Building thermal envelope.
- Portions of text have been re-written to enhance clarity in the document and provide consistent language with other acceptable solutions and verification methods.
- References have been revised to include only documents within the scope of H1/AS1 and have been amended to include the most recent versions of NZS 4246 and ALF in Appendix A.
- The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solutions and verification methods are available from www.building.govt.nz

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This document applies to:

H CR CN Com

a) **housing**; and

b) other *buildings* with a floor area of *occupied space* no greater than 300 m^2, that are **communal residential***,* **communal non-residential** (assembly care only) and **commercial** *buildings*.

> i
>
> COMMENT: **Housing** includes *detached dwellings*, *multi-unit dwellings* such as *buildings* which contain more than one separate household or family, e.g. an apartment *building*, and also group dwellings, e.g. a *wharenui*.

1.1.1.2 For *buildings* that do not meet these characteristics, refer to the Acceptable Solution H1/AS2 or Verification Method H1/VM2 as a means to demonstrate compliance or use an alternative means to demonstrate compliance.

1.1.2 Items outside the scope of this document

1.1.2.1 This verification method does not include the use of foil insulation.

1.1.2.2 This verification method does not include requirements to comply with Building Code clauses H.1.3.1(b), H1.3.4, H1.3.5 or H1.3.6. For these clauses, use an alternative means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This verification method is one option that provides a means of establishing compliance with the performance criteria in Building Code clauses H.1.3.1(a), H1.3.2E, and H1.3.3.

1.1.3.2 Options for demonstrating compliance with H1 Energy Efficiency through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.1.3.3 Compliance with Building Code clause H1.3.1(a) (*adequate thermal resistance*) satisfies clause H1.3.2E (*Building Performance Index* or *BPI*).

> i
>
> COMMENT:
>
> 1. The modelling method described in Part 2. is a verification method for Building Code clause H1.3.1(a) (*adequate thermal resistance*). However, compliance with clause H1.3.2E (*Building Performance Index or BPI*) is not sufficient for demonstrating compliance with clause H1.3.1(a) (*adequate thermal resistance*).
> 2. ALF 4.0, published by BRANZ, calculates the *BPI*. Note that the ALF procedures are intended for detached dwellings and are not suitable for multi-unit dwellings.
> 3. The 20°C stated in the definition of *heating energy* is for calculation purposes only.

TABLE 1.1.3.2: Demonstrating compliance with H1 Energy Efficiency through acceptable solutions and verification methods

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
H1.3.1 (a) and (b) Thermal Envelope	H **Housing** CR **Communal residential** CN **Communal non-residential** (assembly care only) Com **Commercial**	For **housing**, and *buildings* no greater than 300 m^2: H1/AS1 or H1/VM1 For large *buildings*: H1/AS2 or H1/VM2
H1.3.2E *Building performance index*	H **Housing**	H1/AS1 or H1/VM1
H1.3.3 (a) to (f) Physical conditions	All *buildings*	For **housing**, and *buildings* no greater than 300 m^2: H1/AS1 or H1/VM1 For large buildings: H1/AS2 or H1/VM2
H1.3.4 (a) Heating of hot water	All *buildings*	For **housing**, and *buildings* no greater than 300 m^2: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (b) Storage vessels and distribution systems	Individual storage vessels ≤ 700 L in capacity	For **housing**, and *buildings* no greater than 300 m^2: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (c) Efficient use of hot water	H **Housing**	H1/AS1
H1.3.5 Artificial lighting	Lighting not provided solely to meet the requirements of Building Code clause F6 in: Com CN **Commercial** and **Communal non-residential** having *occupied space* greater than 300 m^2	H1/AS2
H.1.3.6 *HVAC systems*	Com **Commercial**	H1/VM3

1.2 Using this verification method

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

Ind 1.2.1.2 In *buildings* containing both **industrial** and other classified uses, the non-industrial portion shall be treated separately according to its classified use. For example, in a building containing both **industrial** and **commercial** classified uses, the **commercial** area shall meet the relevant NZBC energy efficiency requirements.

1.2.2 Determining the area of the building

H 1.2.2.1 For **housing**, use the *floor area* of the *building*.

1.2.2.2 For *buildings* other than **housing**, calculate the area based on the *occupied space* of the *building*.

1.2.3 Features of this document

1.2.3.1 For the purposes of Building Code compliance, the standards and documents referenced in this acceptable solution must be the editions, along with their specific amendments listed in Appendix A.

1.2.3.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.3.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.3.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses. These requirements are also denoted with classified use icons for:

- H a) **Housing**, and
- CR b) **Communal residential**, and
- CN c) **Communal non-residential**, and
- Com d) **Commercial**.
- Ind e) **Industry**, and
- Out f) **Outbuildings**, and
- Anc g) **Ancillary**.

1.2.3.5 Appendices to this verification method are part of, and have equal status to, the verification method. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Building thermal envelope

2.1 Thermal resistance

2.1.1 Demonstrating compliance

2.1.1.1 The *building* envelope shall be provided with *construction* that provides *adequate thermal resistance.* This is demonstrated through the use of the *building* energy use modelling method described in Subsection 2.1.2.

> COMMENT: To satisfy the Building Code performance requirement E3.3.1 for internal moisture, it may be necessary, depending on the method adopted, to provide more insulation (a greater *R-value*) than that required to satisfy energy efficiency provisions alone.

2.1.2 Modelling method for verification of the design

2.1.2.1 Verification of the design is achieved by demonstrating that the energy use of the proposed *building* design does not exceed the energy use of the reference *building* using computer modelling described in Appendix D.

2.1.2.2 The sum of the calculated annual *heating load* and annual *cooling load* of the proposed *building* shall not exceed that of the reference *building*. The reference *building* shall have *construction R-values* from:

a) For *building elements* that contain embedded heat systems, Table 2.1.2.2A; or

b) For *building elements* that do not contain embedded heating systems, Table 2.1.2.2B.

2.1.2.3 The requirements for the reference *building* are separated based on the relevant climate zone for the *building*. A list of the New Zealand Climate zones is provided in Appendix C.

2.1.2.4 For *building elements* that contain embedded heating systems, the proposed *building* must, as a minimum, meet the *construction R-values* of Table 2.1.2.2A.

2.1.3 Determining thermal resistance

2.1.3.1 The *thermal resistance* (*R-values*) of *building elements* may be verified by using NZS 4214.

> COMMENT: The BRANZ 'Housing Insulation Guide' provides thermal resistances of common *Building elements* and is based on calculations from NZS 4214.

TABLE 2.1.2.2A: **Minimum construction R-values for heated ceilings, walls or floors**

Paragraph 2.1.2.2 a), 2.1.2.4

Building element	Construction R-values (m² K/W) (1), (2), (3)					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Heated ceiling	**Refer to the consultation document for the proposed R-values for each element and climate zone**					
Heated wall						
Heated floor						

Notes:

(1) R_{IN}/R-value < 0.1 and R_{IN} is the *thermal resistance* between the heated plane and the inside air.

(2) Floor coverings, for example carpet or cork, will reduce the efficiency of the *heated floor*.

(3) Climate zone boundaries are shown in Appendix C.

TABLE 2.1.2.2B: **Reference building construction R-values for building elements not containing embedded heating systems**

Paragraph 2.1.2.2 b)

Building element	Construction R-values (m² K/W) (1)					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Roof	**Refer to the consultation document for the proposed R-values for each element and climate zone**					
Wall						
Floor						
Windows						
Skylights						

Note:

(1) Climate zone boundaries are shown in Appendix C.

Appendix A. References

For the purposes of Building Code compliance, the Standards and documents referenced in this Verification Method must be the editions, along with their specific amendments, listed below.

Standards New Zealand		Where quoted
NZS 4214: 2006	Methods of determining the total thermal resistance of parts of buildings	2.1.3.1, Definitions
NZS 4303: 1990	Ventilation for acceptable indoor air quality	D.3.2.1.b)

This standard can be accessed from www.standards.govt.nz

American National Standards Institute

ANSI/ASHRAE 140: 2017	Standard method of test for the evaluation of building energy analysis computer programs	D.1.3.1

This standard can be accessed from webstore.ansi.org/

International Energy Agency

Building Energy Simulation Test (BESTEST) and Diagnostic Method (1995)	D.1.3.1

This document can be accessed from www.nrel.gov

BRANZ Ltd

ALF 4.0	Annual Loss Factor version 4.0, 4th Edition (2018)	Definitions

This document can be accessed from www.branz.co.nz

National Institute of Water and Atmospheric Research Ltd (NIWA)

Temperature Normals for New Zealand 1961-1990 by A I Tomlinson and J Sansom (ISBN 0478083343)	Definitions

This document can be accessed from www.niwa.co.nz

Appendix B. Definitions

These definitions are specific to this verification method. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	Means *adequate* to achieve the objectives of the Building Code.
Approved temperature data	Means the temperature data contained in A I Tomlinson and J Sansom, Temperature Normals for New Zealand for period 1961 to 1990 (NIWA, ISBN 0478083343).
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Building element	Any structural or non-structural component or assembly incorporated into or associated with a *building*. Included are *fixtures*, services, *drains*, permanent mechanical installations for access, glazing, partitions, ceilings and temporary supports.
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 performance index (BPI)	In relation to a *building*, means the *heating energy* of the *building* divided by the product of the *heating degrees total* and the sum of the *floor area* and the *total wall area*, and so is calculated in accordance with the following formula: $$\text{BPI} = \frac{\text{Heating energy}}{\text{Heating degrees total x (floor area + total wall area)}}$$
Conditioned space	That part of a *building* within the *building thermal envelope* that may be directly or indirectly heated or cooled for occupant comfort. It is separated from *unconditioned space* by *building elements* (walls, windows, *skylights*, doors, *roof*, and floor) to limit uncontrolled airflow and heat loss.
Construct	In relation to a *building*, includes to design, build, erect, prefabricate, and relocate the *building*.
Construction R-value	The *R-value* of a typical area of a *building element* where: a) For walls and *roofs*, the *R-value* is of a typical area of the *building element* excluding the effects of openings and corners; and b) For framed walls, this includes studs, dwangs, top plates, and bottom plates, but excludes lintels, additional studs that support lintels, and additional studs at corners and junctions; and c) For walls without frames, this excludes any attachment requirements for glazing and doors; and d) For slab floors, the *R-value* is from the inside air to the outside air but excludes carpets and other floor coverings; and e) For suspended floors, the *R-value* is of a typical area of the floor but excludes carpets, other floor coverings, and the effects of openings and corners; and f) For windows, the *R-value* includes the effects of both the glazing materials and the frame materials; and g) For doors, the *R-value* is of the door excluding the frame, opening tolerances, and glazing.
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).

Definitions

Default value	Value(s) to be used for modelling purposes, unless the designer can demonstrate that a different assumption better characterises the *building*'s use over its expected life.
Door area (A_{door})	The total area of doors in the *thermal envelope*, including frames and opening tolerances, but excluding all glazing, decorative glazing, and louvres.
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment
Floor area	In relation to a *building*, means the *floor area* (expressed in square metres) of all interior spaces used for activities normally associated with domestic living.
Heated ceilings, walls or floors	Any ceiling, wall or floor incorporating embedded pipes, electrical cables, or similar means of raising the temperature of the ceiling, wall, or floor for room heating.
Heating degrees	In relation to a location and a *heating month*, means the degrees obtained by subtracting from a base temperature of 14°C the mean (calculated using the *approved temperature data*) of the outdoor temperatures at that location during that month.
Heating degrees total	In relation to a location and year, means whichever is the greater of the following: a) the value of 12 and b) the sum of all the *heating degrees* (calculated using the *approved temperature data*) for all of the *heating months* of the year.
Heating energy	In relation to a *building*, means the energy from a *network utility operator* or a depletable resource (expressed in kilowatt-hours, and calculated using ALF 4.0, A tool for determining the *Building performance index* (BPI) of a house design (2018, BRANZ, Ltd) or some other method that can be correlated with that manual) needed to maintain the *building* at all times within a year at a constant internal temperature under the following standard conditions: a) a continuous temperature of 20°C throughout the *building:* b) an air change rate of 1 change per hour or the actual air leakage rate, whichever is the greater: c) a heat emission contribution arising from internal heat sources for any period in the year of 1000 kilowatt-hours for the first 50 m2 of *floor area*, and 10 kilowatt-hours for every additional square metre of *floor area:* d) no allowance for— i) carpets; or ii) blinds, curtains, or drapes, on windows: e) windows to have a shading coefficient of 0.6 (made up of 0.8 for windows and recesses and 0.75 for site shading).
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).
Heating month	In relation to a location, means a month in which a base temperature of 14°C is greater than the mean (calculated using the *approved temperature data*) of the outdoor temperatures at that location during that month.
HVAC system	For the purposes of performance H1.3.6 and in relation to a *building*, means a mechanical, electrical, or other system for modifying air temperature, modifying air humidity, providing ventilation, or doing all or any of those things, in a space within the *building*.

Definitions

Intended use	In relation to a *building*, — a) includes any or all of the following: i) any reasonably foreseeable occasional use that is not incompatible with the intended use; ii) normal maintenance; iii) activities undertaken in response to *fire* or any other reasonably foreseeable emergency; but b) does not include any other maintenance and repairs or rebuilding.
Network utility operator	Means a *person* who— a) undertakes or proposes to undertake the distribution or transmission by pipeline of natural or manufactured gas, petroleum, biofuel, or geothermal energy; or b) operates or proposes to operate a network for the purposes of— i) telecommunications as defined in section 5 of the Telecommunications Act 2001; or ii) radiocommunications as defined in section 2(1) of the Radiocommunications Act 1989; or c) is an electricity operator or electricity distributor as defined in section 2 of the Electricity Act 1992 for the purpose of line function services as defined in that section; or d) undertakes or proposes to undertake the distribution of water for supply (including irrigation); or e) undertakes or proposes to undertake a drainage or sewerage system
Occupied space	Any space within a *building* in which a person will be present from time to time during the *intended use* of the *building*.
Persons	Includes— a) the Crown; and b) a corporation sole; and c) a body of *persons* (whether corporate or unincorporated).
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	The common abbreviation for describing the values of both *thermal resistance* and *total thermal resistance*.
Roof	Any roof/ceiling combination where the exterior surface of the *building* is at an angle of 60° or less to the horizontal and has its upper surface exposed to the outside.
Roof area (A_{roof})	The area of the roof that is part of the *thermal envelope*, measured on the exterior side and excluding the *skylight area*.
Shading coefficient	The ratio of the total *Solar heat gain coefficient* (SHGC) through a particular glass compared to the total *Solar heat gain coefficient* through 3 mm clear float glass.
Skylight	Translucent or transparent parts of the *roof*.
Skylight area ($A_{skylight}$)	The area of skylights that are part of the *roof thermal envelope*, including frames and opening tolerances.

Definitions

Solar heat gain coefficient (SHGC)	The total solar energy entering a *building* through the glazing, that is, the direct transmission of energy from the sun plus the inwards re-radiation of heat from solar radiation that is absorbed in the glass. The SHGC is also known as the solar factor (SF) or g (glazing factor).
Thermal envelope	The *roof*, wall, window, *skylight*, door and floor *construction* between *unconditioned spaces* and *conditioned spaces*.
Thermal envelope floor area (A_{floor})	The area of the floor that forms part of the *thermal envelope*.
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	The resistance to heat flow of a given component of a *Building element*. It is equal to the air temperature difference (K) needed to produce unit heat flux (W/m^2) through unit area (m^2) under steady conditions. The units are $m^2{\cdot}K/W$.
Total thermal resistance	The overall air-to-air *thermal resistance* across all components of a *building element* such as a wall, *roof* or floor. (This includes the surface resistances which may vary with environmental changes eg temperature and humidity, but for most purposes can be regarded as having standard values as given in NZS 4214.)
Total roof area	The *roof* area (A_{roof}) plus the *skylight area* ($A_{skylight}$)
Total wall area	In relation to a *building,* means the sum (expressed in square metres) of the following: a) the *wall area* of the *building*; and b) the area (expressed in square metres) of all vertical windows in *external walls* of the *building.*
U-value (for glass)	A measure of air-to-air heat transmission (loss or gain) due to the thermal conductance of the glazing and the difference between indoor and outdoor temperatures. It is calculated as (U-value) where U = 1/R (*thermal resistance*). The units are $W/(m^2{\cdot}K)$.
Unconditioned space	Space within the *building envelope* that is not *conditioned space* (for example, this may include a garage, conservatory, atrium, attic, subfloor, and so on). However, where a garage, conservatory or atrium is expected to be heated or cooled these spaces shall be included in the *conditioned space*.
Wall area	The area of walls that are part of the *thermal envelope*, measured on the exterior side and excluding the *door area* and the *window area*.
Wharenui	A communal meeting house having a large open *floor area* used for both assembly and sleeping in the traditional Māori manner.
Window area (A_{window})	The total area of glazing in the *thermal envelope*, including frames and opening tolerances, glazing in doors, and decorative glazing and louvres, but excluding *skylights*.

Appendix C. New Zealand climate zones

C.1 Climate zones

C.1.1 Climate zone boundaries

C.1.1.1 There are six climate zones. The climate zone boundaries are based on climatic data taking into consideration territorial authority boundaries.

C.1.1.2 A list of the climate zones for each territorial authority is provided in Table C.1.1.2 and illustrated in Figure C.1.1.2. The list in the table takes precedence.

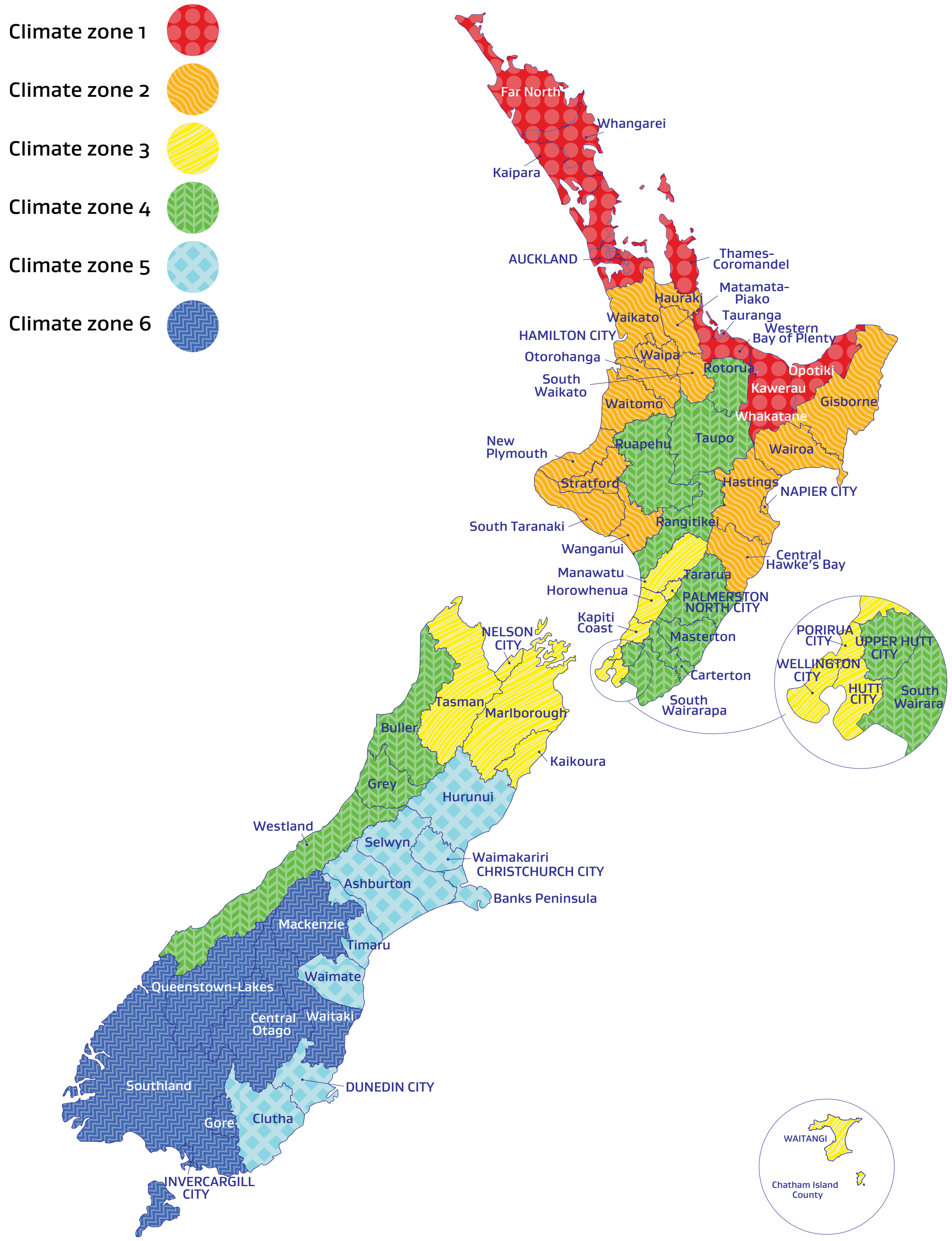
TABLE C.1.1.2: **Climate zones by territorial authority**

Paragraph C.1.1.2

North Island/Te Ika-a-Māui		South Island/Te Waipounamu	
Territorial authority	**Climate zone**	**Territorial authority**	**Climate zone**
Far North District	1	Tasman District	3
Whangarei District	1	Nelson City	3
Kaipara District	1	Marlborough District	3
Auckland	1	Kaikoura District	3
Thames-Coromandel district	1	Buller District	4
Hauraki District	2	Grey District	4
Waikato District	2	Westland District	4
Matamata-Piako District	2	Hurunui District	5
Hamilton City	2	Waimakariri District	5
Waipa District	2	Christchurch City	5
Otorohanga District	2	Selwyn District	5
South Waikato District	2	Ashburton District	5
Waitomo District	2	Timaru District	5
Taupo District	4	Mackenzie District	6
Western Bay of Plenty District	1	Waimate District	5
Tauranga City	1	Chatham Islands	3
Rotorua District	4	Waitaki District	6
Whakatane District	1	Central Otago District	6
Kawerau District	1	Queenstown-Lakes District	6
Opotiki District	1	Dunedin City	5
Gisborne District	2	Clutha District	5
Wairoa District	2	Southland District	6
Hastings District	2	Gore District	6
Napier City	2	Invercargill City	6
Central Hawke's Bay District	2		
New Plymouth District	2		
Stratford District	2		
South Taranaki District	2		
Ruapehu District	4		
Whanganui District	2		
Rangitikei District	4		
Manawatu District	3		
Palmerston North City	3		
Tararua District	4		
Horowhenua District	3		
Kapiti Coast District	3		
Porirua City	3		
Upper Hutt City	4		
Lower Hutt City	3		
Wellington City	3		
Masterton District	4		
Carterton District	4		
South Wairarapa District	4		

FIGURE C.1.1.2: Map of New Zealand Climate zones

Paragraph C.1.1.2



Appendix D. Modelling method – Building energy use comparison

D.1 Modelling requirements

D.1.1 Overview

D.1.1.1 This modelling method is used to assess the energy performance of a proposed *building* by using a simulation of the *building* to predict its space *heating loads* and *cooling loads*. This is compared with the space *heating loads* and *cooling loads* of a reference *building* that is the same shape, dimensions, and orientation as the proposed *building*, but has *building elements* with *construction R-values* from:

a) For *building elements* that contain embedded heating systems, Table 2.1.2.2A; or

b) For *building elements* that do not contain embedded heating systems, Table 2.1.2.2B.

D.1.1.2 Both *buildings* shall be simulated using the same method.

D.1.2 Modelling principles

D.1.2.1 The proposed *building* and reference *building* shall both be analysed using the same techniques and assumptions except where differences in energy efficiency features that are specified in this appendix require a different approach.

D.1.2.2 The specifications of the proposed *building* used in the analysis shall be as similar as is reasonably practicable to those in the plans submitted for a building consent.

D.1.2.3 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*.

D.1.2.4 Features that may differ between the proposed *building* and the reference *building* are:

a) Wall *construction R-value* and *thermal mass*; and/or

b) Floor *construction R-value*; and/or

c) *Roof construction R-value* and *thermal mass*; and/or

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

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

D.1.2.5 The results of the thermal modelling should not be construed as a guarantee of the actual energy use of the *building*.

D.1.3 Modelling software

D.1.3.1 If the application for which the software is to be used has been documented according to the ANSI/ASHRAE Standard 140 procedure, then the method shall pass ANSI/ASHRAE Standard 140 test. If the application for which the software is to be used has not been documented according to the ANSI/ASHRAE Standard 140 procedure, the method shall be tested to BESTEST and pass the BESTEST.

D.1.4 Default values

D.1.4.1 The *default values* and schedules included in this appendix shall be used unless the designer can demonstrate that different assumptions better characterise the *building's* use over its expected life. Any modification of default assumptions shall be used in simulating both the proposed building and the reference building.

D.1.4.2 Other aspects of the *building's* performance for which no *default values* are provided may be simulated 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*.

D.1.4.3 In all the following cases, modelling is to be identical for both the proposed *building* and the reference *building*. Some of these items have limitations on the input values and others have default schedules that may be used when actual figures are not known. In all cases these values shall be reasonable approximations of the requirements of the *building* and its use during its expected life:

a) Heating, set-points, and schedules; and
b) Cooling, set-points, and schedules; and
c) Ventilation, set-points, and schedules; and
d) Fresh air ventilation, air change rates, and schedules; and
e) Internal gains loads and schedules; and
f) Occupancy loads and schedules; and
g) The location and *R-values* of carpets and floor coverings; and
h) Incidental shading.

D.1.5 Climate data

D.1.5.1 Both the proposed *building* and the reference *building* shall be modelled using the same climate data. The climate data shall be from a weather station that best represents the climate at the *building* site. The climate data shall represent an average year for the site, over at least a 10-year period.

> COMMENT: Using the relevant NIWA Typical Meterological Year climate files is one way to achieve this requirement.

D.1.6 Thermal zones

D.1.6.1 The model of the proposed *building* and the reference *building* shall be identically and suitably divided into separate thermal zones.

D.1.6.2 Spaces that are likely to have significantly different space conditioning requirements shall be modelled as separate zones.

D.1.6.3 The *conditioned space* shall be divided into a minimum of three thermal zones.

D.1.6.4 *Roof* spaces and enclosed subfloor spaces shall be modelled as thermal zones.

D.1.6.5 The model shall have a representation of internal conductive heat flows between thermal zones. Internal partitions between thermal zones require modelling and shall be described in terms of their location, surface area, pitch, and *construction R-value*.

D.1.6.6 The same internal partitions as modelled in the proposed *building* shall be modelled in the reference *building*.

D.1.6.7 Internal partitions within a thermal zone which may affect the thermal performance of the *building* shall be modelled.

D.1.6.8 Airflow between thermal zones need not be modelled unless desired.

D.1.7 Adjoining spaces

D.1.7.1 *Building element*s that separate adjoining *conditioned space*s of dwellings may be assumed to have no heat transfer.

D.1.7.2 *Building element*s separating *conditioned space* from adjacent *unconditioned space* (for example, a garage) may be modelled with a *construction R-value* that is 0.5 higher than the *actual construction R-value* and zero solar absorptance. This adjustment to the *construction R-value* takes into account the insulation from the still air in the *unconditioned space*.

D.1.8 Thermal mass

D.1.8.1 The *thermal mass* may either be modelled:

a) The same way for both the proposed *building* and the reference *building*; or
b) As proposed for the proposed *building* and modelled as lightweight for the reference *building*.

D.1.9 Thermal mass of contents

D.1.9.1 The *thermal mass* of the contents shall be the same for both models, and may be regarded as zero for modelling purposes.

D.1.10 Floor coverings

D.1.10.1 Floor coverings shall be modelled as proposed in both the proposed building and the reference building. If no floor coverings are specified, ceramic tiles shall be modelled in wet areas (kitchens, bathrooms, toilets, and laundries) and carpet to all other areas.

D.1.11 Shading

D.1.11.1 Exterior shading such as fins and overhangs shall be modelled as proposed in the proposed building, but need not be modelled in the reference building.

D.1.11.2 No account shall be taken of internal shading devices such as blinds, drapes, and other non-permanent window treatments.

D.1.12 Incidental shading

D.1.12.1 Shading by structures and terrain that have a significant effect on the *building* shall be modelled in the same way for the proposed *building* and the reference *building*.

D.1.12.2 No account shall be taken of trees or vegetation.

D.1.13 Infiltration

D.1.13.1 Infiltration assumptions for the proposed *building* and the reference *building* shall be the same, and shall be reasonable for the *building construction*, location, and use.

D.2 Thermal envelope

D.2.1 Thermal envelope building elements

D.2.1.1 All *building element*s shall be described in terms of surface area, orientation, pitch, and *construction R-value*. *Window areas* shall have their *solar heat gain coefficient* (*SHGC*) specified.

D.2.1.2 The solar absorption of external *building elements*, except as specified in Paragraph D.1.11.2, shall be modelled in both the proposed *building* and reference *building* as proposed. If solar absorption is not specified, they shall be modelled in both the proposed *building* and reference *building* as 0.5.

D.2.1.3 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 method less the standardised surface resistances of 0.03 $m^2 \cdot K/W$ outside and 0.09 $m^2 \cdot K/W$ inside (0.12 $m^2 \cdot K/W$ total). The same method of calculation shall be used for the proposed *building* and the reference *building*.

D.2.2 Windows

D.2.2.1 If the *window area* in the proposed *building* is more than 30% of the *total wall area*, then the *window area* of the reference *building* shall be 30% of the total wall area. If the *window area* of the proposed *building* is 30% or less of the *total wall area*, then the *window area* of the reference *building* shall either be the same as the proposed *building* or 30% of the *total wall area* (at the discretion of the modeller).

D.2.2.2 If the *window area* in the proposed *building* and the reference *building* are different, then the *window area* in the reference *building* shall either be distributed evenly around the *building*, or the size of each glazed unit be changed by the same proportion to achieve a *window area* of 30% and be modelled in the same location with the same head height as in the proposed *building.*

D.2.3 Skylights

D.2.3.1 In the reference *building* the *roof area* (A_{roof}) shall be set equal to the *total roof area* and the *skylight area* ($A_{skylight}$) shall be set to zero.

D.2.4 Door area

D.2.4.1 In the reference *building*:

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

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

D.3 Space conditioning

D.3.1 Control temperatures

H D.3.1.1 For **housing**, a minimum temperature of 18°C at any time, and a maximum temperature of 25°C at any time, is required to be modelled. Prior to the use of artificial cooling, natural ventilation shall be modelled at a set point of 24°C. The ventilation rate shall be reasonable for the amount of available venting area for each zone and shall be the same for the proposed *building* and reference *building*.

D.3.1.2 For *buildings* other than **housing**, a minimum temperature of 18°C and a maximum temperature of 25°C from 8am – 6pm, five days a week, shall be modelled unless a different schedule can be justified for the life of the *building*.

D.3.2 Fresh air ventilation

D.3.2.1 The fresh air ventilation rate and schedule shall be the same for both the proposed *building* and the reference *building*. The minimum fresh air ventilation rate shall be:

H a) 0.5 air changes per hour for **housing**; and

b) As specified in NZS 4303 for other *buildings*.

D.3.3 Conditioning system modelling

D.3.3.1 The calculation of the annual loads for space heating and cooling does not include an assessment of heating, cooling, and ventilating equipment. A simulation of the heating, cooling, and ventilating equipment is not required, but shall be the same for the proposed *building* and reference *building* if modelled. Sizing is the only feature that may be changed in response to load requirements.

D.4 Internal loads

D.4.1 Lighting

D.4.1.1 Lighting need not be modelled. However, if it is, it shall be the same for both the proposed *building* and the reference *building.*

D.4.2 Domestic hot water

D.4.2.1 For both the proposed *building* and the reference *building*, the power density for an internal cylinder shall either be ignored, or the *default value* from Table D.5.1.1 shall be used.

D.4.3 Occupant and plug loads

D.4.3.1 The maximum heat release into a *building* from occupants and *plug loads* is provided in Table D.5.1.1. and is modified to provide default values for heat release at different times of day. The modification factors are provided for:

H a) **Housing** in Table D.5.1.2A; and

CR b) **Communal residential** including hotels, motels, and health consultancies in Table D.5.1.2B; and

CN c) **Communal non-residential** assembly care including schools in Table D.5.1.2C; and

Com d) **Commercial** including offices, restaurants, and retail shops in Table D.5.1.2D.

D.4.3.2 These *default values* shall be used unless other suitable parameters specific to the *building's* use are shown to be more appropriate. All internal gains are regarded as sensible heat.

D.4.3.3 *Unconditioned spaces* shall be assigned zero internal gains.

D.4.4 Process loads

D.4.4.1 Process loads are those *heat loads* that result from the production of goods within a *building*.

D.4.4.2 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 *building* and reference *buildings*.

D.5 Reference building

D.5.1 Schedules

D.5.1.1 The default power densities for internal gains from occupants and *plug load* are provided in Table D.5.1.1.

TABLE D.5.1.1: Default power densities for internal gains from occupants and plug loads

Paragraphs D.4.3.1, D.5.1.1

Classified use	Applies to[1]	Occupancy (W/m²)	Plug load (W/m²)
H	**Housing**	[2]	24.5
CR	Community service – hotels and motels	2.9	2.7
	Community care – Unrestrained – health/institutional	3.6	10.7
CN	Assembly care – schools	9.7	5.4
Com	Office	2.7	8.1
	Restaurant	7.3	1.1
	Retail shop	2.4	2.7
	Car park	N/A	N/A

Notes:

(1) If an activity for the proposed *building* is not specifically described, use the nearest description for the both the proposed *building* and the reference *building*.

(2) **Housing** modelling assumptions:

(a) Domestic hot water (DHW) contribution (per *building* for each internal cylinder) is 100 W
(b) Occupants (up to 50 m² *floor area*) (sensible heat) are 150 W
(c) Occupants (per m² over 50 m² *floor area*) (sensible heat) are 3 W/m²

D.5.1.2 The default schedules for occupancy and *plug loads* are provided for:

H a) **Housing** in Table D.5.1.2A; and

CR b) **Communal residential** including hotels, motels, and health consultancies in Table D.5.1.2.B; and

CN c) **Communal non-residential** assembly care including schools in Table D.5.1.2C; and

Com d) **Commercial** including offices, restaurants, and retail shops in Table D.5.1.2D.

TABLE D.5.1.2A: Default schedules for occupancy and plug loads – Percentage of maximum load or percentage of power density for housing

Paragraphs D.4.3.1 a), D.5.1.2 a)

Occupancy	12 am – 8 am	8 am – 11 am	11 am – 6 pm	6 pm – 10 pm	10 pm – 12 am
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 D.5.1.2B: **Default schedules for occupancy and plug loads – Percentage of maximum load or percentage of power density for communal residential**

Paragraphs D.4.3.1 b), D.5.1.2 b)

Community service – Hotels and motels					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
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
Community service – residential care such as retirement village					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
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
Community care – Health/medical specialist					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
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

TABLE D.5.1.2C: Default schedules for occupancy and plug loads – Percentage of maximum load or percentage of power density for communal non-residential – assembly care

Paragraphs D.4.3.1 c), D.5.1.2 c)

Schools					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
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

TABLE D.5.1.2D: Default schedules for occupancy and plug loads – Percentage of maximum load or percentage of power density for commercial buildings

Paragraphs D.4.3.1 d), D.5.1.2 d)

Office					
Occupancy	12 am – 8 am	8 am – 11 am	11 am – 6 pm	6 pm – 10 pm	10 pm – 12 am
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					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
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 shop					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
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

D.6 Documentation

D.6.1 Documentation of analysis

D.6.1.1.1 Documentation of computer modelling analysis shall contain:

a) The name of the modeller;

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

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

d) The sum of the *heating load* and *cooling load* for the proposed *building* and reference *building*;

e) Where possible, the *heating load* and *cooling load* for the proposed *building* and the reference *building*.

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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

BP 6478

BUILDING PERFORMANCE

H1 Energy Efficiency

Acceptable Solution H1/AS2

Energy efficiency for buildings greater than 300 m^2

FIRST EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

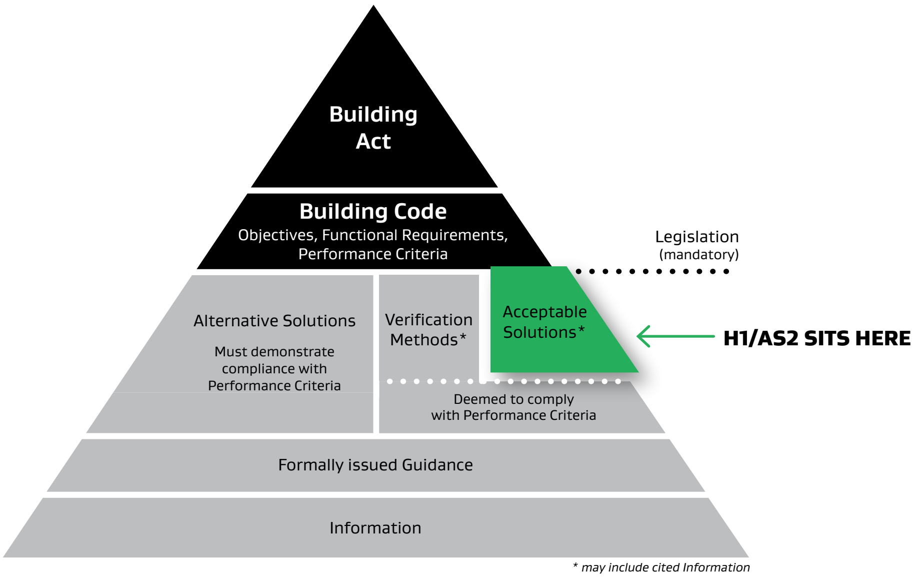
Document status

This document (H1/AS2) is an acceptable solution issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXXX XXXX. The previous Acceptable Solution H1/AS1, as amended, can be used to show compliance until X XXXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXXX XXXX.

Building Code regulatory system

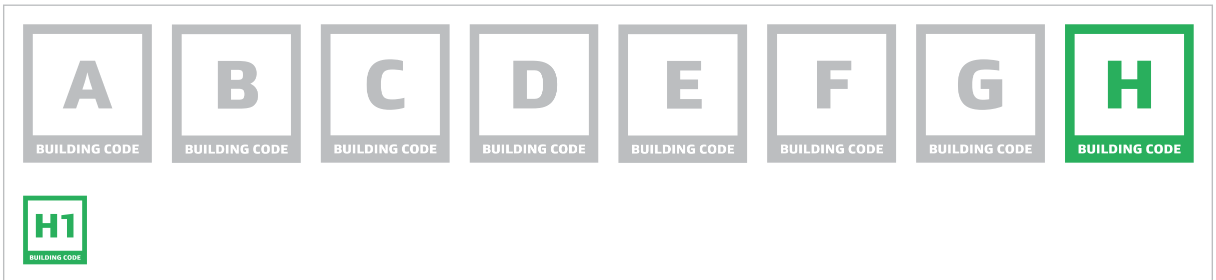
Each acceptable solution outlines the provisions of the Building Code that it relates to. Complying with an acceptable Solution or verification Method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this acceptable solution relates to is clause H Energy Efficiency. Further information on the scope of this document is provided in the introduction on page 5.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This is the first edition of H1/AS2. However, prior to its release, similar requirements were previously found within H1/AS1. The main changes from the previous version of H1/AS1 are:

› The scope of H1/AS1 has been reduced to cover only housing, and buildings other than housing less than 300 m². Requirements applicable to larger buildings have been combined into Acceptable Solution H1/AS2. To reflect the new scope of the documents and the new document layout, a new introduction and scope has been provided in Part 1. General.

› Citations of NZS 4218: 2009 "Thermal insulation - Housing and small buildings" and NZS 4243.1: 2007 "Energy Efficiency – large buildings. Building thermal envelope" have been removed from the document. The relevant content from these standards has been adopted into H1/AS1 and H1/AS2 with permission from Standards New Zealand.

› The three-zone climate zone map previously found in NZS 4218 and NZS 4243.1 has been updated with a six-zone climate zone map in Appendix C.

› The minimum R-values previous found in NZS 4218 and NZS 4243.1 have been replaced with new values found in Part 2. Building thermal envelope.

› Portions of text for the Building thermal envelope requirements have been re-written to enhance clarity in the document and provide a consistent format with other acceptable solutions and verification methods.

› References have been revised to include only documents within the scope of H1/AS2 in Appendix A.

› The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solutions and verification methods and are available from www.building.govt.nz

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This document can be used for *buildings* other than **housing** with an area of *occupied space* greater than 300 m².

H 1.1.1.2 For all **housing**, and *buildings* other than **housing** with an *occupied space* less than 300 m², refer to the Acceptable Solution H1/AS1 or Verification Method H1/VM1 as a means to demonstrate compliance or use an alternative means to demonstrate compliance.

1.1.2 Items outside the scope of this document

1.1.2.1 This acceptable solution does not include the use of foil insulation.

Com 1.1.2.2 For **commercial** *buildings*, this acceptable solution does not include requirements to comply with clause H1.3.6 of the Building Code for the energy efficiency of HVAC systems. For this clause, use Verification Method H1/VM3 or use an alternative means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This acceptable solution is one option that provides a means of establishing compliance with the performance criteria in Building Code clauses H1.3.1, H1.3.3, H1.3.4 and H1.3.5.

1.1.3.2 Options for demonstrating compliance with H1 Energy Efficiency through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.2 Using this acceptable solution

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

Ind 1.2.1.2 In *buildings* containing both **industrial** and other classified uses, the non-industrial portion shall be treated separately according to its classified use. For example, in a *building* containing both **industrial** and **commercial** classified uses, the **commercial** area shall meet the relevant energy efficiency requirements of the Building Code.

1.2.2 Features of this document

1.2.2.1 For the purposes of Building Code compliance, the standards and documents referenced in this acceptable solution must be the editions, along with their specific amendments listed in Appendix A.

1.2.2.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.2.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

TABLE 1.1.3.2: Demonstrating compliance with H1 Energy Efficiency through acceptable solutions and verification methods

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
H1.3.1 (a) and (b) Thermal Envelope	H **Housing** CR **Communal residential** CN **Communal non-residential** (assembly care only) Com **Commercial**	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large *buildings*: H1/AS2 or H1/VM2
H1.3.2E *Building performance index*	H **Housing**	H1/AS1 or H1/VM1
H1.3.3 (a) to (f) Physical conditions	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large buildings: H1/AS2 or H1/VM2
H1.3.4 (a) Heating of hot water	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (b) Storage vessels and distribution systems	Individual storage vessels ≤ 700 L in capacity	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (c) Efficient use of hot water	H **Housing**	H1/AS1
H1.3.5 Artificial lighting	Lighting not provided solely to meet the requirements of Building Code clause F6 in: Com CN **Commercial** and **Communal non-residential** having *occupied space* greater than 300 m²	H1/AS2
H.1.3.6 *HVAC systems*	Com **Commercial**	H1/VM3

1.2.2.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses. These requirements are also denoted with classified use icons for:

- H a) **Housing**, and
- CR b) **Communal residential**, and
- CN c) **Communal non-residential**, and
- Com d) **Commercial**, and
- Ind e) **Industrial**, and
- Out f) **Outbuildings**, and
- Anc g) **Ancillary**.

1.2.2.5 Appendices to this acceptable solution are part of, and have equal status to, the acceptable solution. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Building thermal envelope

2.1 Thermal resistance

2.1.1 Demonstrating compliance

CR CN Com

2.1.1.1 For **communal residential**, **communal non-residential** assembly care, and **commercial** *buildings,* the *building envelope* shall be provided with *construction* that provides *adequate thermal resistance.* The minimum required *construction R-values* shall be determined through the use of:

a) the Schedule method in Subsection 2.1.2, or

b) the Calculation method in Subsection 2.1.3, or

c) the Modelling method in H1/VM2.

2.1.1.2 For mixed-use *buildings* that include **housing**, the H1/AS1 Subsection 2.1.2 "Schedule Method", or H1/AS1 Subsection 2.1.3 "Calculation Method" shall be used for the parts of the *building* containing **housing**. For the other parts of the *building*, the methods in Paragraph 2.1.1.1 can be used.

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> COMMENT: To satisfy the Building Code performance requirement E3.3.1 for internal moisture, it may be necessary, depending on the method adopted, to provide more insulation (a greater *R-value*) than that required to satisfy energy efficiency provisions alone.

2.1.1.3 The requirements for the Schedule method and Calculation method are separated based on the relevant climate zone for the *building*. A list of the New Zealand Climate zones is provided in Appendix C.

2.1.1.4 For *building elements* with embedded heating systems, the minimum *construction R-values* shall be determined through the Schedule method. These apply whenever *building elements* that are part of the *thermal envelope* include heating systems and may not be reduced by applying the Calculation method in Subsection 2.1.3.

2.1.1.5 The *construction R-values* of individual *building elements* shall be determined in accordance with Subsection 2.1.4.

2.1.1.6 Insulation materials shall be installed in a way that achieves the intended thermal performance in *buildings* without compromising the durability and safety of insulation or *building elements* and the health and safety of installers and *building* occupants. Gaps, tucks, folds, and over compaction of insulation material shall be avoided.

2.1.2 Schedule method

2.1.2.1 The schedule method shall only be used for *buildings* that have a *window-to-wall ratio (WWR)* of less than or equal to 50%. If the *WWR* is greater than 50%, the Calculation method in Subsection 2.1.3 or the Modelling method in H1/VM2 shall be used.

2.1.2.2 *Building elements* that are part of the *thermal envelope* shall have minimum *construction R-values* no less than:

a) For *building elements* that contain embedded heating systems, those in Table 2.1.2.2A; or

b) For *building elements* that do not contain embedded heating systems, Table 2.1.2.2B.

TABLE 2.1.2.2A: Minimum construction R-values for heated roofs, walls or floors

Paragraph 2.1.2.2 a)

Building element	Construction R-values (m^2 K/W)(1),(2),(3)					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Heated roof	Refer to the consultation document for the proposed *R-values* for each element and climate zone					
Heated wall						
Heated floor						

Notes:

(1) R_{IN}/R-value < 0.1 and R_{IN} is the *thermal resistance* between the heated plane and the inside air.

(2) Floor coverings, for example carpet or cork, will reduce the efficiency of the *heated floor*.

(3) Climate zone boundaries are shown in Appendix C.

TABLE 2.1.2.2B: Minimum construction R-values for building elements that do not contain embedded heating systems

Paragraphs 2.1.2.2 b), 2.1.3.11

Building element	Construction R-values (m^2 K/W)(1)					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Roof	Refer to the consultation document for the proposed *R-values* for each element and climate zone					
Wall						
Floor						
Windows						
Skylights						

Notes:

(1) Climate zone boundaries are shown in Appendix C.

2.1.3 Calculation method

2.1.3.1 This method allows for increased flexibility in proposed wall *construction* such as more than one type of wall *construction*, a mix of window types, a range of *thermal resistances*, any *WWR*, or a combination of these.

2.1.3.2 The thermal performance of the proposed *building* wall, as defined by the total wall *thermal resistance* (R_{total}) and the *solar aperture* (*V*), shall be at least equal to the reference *building* wall.

2.1.3.3 *Building elements* that form part of the *thermal envelope* with *construction R-values* and conditions different from those given in the Schedule method in Subsection 2.1.2 may be used providing the heat loss of the proposed *building* is less than or equal to the heat loss of the reference *building* for the relevant climate zone as per Equation 1.

Equation 1: $HL_{Proposed} \leq HL_{Reference}$ for $V \leq 0.5$

where:

$HL_{Proposed}$ is the heat loss of the proposed total wall (K/W), and

$HL_{Reference}$ is the heat loss of the reference total wall (K/W), and

V is the proposed *solar aperture* and shall be less than or equal to 0.5

2.1.3.4 $HL_{Reference}$ shall be calculated from Equation 2 in Paragraph 2.1.3.7 using the *thermal resistance* and conditions from Subsection 2.1.2 as appropriate.

2.1.3.5 $HL_{Proposed}$ shall be calculated from Equation 2 in Paragraph 2.1.3.7 using the actual proposed areas and *R-values* from Paragraphs 2.1.3.2, 2.1.3.6, and 2.1.3.7.

2.1.3.6 The reference *building wall areas* and *window area* are determined by the proposed *building window-to-wall ratio* assuming the following:

a) If the proposed *building WWR* is less than or equal to 50% (i.e. the proposed *window area* is less than or equal to the proposed *wall area*) then the reference *wall areas* and *window area* are as proposed; or

b) If the proposed *building WWR* is greater than 50% (i.e. the proposed *window area* is greater than the proposed *wall area*) then the reference *wall areas* and *window areas* are both equal to half the *total wall area*.

2.1.3.7 The heat flow (HL) through the *thermal envelope* shall be demonstrated by the *building* heat loss (HL) in Equation 2:

Equation 2: $$HL = \frac{A_{wall}}{R_{wall}} + \frac{A_{window}}{R_{window}}$$

where:

HL is the heat loss of the total wall (W/K), and

A_{wall} is the wall area (m^2), and

A_{window} is the window area (m^2), and

R_{wall} and R_{window} are the proposed or reference *R-values* ($m^2 \cdot K/W$) of the corresponding *building thermal envelope* components.

2.1.3.8 The *total wall area* used shall be the same for both the proposed and reference *building*.

2.1.3.9 Where a *building thermal envelope* component is proposed to have two 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:

$$\sum \frac{A_{wall}}{R_{wall}} \text{ becomes } \frac{A_{wall(1)}}{R_{wall(1)}} + \frac{A_{wall(2)}}{R_{wall(2)}}$$

2.1.3.10 The *solar aperture* (V) of the proposed *wall* is given by Equation 3:

Equation 3: $$V = \frac{\sum SC_{window} A_{window}}{\sum A_{wall} + \sum A_{window}}$$

where:

V is the *solar aperture*, and

SC_{window} is the *shading coefficient*.

A_{window} is the *window area* (m^2), and

A_{wall} is the *wall area* (m^2).

2.1.3.11 The reference wall has a maximum *WWR* of 50% with a *shading coefficient* of 1.0, and window and wall *R-values* from Table 2.1.2.1B.

2.1.4 Determining thermal resistance of building elements

2.1.4.1 Acceptable methods for determining the thermal resistance (R-values) of building elements are contained in NZS 4214.

2.1.4.2 Acceptable methods for determining the *thermal resistance* (*R-values*) of some insulation materials are contained in AS/NZS 4859.1.

2.1.4.3 The *construction R-values* of *building elements* shall be calculated as follows:

a) For walls and *roofs*, the *R-value* is of a typical area of the *building element* excluding the effects of openings and corners; and

b) For framed walls, this includes studs, dwangs, top plates, and bottom plates, but excludes lintels, additional studs that support lintels, and additional studs at corners and junctions; and

c) For walls without frames, this excludes any attachment requirements for windows and doors; and

d) For slab floors, the *R-value* is from the inside air to the outside air; and

e) For suspended floors, the *R-value* is of a typical area of the floor excluding the effects of openings and corners; and

f) For windows, refer to R_{window} as specified in Appendix D; and

g) For doors, the *R-value* is of the door excluding the frame, opening tolerances, and glazing.

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

2.1.4.5 The *R-value* of an unconditioned air-space between the *thermal envelope* and the *building envelope* may be included in the *construction R-value*. This can include a subfloor, *roof* space, garage, and/or conservatory.

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> COMMENT: Garages should form part of the *unconditioned space* of a *building*, that is, they should be outside the *thermal envelope*. Any building elements between attached garages and the conditioned spaces of a building form part of the thermal envelope and therefore be insulated.

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

2.1.4.7 Concrete slab-on-ground floors are deemed to achieve a *construction R-value* of 1.3 $m^2 \cdot K/W$, unless a higher *R-value* is justified by calculation or physical testing.

2.2 Airflow

2.2.1 Control of airflow

CR CN Com 2.2.1.1 **Communal residential**, **communal non-residential** assembly care, and **commercial** *buildings* shall have windows, doors, vents or other *building elements* that allow significant movement of air, to be *constructed* in such a way that they are capable of being fixed in the closed position.

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> COMMENT: G4/AS1 provides for the supply of outdoor air for ventilation by way of windows and doors that can be fixed in the open position.

2.3 Solar heat gains

2.3.1 Control of solar heat gains

2.3.1.1 Requirements to account for heat gains from solar radiation are satisfied by complying with the requirements for *thermal resistance* in Section 2.1.

Part 3. Building services

3.1 Hot water systems

3.1.1 Hot water systems for sanitary fixtures and sanitary appliances

3.1.1.1 Hot water systems for *sanitary fixtures* and *sanitary appliances* having a storage water heater capacity of up to 700 litres shall comply with NZS 4305.

COMMENT:

1. NZS 4305 deals with domestic type electrical and gas systems having a storage water heater capacity of up to 700 litres. Larger systems and their associated piping are not controlled by the Building Code.
2. The manufacture and sale of hot water cylinders and gas water heaters are covered by the Energy Efficiency (Energy Using Products) Regulations 2002. The associated NZ Minimum Energy Performance Standards for electric storage water heaters (MEPS as defined in NZS 4606.1 and the relevant NZ section of AS/NZS 4692.2) are equivalent to the requirements in this acceptable solution (see NZS 4305 clause 2.1.1). Electric storage water heaters that do not comply with NZ MEPS do not comply with this acceptable solution.

3.2 Artificial lighting

3.2.1 Communal Non-residential and Commercial Buildings

CN Com 3.2.1.1 Artificial lighting energy consumption in **communal non-residential** and **commercial** *buildings* having *occupied space* greater than 300 m^2 shall comply with NZS 4243.2 section 3.3.

Appendix A. References

For the purposes of Building Code compliance, the standards and documents referenced in this acceptable solution must be the editions, along with their specific amendments, listed below.

Standards New Zealand		**Where quoted**
NZS 4214: 2006	Methods of determining the total thermal resistance of parts of buildings	2.1.4.1, Definitions
NZS 4243:-	Energy efficiency – large buildings	
Part 2: 2007	Lighting Amend 1	3.2.1.1
NZS 4305: 1996	Energy efficiency – domestic type hot water systems	3.1.1.1
NZS 4606:-	Storage water heaters	
Part 1: 1989	General requirements	3.1.1.1 Comment
AS/NZS 4692:-	Electric water heaters	
Part 2: 2005	Minimum Energy Performance Standards (MEPS) requirements and energy labelling	3.1.1.1 Comment
AS/NZS 4859:-	Materials for the thermal insulation of buildings	
Part 1: 2002	General criteria and technical provisions	2.1.4.2

These standards can be accessed from www.standards.govt.nz

New Zealand Legislation	
Energy Efficiency (Energy Using Products) Regulations 2002	3.1.1.1 Comment

This document can be accessed from www.legislation.govt.nz

Appendix B. Definitions

These definitions are specific to this acceptable solution. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	Means *adequate* to achieve the objectives of the Building Code.
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Building element	Any structural or non-structural component or assembly incorporated into or associated with a *building*. Included are *fixtures*, services, *drains*, permanent mechanical installations for access, glazing, partitions, ceilings and temporary supports.
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).
Conditioned space	That part of a *building* within the *building thermal envelope* that may be directly or indirectly heated or cooled for occupant comfort. It is separated from *unconditioned space* by *building elements* (walls, windows, *skylights*, doors, *roof*, and floor) to limit uncontrolled airflow and heat loss.
Construct	In relation to a *building*, includes to design, build, erect, prefabricate, and relocate the *building*; and *construction* has a corresponding meaning.
Construction R-value	The *R-value* of a typical area of a *building element* where: a) For walls and *roofs*, the *R-value* is of a typical area of the *building element* excluding the effects of openings and corners; and b) For framed walls, this includes studs, dwangs, top plates, and bottom plates, but excludes lintels, additional studs that support lintels, and additional studs at corners and junctions; and c) For walls without frames, this excludes any attachment requirements for windows and doors; and d) For slab floors, the *R-value* is from the inside air to the outside air but excludes carpets and other floor coverings; and e) For suspended floors, the *R-value* is of a typical area of the floor but excludes carpets, other floor coverings, and the effects of openings and corners; and f) For windows, the *R-value* includes the effects of both the glazing materials and the frame materials; and g) For doors, the *R-value* is of the door excluding the frame, opening tolerances, and glazing.
Door area (A_{door})	The total area of doors in the *thermal envelope*, including frames and opening tolerances, but excluding all glazing, decorative glazing, and louvres.
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment
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.
HVAC system	For the purposes of performance H1.3.6 and in relation to a *building*, means a mechanical, electrical, or other system for modifying air temperature, modifying air humidity, providing ventilation, or doing all or any of those things, in a space within the *building*.
Insulating glass unit (IGU)	Two or more panes of glass spaced apart and factory sealed with dry air or special gases in the unit cavity. (Often abbreviated to IGU or referred to as the unit or double glazing).

Intended use	In relation to a *building*, — a) includes any or all of the following: i) any reasonably foreseeable occasional use that is not incompatible with the intended use; ii) normal maintenance; iii) activities undertaken in response to *fire* or any other reasonably foreseeable emergency; but b) does not include any other maintenance and repairs or rebuilding.
Occupied space	Any space within a *building* in which a person will be present from time to time during the *intended use* of the *building*
Persons	Includes— a) the Crown; and b) a corporation sole; and c) a body of *persons* (whether corporate or unincorporated).
R-value	The common abbreviation for describing the values of both *thermal resistance* and *total thermal resistance*.
Roof	Any *roof*-ceiling combination where the exterior surface of the *building* is at an angle of 60° or less to the horizontal and has its upper surface exposed to the outside.
Roof area (A_{roof})	The area of the roof that is part of the thermal envelope, excluding the *skylight area*.
Sanitary appliance	An appliance which is intended to be used for *sanitation*, but which is not a *sanitary fixture*. Included are machines for washing dishes and clothes.
Sanitary fixture	Any *fixture* which is intended to be used for *sanitation.*
Sanitation	The term used to describe the activities of washing and/or excretion carried out in a manner or condition such that the effect on health is minimised, with regard to dirt and infection
Shading coefficient (SC)	The ratio of the total *solar heat gain coefficient* (SHGC) through a particular glass compared to the total *solar heat gain coefficient* through 3 mm clear float glass.
Skylight	Translucent or transparent parts of the *roof*.
Skylight area ($A_{skylight}$)	The area of *skylights* that are part of the *roof thermal envelope*, including frames and opening tolerances.
Solar aperture (V)	The fraction of total solar radiation received on the vertical *wall* (opaque and glazed) that actually enters the perimeter space being considered.
Solar heat gain coefficient (SHGC)	The total solar energy entering a *building* through the glazing, that is, the direct transmission of energy from the sun plus the inwards re-radiation of heat from solar radiation that is absorbed in the glass. The SHGC is also known as the solar factor (SF) or g (glazing factor).
Surface (of glass)	The glass surfaces of single glazing and double glazing are numbered from the outside to the inside. The outside face of the outer pane is surface one, the inside face of the outer pane is surface two. In single glazing there are only two surfaces. With double glazing the outer surface of the inner pane is surface three, and the inner surface of the inner pane is surface four.
Thermal envelope	The *roof*, wall, window, *skylight*, door and floor *construction* between *unconditioned spaces* and *conditioned spaces*.
Thermal envelope floor area (A_{floor})	The area of the floor that forms part of the *thermal envelope*.
Thermal resistance	The resistance to heat flow of a given component of a *building element*. It is equal to the air temperature difference (K) needed to produce unit heat flux (W/m^2) through unit area (m^2) under steady conditions. The units are $m^2 \cdot K/W$.

Total thermal resistance	The overall air-to-air *thermal resistance* across all components of a *building element* such as a wall, *roof* or floor. (This includes the surface resistances which may vary with environmental changes e.g. temperature and humidity, but for most purposes can be regarded as having standard values as given in NZS 4214.)
Total roof area	The *roof* area (A_{roof}) plus the *skylight area* ($A_{skylight}$)
Total wall area	In relation to a *building,* means the sum (expressed in square metres) of the following: a) the *wall area* of the *building*; and b) the area (expressed in square metres) of all vertical windows in *external walls* of the *building.*
U-value (for windows)	A measure of air-to-air heat transmission (loss or gain) due to the thermal conductance of the window and the difference between indoor and outdoor temperatures. It is calculated as (U-value) where U = 1/R (*thermal resistance*). The units are $W/(m^2{\cdot}K)$.
Unconditioned space	Space within the *building envelope* that is not *conditioned space* (for example, this may include a garage, conservatory, atrium, attic, subfloor, and so on). However, where a garage, conservatory or atrium is expected to be heated or cooled these spaces shall be included in the *conditioned space*.
Wall area	The area of walls that are part of the *thermal envelope*, excluding the *door area* and the *window area*.
Window area (A_{window})	The total area of glazing in the *thermal envelope*, including frames and opening tolerances, glazing in doors, and decorative glazing and louvres, but excluding *skylights*.
Window-to-wall ratio (WWR)	The ratio of the *window area* to the *total wall area*.

Appendix C. New Zealand climate zones

C.1 Climate zones

C.1.1 Climate zone boundaries

C.1.1.1 There are six climate zones. These climate zone boundaries are based on climatic data taking into consideration territorial authority boundaries.

C.1.1.2 A list of the climate zones for each territorial authority is provided in Table C.1.1.2 and illustrated in Figure C.1.1.2. The list in the table takes precedence.

New Zealand climate zones

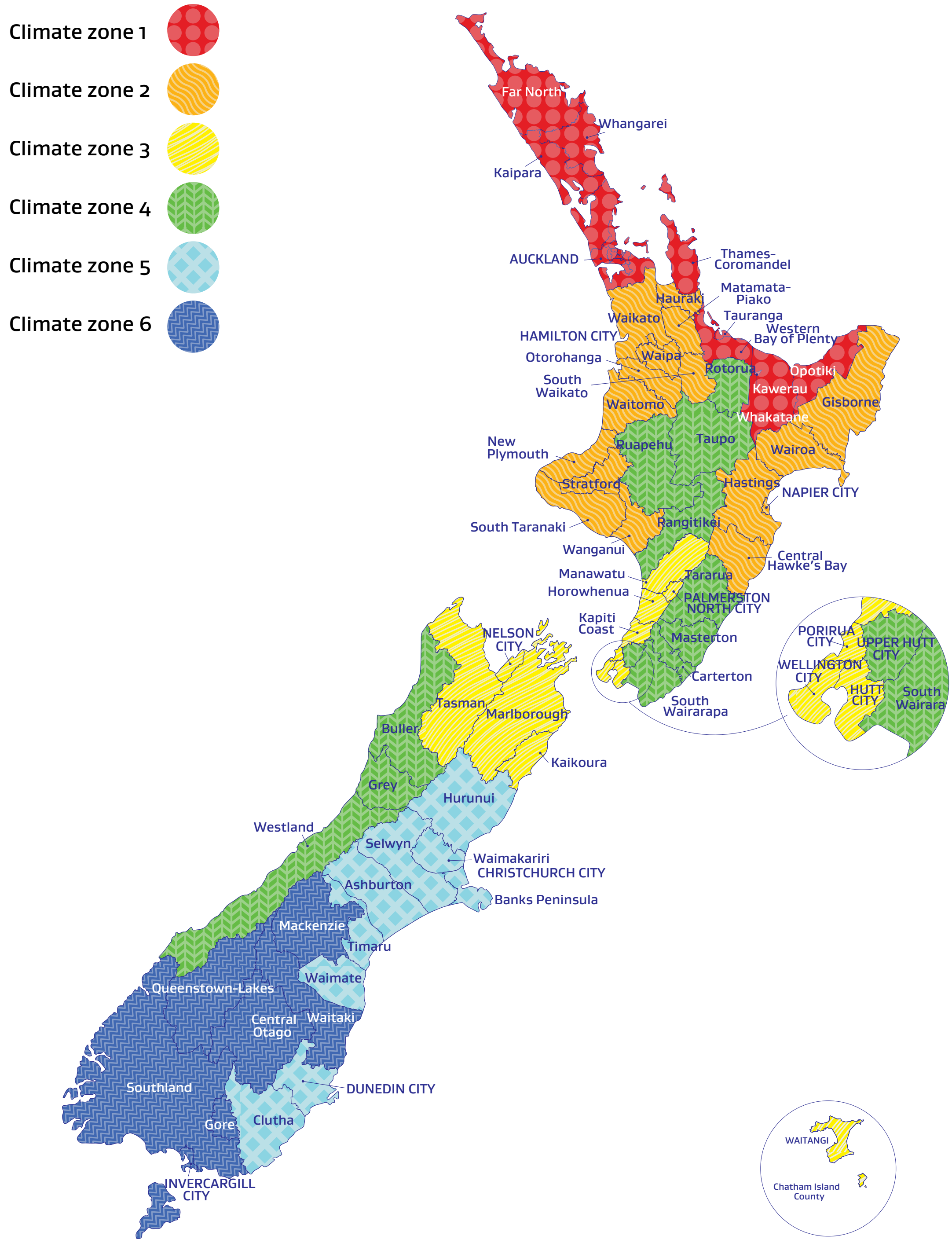
TABLE C.1.1.2: Climate zones by territorial authority

Paragraph C.1.1.2

North Island/Te Ika-a-Māui		South Island/Te Waipounamu	
Territorial authority	Climate zone	Territorial authority	Climate zone
Far North District	1	Tasman District	3
Whangarei District	1	Nelson City	3
Kaipara District	1	Marlborough District	3
Auckland	1	Kaikoura District	3
Thames-Coromandel district	1	Buller District	4
Hauraki District	2	Grey District	4
Waikato District	2	Westland District	4
Matamata-Piako District	2	Hurunui District	5
Hamilton City	2	Waimakariri District	5
Waipa District	2	Christchurch City	5
Otorohanga District	2	Selwyn District	5
South Waikato District	2	Ashburton District	5
Waitomo District	2	Timaru District	5
Taupo District	4	Mackenzie District	6
Western Bay of Plenty District	1	Waimate District	5
Tauranga City	1	Chatham Islands	3
Rotorua District	4	Waitaki District	6
Whakatane District	1	Central Otago District	6
Kawerau District	1	Queenstown-Lakes District	6
Opotiki District	1	Dunedin City	5
Gisborne District	2	Clutha District	5
Wairoa District	2	Southland District	6
Hastings District	2	Gore District	6
Napier City	2	Invercargill City	6
Central Hawke's Bay District	2		
New Plymouth District	2		
Stratford District	2		
South Taranaki District	2		
Ruapehu District	4		
Whanganui District	2		
Rangitikei District	4		
Manawatu District	3		
Palmerston North City	3		
Tararua District	4		
Horowhenua District	3		
Kapiti Coast District	3		
Porirua City	3		
Upper Hutt City	4		
Lower Hutt City	3		
Wellington City	3		
Masterton District	4		
Carterton District	4		
South Wairarapa District	4		

TABLE C.1.1.2: Climate zones by territorial authority

Paragraph C.1.1.2



Appendix D. Windows and glazing

D.1 Vertical windows

D.1.1 Construction R-values

D.1.1.1 The *construction R-values* for vertical windows shall include the effects of both the glazing materials and the frame materials, and are defined as R_{window}. R_{window} shall be determined using the method described in Subsection D.1.2, or determined from the performance tables in Subsection D.1.3.

COMMENT:

1. The thermal performance of a window shall take account of both the glazing materials and the frame material in order to provide the true *thermal resistance* (*R-value*, or the reciprocal of this being the thermal transmission or *U-value*) of the window as a 'total product'. The thermal performance of glazing products is measured without the influence of the frame and is normally quoted as centre of glass (COG) *U-values* or *R-values*.
2. The window size and frame material have a major bearing on the *total thermal resistance* of the window as a *building element* and often the centre of glass *R-value* (RCOG) and the *total thermal resistance* (R_{Window}) values are dissimilar. For large windows the centre of glass *R-value* (R_{COG}) will have more bearing on the overall performance than in a small window, which is dominated by the frame performance.
3. The amount of free heat that enters a window from the sun is measured with the *SHGC* or the *shading coefficient* (SC). If the *SHGC* is below 0.69, the solar heat captured in winter may fall below an acceptable level and this should be considered in design.

D.1.2 Calculating window R-values

D.1.2.1 To calculate R_{window} for vertical windows, use a standardised procedure for determining the *R-value* of the glazing and frame based on heat transfer analysis. This shall be based on a generic window of size 1800 mm wide x 1500 mm high with a central mullion and one opening light.

COMMENT:

1. The standard window described in Paragraph D.1.2.1 gives typical R_{window} *R-values* for standard aluminium joinery of 0.15 $m^2·K/W$ for single glazing and 0.26 $m^2·K/W$ for a standard IGU, based on a 4 mm glass/12 mm air/4 mm glass combination.
2. The BRANZ website provides information on the glazing systems used for the generic windows, and also has additional information about alternative framing and glazing options.
3. The *R/U-values* of windows *constructed* of different materials vary, as indicated in Table D.1.3.1A, Table D.1.3.1B, Table D.1.3.1C, and Table D.1.3.1D.

D.1.3 Performance tables

D.1.3.1 The thermal performance of generic windows and glazing (R_{window}) may be determined from:

a) In aluminium frame, Table D.1.3.1A; and
b) In composite aluminium frame, Table D.1.3.1B; and
c) In thermally broken aluminium frame, Table D.1.3.1C; and
d) In PVC/wooden frame, Table D.1.3.1D.

COMMENT:

1. Table D.1.3.1A, Table D.1.3.1B, Table D.1.3.1C, and Table D.1.3.1D show both R_{window} and U_{window} of window systems with different glass types along with the U_{COG} and R_{COG}, so that designers have a guide to the total performance of a window given the U_{COG} for any glass type.
2. $SHGC_{COG}$ and SC_{COG} are given to allow comparison of the solar control or summer cooling performance of the window. The *shading coefficient* is calculated as SC = SHGC/0.86.
3. Manufacturers should be consulted about the suitability of using single glazed Low E glass. Low E coatings on single glazing can have a lower surface temperature in winter, and so can collect more condensation, which temporarily removes the benefit of the low emissivity surface.

D.2 Skylights

D.2.1 Construction R-values

D.2.1.1 The *construction R-values* for *skylights* ($R_{skylight}$) may be determined using the method described in Subsection D.1.2 by changing the window tilt or slope and thus the heat flow requirements.

D.2.1.2 Alternatively, manufacturer's data for the *construction R-value* may be used. In the absence of this information, $R_{skylight}$ shall be determined from the values of R_{window} from:

a) In aluminium frame, Table D.1.3.1A; and
b) In composite aluminium frame, Table D.1.3.1B; and
c) In thermally broken aluminium frame, Table D.1.3.1C; and
d) In PVC/wooden frame, Table D.1.3.1D.

TABLE D.1.3.1A: **Thermal performance of generic windows in aluminium frame**

Paragraphs D.1.3.1 a), D.2.1.2 a)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in aluminium frame(1)											
101	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.70	0.15
102	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	6.58	0.15
103	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.81	0.21
104	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	5.21	0.19
105	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.68	0.15
106	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.68	0.15
107	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.66	0.15
108	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.68	0.15
109	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	6.65	0.15
Insulating glass units in aluminium frame(2),(3)											
110	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	4.22	0.24
111	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	4.06	0.25
112	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.96	0.25
113	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.90	0.26
114	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.89	0.26
115	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.89	0.26
116	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.89	0.26
117	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.89	0.26
118	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.89	0.26
119	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.90	0.26
120	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.82	0.26
121	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.78	0.26
122	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.78	0.26
123	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	3.28	0.31
124	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	3.44	0.29
125	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	3.27	0.31
126	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	3.27	0.31
127	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	3.14	0.32
128	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	3.09	0.32

Notes:

(1) For single glazing, the Low E coated *surface* is on *surface* 2 inside the *building*.

(2) For an *IGU,* the Low E coating is on *surface* 2 if an outer pane and *surface* 3 of the *IGU* if an inner pane.

(3) The performance of units containing argon gas is based on the cavity having a 90% argon/10% air mix.

TABLE D.1.3.1B: **Thermal performance of generic windows in composite aluminium frame**

Paragraphs D.1.3.1 b), D.2.1.2 b)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in composite frame[1]											
201	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.58	0.15
202	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	6.46	0.15
203	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.69	0.21
204	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	5.09	0.20
205	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.56	0.15
206	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.56	0.15
207	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.53	0.15
208	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.56	0.15
209	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	6.53	0.15
Insulating glass units in composite frame[2],[3]											
210	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	4.19	0.24
211	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	4.03	0.25
212	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.92	0.25
213	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.86	0.26
214	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.86	0.26
215	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.86	0.26
216	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.85	0.26
217	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.86	0.26
218	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.85	0.26
219	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.86	0.26
220	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.79	0.26
221	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.74	0.27
222	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.74	0.27
223	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	3.24	0.31
224	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	3.41	0.29
225	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	3.24	0.31
226	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	3.24	0.31
227	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	3.10	0.32
228	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	3.06	0.33

Notes:

(1) For single glazing, the Low E coated *surface* is on *surface* 2 inside the *building*.

(2) For an *IGU,* the Low E coating is on *surface* 2 if an outer pane and *surface* 3 of the *IGU* if an inner pane.

(3) The performance of units containing argon gas is based on the cavity having a 90% argon/10% air mix.

TABLE D.1.3.1C: **Thermal performance of generic windows in thermally broken aluminium frame**

Paragraphs D.1.3.1 c), D.2.1.2 c)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in thermally broken aluminium frame[1]											
301	4	Clear	–	–	–	0.84	0.97	5.88	0.17	6.04	0.17
302	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	5.92	0.17
303	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	4.16	0.24
304	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	4.55	0.22
305	5	Grey	–	–	–	0.62	0.71	5.85	0.17	6.02	0.17
306	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	6.02	0.17
307	6	Green	–	–	–	0.61	0.71	5.82	0.17	6.00	0.17
308	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	6.02	0.17
309	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	5.99	0.17
Insulating glass units in thermally broken aluminium frame[2],[3]											
310	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	3.54	0.28
311	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	3.38	0.30
312	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	3.28	0.31
313	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	3.22	0.31
314	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	3.21	0.31
315	5	Bronze	12	4	Clear	0.55	0.64	2.73	0.37	3.21	0.31
316	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	3.21	0.31
317	5	Evergreen	12	4	Clear	0.46	0.54	2.72	0.37	3.21	0.31
318	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	3.20	0.31
319	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	3.22	0.31
320	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	3.14	0.32
321	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	3.10	0.32
322	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	3.10	0.32
323	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	2.60	0.39
324	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	2.76	0.36
325	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	2.59	0.39
326	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	2.59	0.39
327	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	2.46	0.41
328	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	2.41	0.41

Notes:

(1) For single glazing, the Low E coated *surface* is on *surface* 2 inside the *building*.

(2) For an *IGU,* the Low E coating is on *surface* 2 if an outer pane and *surface* 3 of the *IGU* if an inner pane.

(3) The performance of units containing argon gas is based on the cavity having a 90% argon/10% air mix.

TABLE D.1.3.1D: **Thermal performance of generic windows in PVC/wooden frame**

Paragraphs D.1.3.1 d), D.2.1.2 d)

Code	mm	Outer	Space (mm)	Inner pane mm		$SHGC_{COG}$	SC_{COG}	U_{COG}	R_{COG}	U_{window}	R_{window}
Single glass in PVC/wooden frame[1]											
401	4	Clear	–	–	–	0.85	0.97	5.88	0.17	5.23	0.19
402	6	Clear Laminated	–	–	–	0.79	0.92	5.72	0.17	5.11	0.20
403	4	Clear Low E	–	–	–	0.71	0.82	3.67	0.27	3.35	0.30
404	6	Solar Low E	–	–	–	0.59	0.69	4.13	0.24	3.74	0.27
405	5	Grey	–	–	–	0.62	0.71	5.85	0.17	5.21	0.19
406	5	Bronze	–	–	–	0.67	0.77	5.85	0.17	5.21	0.19
407	6	Green	–	–	–	0.61	0.71	5.82	0.17	5.19	0.19
408	5	Evergreen	–	–	–	0.58	0.67	5.85	0.17	5.21	0.19
409	6	Arctic blue	–	–	–	0.52	0.60	5.81	0.17	5.18	0.19
Insulating glass units in PVC/wooden frame[2],[3]											
410	4	Clear	6	4	Clear	0.74	0.85	3.15	0.32	3.07	0.33
411	4	Clear	8	4	Clear	0.74	0.85	2.94	0.34	2.91	0.34
412	4	Clear	10	4	Clear	0.74	0.85	2.81	0.36	2.81	0.36
413	4	Clear	12	4	Clear	0.74	0.85	2.73	0.37	2.75	0.36
414	5	Grey	12	4	Clear	0.50	0.58	2.73	0.37	2.75	0.36
415	5	Bronze	12	4	Clear	0.56	0.64	2.73	0.37	2.75	0.36
416	6	Green	12	4	Clear	0.50	0.58	2.72	0.37	2.74	0.36
417	5	Evergreen	12	4	Clear	0.46	0.54	2.73	0.37	2.75	0.36
418	6	Arctic blue	12	4	Clear	0.40	0.46	2.72	0.37	2.74	0.36
419	4	Clear	8 argon	4	Clear	0.74	0.85	2.73	0.37	2.75	0.36
420	4	Clear	10 argon	4	Clear	0.74	0.85	2.63	0.38	2.67	0.37
421	5	Grey	12 argon	4	Clear	0.50	0.58	2.57	0.39	2.63	0.38
422	5	Evergreen	12 argon	4	Clear	0.46	0.53	2.57	0.39	2.63	0.38
423	4	Clear	12	4	Clear Low E	0.69	0.80	1.90	0.53	2.13	0.47
424	6	Solar Low E	12	4	Clear	0.51	0.59	2.12	0.47	2.29	0.44
425	5	Grey	12	4	Clear Low E	0.45	0.52	1.89	0.53	2.13	0.47
426	5	Evergreen	12	4	Clear Low E	0.41	0.47	1.89	0.53	2.13	0.47
427	4	Clear	10 argon	4	Clear Low E	0.70	0.80	1.70	0.59	1.99	0.50
428	5	Grey	12 argon	4	Clear Low E	0.44	0.51	1.64	0.61	1.95	0.51

Notes:

(1) For single glazing, the Low E coated *surface* is on *surface* 2 inside the *building*.

(2) For an *IGU,* the Low E coating is on *surface* 2 if an outer pane and *surface* 3 of the *IGU* if an inner pane.

(3) The performance of units containing argon gas is based on the cavity having a 90% argon/10% air mix.

Appendix E. Orientation

E.1 Orientation

E.1.1 Establishing building orientation

E.1.1.1 A *building* wall, including the windows it contains, shall be considered to face north if it faces any direction in the north orientation sector of Figure E.1.2.1.

E.1.1.2 The orientations of skylights and other walls, including the windows they contain, shall be determined in a similar way.

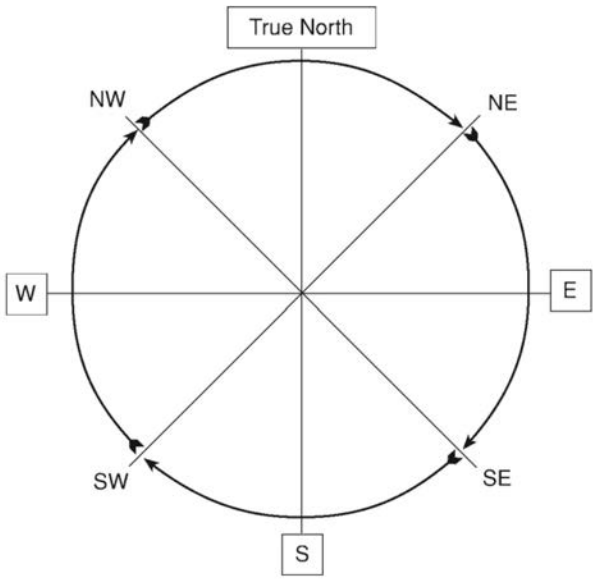
E.1.2 Description of sectors

E.1.2.1 Orientation sectors are based on true north and are as follows (see Figure E.1.2.1):

a) North sector lies between north west (more than 315°) and north east (less than 45°); and
b) East sector lies between north east (45°) and south east (135°); and
c) South sector lies between south east (more than 135°) and south west (less than 225°); and
d) West sector lies between south west (225°) and north west (315°).

FIGURE E.1.2.1: Orientation sector map

Paragraphs E.1.1.1, E.1.2.1



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COMMENT: A compass points toward magnetic north. Magnetic north varies from true north by 19.5° in Auckland, 22° in Wellington and 23.5° in Christchurch. In New Zealand magnetic north is always east of true north. It is important that true north is used for the orientation rather than magnetic north. The following website calculates the difference between magnetic north and true north (magnetic declination) https://www.gns.cri.nz/Home/Our-Science/Land-and-Marine-Geoscience/Earth-s-Magnetic-Field/Declination-around-New-Zealand.

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MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

BP 6458

BUILDING PERFORMANCE

H1 Energy Efficiency

Verification Method H1/VM2

Energy efficiency for buildings greater than 300 m²

DRAFT FOR PUBLIC CONSULTATION

FIRST EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

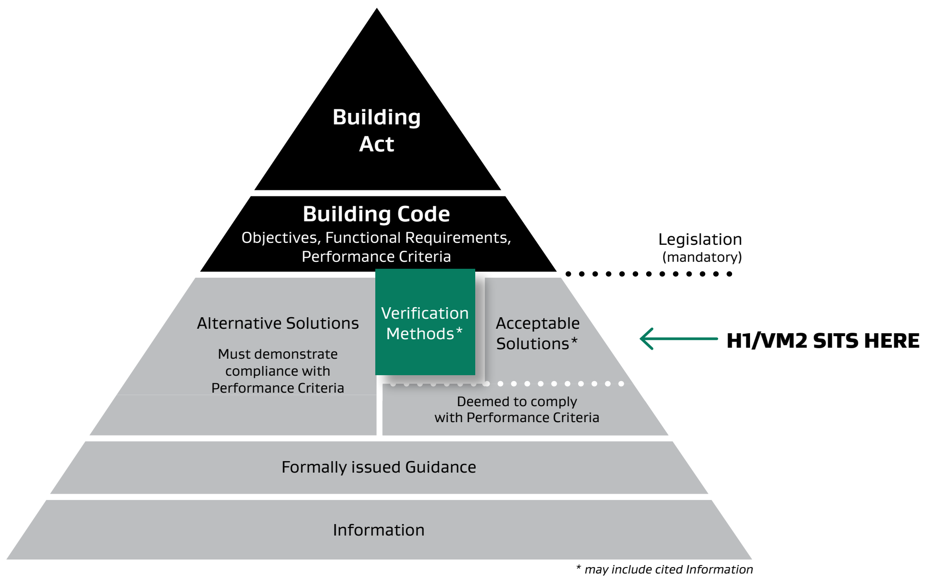
Document status

This document (H1/VM2) is a verification method issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXXX XXXX The previous Verification Method H1/VM1, as amended, can be used to show compliance until X XXXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX

Building Code regulatory system

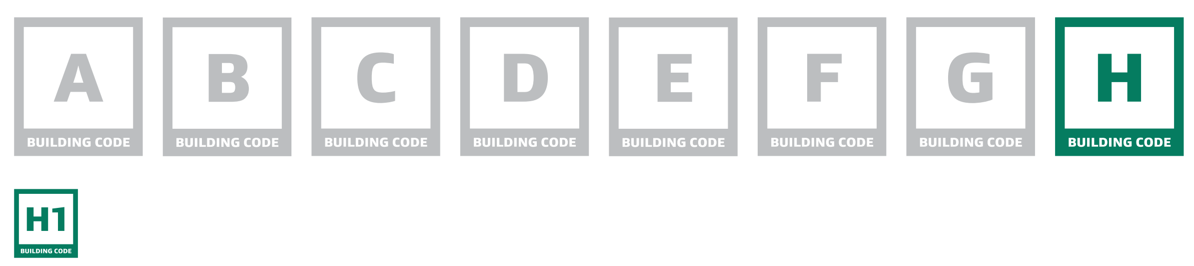
Each verification method outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this verification method relates to is clause H1 Energy Efficiency. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This is the first edition of H1/VM2. However, prior to its release, similar requirements were previously found within H1/VM1. The main changes from the previous version of H1/VM1 are:

- The scope of H1/VM1 has been reduced to cover only housing, and buildings other than housing less than 300m². Requirements applicable to large *buildings* have been combined into the new Verification Method H1/VM2. To reflect the new scope of the documents and the new document layout, a new introduction and scope has been provided in Part 1. General.
- Citation of NZS 4243.1: 2007 "Energy Efficiency – Large Buildings Part 1: Building Thermal Envelope" has been removed from the document. The relevant content from this standard has been adopted into H1/VM2 with permission from Standards New Zealand.
- The three-zone climate zone map previously found in NZS 4218 and NZS 4243.1 has been replaced with a six-zone climate zone map in Appendix C.
- The minimum *R-values* previous found in NZS 4218 and NZS 4243.1 have been updated with new values found in Part 2. Building.
- Portions of text have been re-written to enhance clarity in the document and provide consistent language with other Acceptable Solutions and Verification Methods.
- References have been revised to include only documents within the scope of H1/VM2.
- The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solution and verification methods are available from www.building.govt.nz

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

CR 1.1.1.1 This document applies to **communal residential**, **communal non-residential** (assembly care only) and **commercial** *buildings* with a floor area of *occupied space* greater than 300 m^2.

H 1.1.1.2 For all **housing**, and *buildings* other than **housing** with an *occupied space* less than 300 m², refer to the Acceptable Solution H1/AS1 or Verification Method H1/VM1 as a means to demonstrate compliance or use an alternative means demonstrate compliance.

1.1.2 Items outside the scope of this document

1.1.2.1 This verification method does not include the use of foil insulation.

1.1.2.2 This verification method does not include requirements to comply with Building Code clauses H.1.3.1(b), H1.3.4, H1.3.5 or H1.3.6. For these clauses, use an alternative means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This verification method is one option that provides a means of establishing compliance with the performance criteria in Building Code clauses H1.3.1 (a), and H1.3.3.

1.1.3.2 Options for demonstrating compliance with H1 Energy Efficiency through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.2 Using this verification method

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

Ind 1.2.1.2 In *buildings* containing both **industrial** and other classified uses, the non-industrial portion shall be treated separately according to its classified use. For example, in a *building* containing both **industrial** and **commercial** classified uses, the **commercial** area shall meet the relevant energy efficiency requirements of the Building Code

1.2.2 Features of this document

1.2.2.1 For the purposes of Building Code compliance, the standards and documents referenced in this verification method must be the editions, along with their specific amendments listed in Appendix A.

1.2.2.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.2.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

TABLE 1.1.3.2: Demonstrating compliance with H1 Energy Efficiency through acceptable solutions and verification methods

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
H1.3.1 (a) and (b) Thermal Envelope	H **Housing** CR **Communal residential** CN **Communal non-residential** (assembly care only) Com **Commercial**	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large *buildings*: H1/AS2 or H1/VM2
H1.3.2E *Building performance index*	H **Housing**	H1/AS1 or H1/VM1
H1.3.3 (a) to (f) Physical conditions	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large buildings: H1/AS2 or H1/VM2
H1.3.4 (a) Heating of hot water	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (b) Storage vessels and distribution systems	Individual storage vessels ≤ 700 L in capacity	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (c) Efficient use of hot water	H **Housing**	H1/AS1
H1.3.5 Artificial lighting	Lighting not provided solely to meet the requirements of Building Code clause F6 in: Com CN **Commercial** and **Communal non-residential** having *occupied space* greater than 300 m²	H1/AS2
H.1.3.6 *HVAC systems*	Com **Commercial**	H1/VM3

1.2.2.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses. These requirements are also denoted with classified use icons for:

- H a) **Housing**, and
- CR b) **Communal residential**, and
- CN c) **Communal non-residential**, and
- Com d) **Commercial**.
- Ind e) **Industry**, and

Out f) **Outbuildings**, and

Anc g) **Ancillary**.

1.2.2.5 Appendices to this verification method are part of, and have equal status to, the verification method. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Building Thermal envelope

2.1 Thermal resistance

2.1.1 Demonstrating compliance

2.1.1.1 The *building envelope* shall be provided with *construction* that provides *adequate thermal resistance*. This is demonstrated through the use of the *building* energy use modelling method described in Subsection 2.1.2.

> COMMENT: To satisfy the Building Code performance requirement E3.3.1 for internal moisture, it may be necessary, depending on the method adopted, to provide more insulation (greater R-value) than that required to satisfy energy efficiency provisions alone.

2.1.2 Modelling method for verification of the design

2.1.2.1 Verification of the design is achieved by demonstrating that the energy use of the *proposed building* design does not exceed the energy use of the *reference building* using computer modelling described in Appendix D.

2.1.2.2 The sum of the calculated annual *heating load* and annual *cooling load* of the *proposed building* shall not exceed that of the *reference building*. The *reference building* shall have *construction R-values* from:

a) For *building elements* that contain embedded heating systems Table 2.1.2.2A; or

b) For *building elements* that do not contain embedded heating systems, Table 2.1.2.2B.

2.1.2.3 The requirements for the *reference building* are separated based on the relevant climate zone for the *building*. A list of the New Zealand Climate zones is provided in Appendix C.

2.1.2.4 For *building elements* that contain embedded heating systems, the *proposed building* must, as a minimum, meet the *construction R-values* of Table 2.1.2.2A.

2.1.3 Determining thermal resistance of building elements

2.1.3.1 Verification of the *thermal resistance* (*R-values*) of *building elements* is achieved by using NZS 4214.

TABLE 2.1.2.2A: Minimum construction R-values for heated ceilings, walls or floors

Paragraph 2.1.2.2 a), 2.1.2.4

Building element	Minimum construction R-values (m² K/W) (1), (2), (3)					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Heated roof	**Refer to the consultation document for the proposed *R-values* for each element and climate zone**					
Heated wall						
Heated floor						

Notes:

(1) R_{IN}/R-value < 0.1 and R_{IN} is the *thermal resistance* between the heated plane and the inside air.

(2) Floor coverings, for example carpet or cork, will reduce the efficiency of the *heated floor*.

(3) Climate zone boundaries are shown in Appendix C.

TABLE 2.1.2.2B: Minimum construction R-values for building elements not containing embedded heating systems

Paragraph 2.1.2.2 a)

Building element	Construction R-values (m² K/W) (1)					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Roof	**Refer to the consultation document for the proposed *R-values* for each element and climate zone**					
Wall						
Floor						
Windows						
Skylights						

Note:

(1) Climate zone boundaries are shown in Appendix C.

Appendix A. References

For the purposes of Building Code compliance, the standards and documents referenced in this verification method must be the editions, along with their specific amendments, listed below.

Standards New Zealand		**Where quoted**
NZS 4214: 2006	Methods of determining the total thermal resistance of parts of buildings	2.1.3.1, Definitions

This standard can be accessed from www.standards.govt.nz

American National Standards Institute		
ANSI/ASHRAE 140: 2017	Standard method of test for the evaluation of building energy analysis computer programs	D.1.3.1

This standard can be accessed from webstore.ansi.org/

International Energy Agency	
Building Energy Simulation Test (BESTEST) and Diagnostic Method (1995)	D.1.3.1

This document can be accessed from www.nrel.gov

Appendix B. Definitions

These definitions are specific to this verification method. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	Means *adequate* to achieve the objectives of the Building Code.
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Building element	Any structural or non-structural component or assembly incorporated into or associated with a *building*. Included are *fixtures*, services, *drains*, permanent mechanical installations for access, glazing, partitions, ceilings and temporary supports.
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).
Conditioned space	That part of a *building* within the *building thermal envelope* that may be directly or indirectly heated or cooled for occupant comfort. It is separated from *unconditioned space* by *building elements* (walls, windows, *skylights*, doors, *roof*, and floor) to limit uncontrolled airflow and heat loss.
Construct	In relation to a *building*, includes to design, build, erect, prefabricate, and relocate the *building*; and *construction* has a corresponding meaning.
Construction R-value	The *R-value* of a typical area of a *building element* where: a) For walls and *roofs*, the *R-value* is of a typical area of the *building element* excluding the effects of openings and corners; and b) For framed walls, this includes studs, dwangs, top plates, and bottom plates, but excludes lintels, additional studs that support lintels, and additional studs at corners and junctions; and c) For walls without frames, this excludes any attachment requirements for windows and doors; and d) For slab floors, the *R-value* is from the inside air to the outside air but excludes carpets and other floor coverings; and e) For suspended floors, the *R-value* is of a typical area of the floor but excludes carpets, other floor coverings, and the effects of openings and corners; and f) For windows, the *R-value* includes the effects of both the glazing materials and the frame materials; and g) For doors, the *R-value* is of the door excluding the frame, opening tolerances, and glazing.
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).
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment
Floor area	In relation to a *building*, means the *floor area* (expressed in square metres) of all interior spaces used for activities normally associated with domestic living.
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).

Definitions

HVAC system	For the purposes of performance H1.3.6 and in relation to a *building*, means a mechanical, electrical, or other system for modifying air temperature, modifying air humidity, providing ventilation, or doing all or any of those things, in a space within the *building*.
Insulation plane	The plane within a *building envelope component* where the predominant *R-value* is achieved.
Intended use	In relation to a *building*, — a) includes any or all of the following: i) any reasonably foreseeable occasional use that is not incompatible with the intended use; ii) normal maintenance; iii) activities undertaken in response to *fire* or any other reasonably foreseeable emergency; but b) does not include any other maintenance and repairs or rebuilding.
Lighting power density limit (LPDL)	The limit that the lighting load shall not exceed. It is set in terms of watts per square metre of lit area and based on recommended maintained illuminances and other factors.
Occupied space	Any space within a *building* in which a person will be present from time to time during the *intended use* of the *building.*
Persons	Includes— a) the Crown; and b) a corporation sole; and c) a body of *persons* (whether corporate or unincorporated).
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	The common abbreviation for describing the values of both *thermal resistance* and *total thermal resistance*.
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.
Shading coefficient (SC)	The ratio of the total *solar heat gain coefficient* (SHGC) through a particular glass compared to the total *solar heat gain coefficient* through 3 mm clear float glass.
Skylight	Translucent or transparent parts of the *roof*.
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.)
Thermal envelope	The *roof*, wall, window, *skylight*, door and floor *construction* between *unconditioned space*s and *conditioned spaces*.
Thermal mass	The heat capacity of the materials of the *building* affecting *building* heat loads by storing and releasing heat as the interior and/or exterior temperature and radiant conditions fluctuate.
Thermal resistance	The resistance to heat flow of a given component of a *building element*. It is equal to the air temperature difference (K) needed to produce unit heat flux (W/m^2) through unit area (m^2) under steady conditions. The units are $m^2 \cdot K/W$

Total thermal resistance	The overall air-to-air *thermal resistance* across all components of a *building element* such as a wall, *roof* or floor. (This includes the surface resistances which may vary with environmental changes eg temperature and humidity, but for most purposes can be regarded as having standard values as given in NZS 4214.)
Total wall area	In relation to a *building,* means the sum (expressed in square metres) of the following: a) the *wall area* of the *building*; and b) the area (expressed in square metres) of all vertical windows in *external walls* of the *building.*
Unconditioned space	Space within the *building envelope* that is not *conditioned space* (for example, this may include a garage, conservatory, atrium, attic, subfloor, and so on). However, where a garage, conservatory or atrium is expected to be heated or cooled these spaces shall be included in the *conditioned space*.
Wall area	The area of walls that are part of the *thermal envelope*, measured on the exterior side and excluding the *door area* and the *window area*.
Window area (A_{window})	The total area of glazing in the *thermal envelope*, including frames and opening tolerances, glazing in doors, and decorative glazing and louvres, but excluding *skylights*.

Appendix C. New Zealand climate zones

C.1 Climate zones

C.1.1 Climate zone boundaries

C.1.1.1 There are six climate zones. The climate zone boundaries are based on climatic data taking into consideration territorial authority boundaries.

C.1.1.2 A list of the climate zones for each territorial authority is provided in Table C.1.1.2 and illustrated in Figure C.1.1.2. The list in the table takes precedence.

New Zealand climate zones

TABLE C.1.1.2: Climate zones by territorial authority

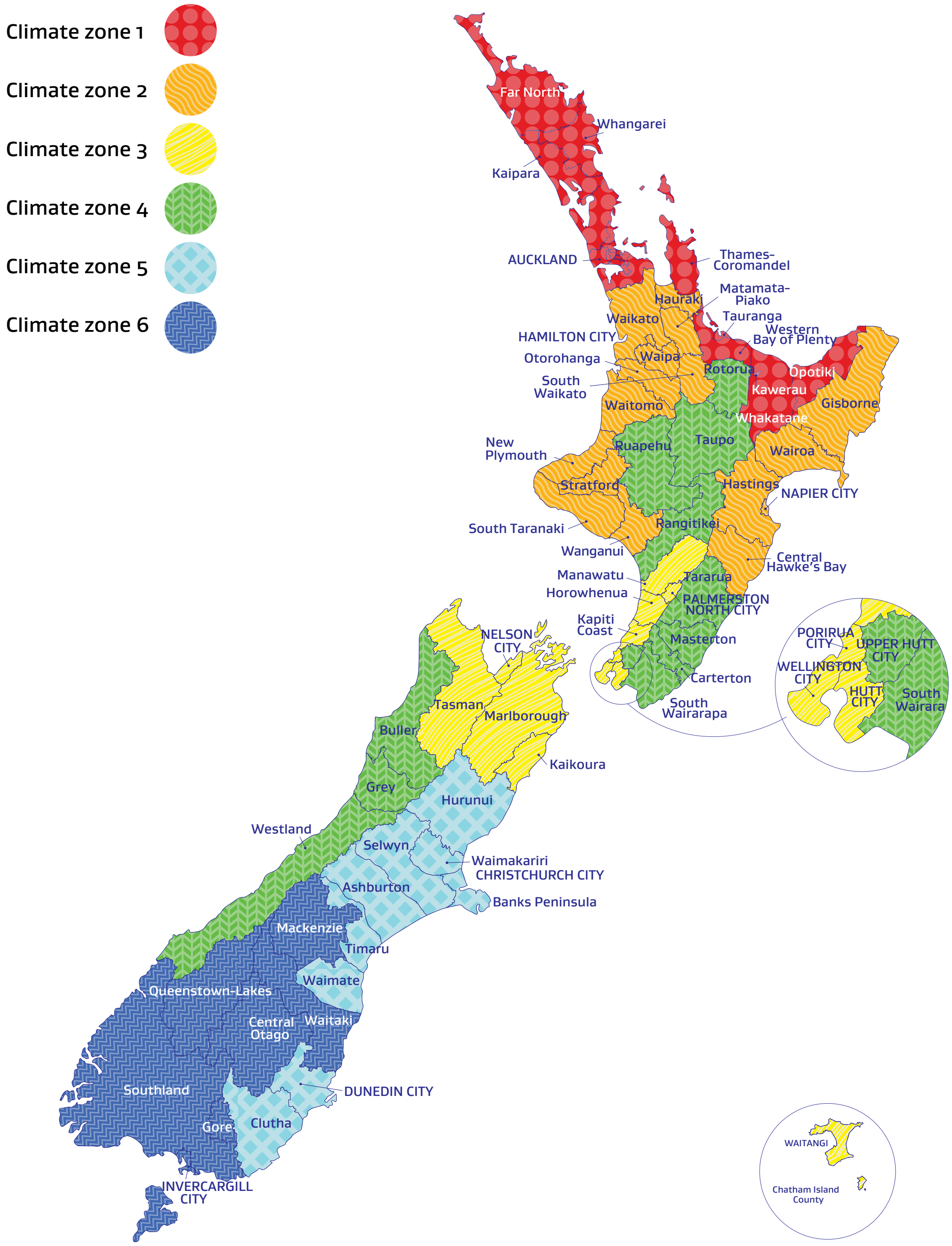
Paragraph C.1.1.2

North Island/Te Ika-a-Māui		South Island/Te Waipounamu	
Territorial authority	**Climate zone**	**Territorial authority**	**Climate zone**
Far North District	1	Tasman District	3
Whangarei District	1	Nelson City	3
Kaipara District	1	Marlborough District	3
Auckland	1	Kaikoura District	3
Thames-Coromandel district	1	Buller District	4
Hauraki District	2	Grey District	4
Waikato District	2	Westland District	4
Matamata-Piako District	2	Hurunui District	5
Hamilton City	2	Waimakariri District	5
Waipa District	2	Christchurch City	5
Otorohanga District	2	Selwyn District	5
South Waikato District	2	Ashburton District	5
Waitomo District	2	Timaru District	5
Taupo District	4	Mackenzie District	6
Western Bay of Plenty District	1	Waimate District	5
Tauranga City	1	Chatham Islands	3
Rotorua District	4	Waitaki District	6
Whakatane District	1	Central Otago District	6
Kawerau District	1	Queenstown-Lakes District	6
Opotiki District	1	Dunedin City	5
Gisborne District	2	Clutha District	5
Wairoa District	2	Southland District	6
Hastings District	2	Gore District	6
Napier City	2	Invercargill City	6
Central Hawke's Bay District	2		
New Plymouth District	2		
Stratford District	2		
South Taranaki District	2		
Ruapehu District	4		
Whanganui District	2		
Rangitikei District	4		
Manawatu District	3		
Palmerston North City	3		
Tararua District	4		
Horowhenua District	3		
Kapiti Coast District	3		
Porirua City	3		
Upper Hutt City	4		
Lower Hutt City	3		
Wellington City	3		
Masterton District	4		
Carterton District	4		
South Wairarapa District	4		

New Zealand climate zones

FIGURE C.1.1.2: Map of New Zealand Climate zones

Paragraph C.1.1.2



Appendix D. Modelling method – Building energy use comparison

D.1 Modelling requirements

D.1.1 Overview

D.1.1.1 This modelling method is used to assess the energy performance of a proposed *building* by using a simulation of the *building* to predict its space *heating loads* and *cooling loads*. This is compared with the space *heating loads* and *cooling loads* of a reference *building* that is the same shape, dimensions, and orientation as the proposed *building*, but has *building elements* with *construction R-values* from:

a) For *building elements* that contain embedded heating systems Table 2.1.2.2A; or

b) For *building elements* that do not contain embedded heating systems, Table 2.1.2.2B.

D.1.1.2 Both *buildings* shall be simulated using the same method.

D.1.2 Modelling principles

D.1.2.1 The proposed *building* and reference *building* shall both be analysed using the same techniques and assumptions except where differences in energy efficiency features that are specified in this appendix require a different approach.

D.1.2.2 The specifications of the proposed *building* used in the analysis shall be as similar as is reasonably practicable to those in the plans submitted for a building consent.

D.1.2.3 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*.

D.1.2.4 Features that may differ between the proposed *building* and the reference *building* are:

a) Wall *construction R-value* and *thermal mass*; and/or

b) Floor *construction R-value*; and/or

c) *Roof construction R-value* and *thermal mass*; and/or

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

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

D.1.2.5 The results of the thermal modelling should not be construed as a guarantee of the actual energy use of the *building*.

D.1.3 Modelling software

D.1.3.1 If the application for which the software is to be used has been documented according to the ANSI/ASHRAE Standard 140 procedure, then the method shall pass ANSI/ASHRAE Standard 140 test. If the application for which the software is to be used has not been documented according to the ANSI/ASHRAE Standard 140 procedure, the method shall be tested to BESTEST and pass the BESTEST.

D.1.4 Default values

D.1.4.1 The *default values* and schedules included in this appendix shall be used unless the designer can demonstrate that different assumptions better characterise the *building's* use over its expected life. Any modification of default assumptions shall be used in simulating both the proposed *building* and the reference *building*.

D.1.4.2 Other aspects of the *building's* performance for which no *default values* are provided may be simulated 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*.

D.1.4.3 In all the following cases, modelling is to be identical for both the proposed *building* and the reference *building*. Some of these items have limitations on the input values and others have default schedules that may be used when actual figures are not known. In all cases these values shall be reasonable approximations of the requirements of the *building* and its use during its expected life:

a) Heating set-points, and schedules; and
b) Cooling set-points, and schedules; and
c) Ventilation set-points, and schedules; and
d) Fresh air ventilation air change rates and schedules; and
e) Internal gains loads and schedules; and
f) Occupancy loads and schedules; and
g) Lighting schedules; and
h) The location and *R-value*s of carpets and floor coverings; and
i) Incidental shading; and
j) Heating, cooling and ventilation plant, type and modelling method.

D.1.5 Climate data

D.1.5.1 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 *construct*ed. The climate data shall represent an average year for the location.

> COMMENT: Using the relevant NIWA Typical Meterological Year climate files is one way to achieve this requirement.

D.1.6 Thermal zones

D.1.6.1 The model of the proposed *building* and the reference *building* shall be identically and suitably divided into separate thermal zones.

D.1.6.2 Spaces that are likely to have significantly different space conditioning requirements shall be modelled as separate zones.

D.1.6.3 The *conditioned space* shall be divided into a minimum of three thermal zones.

D.1.6.4 *Roof* spaces and enclosed subfloor spaces shall be modelled as thermal zones.

D.1.6.5 The model shall have a representation of internal conductive heat flows between thermal zones. Internal partitions between thermal zones require modelling and shall be described in terms of their location, surface area, pitch, and *construction R-value*.

D.1.6.6 The same internal partitions as modelled in the proposed *building* shall be modelled in the reference *building*.

D.1.6.7 Internal partitions within a thermal zone which may affect the thermal performance of the *building* shall be modelled.

D.1.6.8 Airflow between thermal zones need not be modelled unless desired.

D.1.7 Unconditioned *space*

D.1.7.1 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 windows) between it and the rest of the *building* forms part of the *building thermal envelope* and in the reference *building* it shall meet the requirements of Subsection 2.1.2.

D.1.7.2 An *unconditioned space* outside the *building thermal envelope* need not be modelled.

D.1.8 Units and group buildings

D.1.8.1 Walls and other surfaces that separate occupied units may be assumed to have no heat transfer.

D.1.9 Thermal mass

D.1.9.1 The *thermal mass* may either be modelled:

a) The same way for both the proposed *building* and the reference *building*; or

b) As proposed for the proposed *building* and modelled as lightweight for the reference *building*.

D.1.10 Thermal mass of contents

D.1.10.1 The *thermal mass* of the contents shall be the same for both models, and may be regarded as zero for modelling purposes.

D.1.11 Shading

D.1.11.1 Exterior attached shading such as fins and overhangs should be modelled as proposed in the proposed *building* but need not be modelled in the reference *building*.

D.1.11.2 No account shall be taken of internal shading devices such as blinds, drapes and other non-permanent window treatments.

D.1.12 Incidental shading

D.1.12.1 Shading by structures and terrain that have a significant effect on the *building* shall be modelled in the same way for the proposed *building* and the reference *building*.

D.1.12.2 No account shall be taken of trees or vegetation.

D.1.13 Infiltration

D.1.13.1 Infiltration assumptions for proposed *building*s and the reference *building* shall be the same, and shall be reasonable for the *building construction*, location, and use.

D.1.14 Internal air flows

D.1.14.1 Interzone air flow does not require modelling.

D.1.15 Internal doors

D.1.15.1 Internal doors need not be modelled.

D.2 Thermal envelope

D.2.1 Thermal envelope building elements

D.2.1.1 All *building element*s shall be described in terms of surface area, orientation, pitch, and *construction R-value*. *Window areas* shall have their *solar heat gain coefficient* (*SHGC*) specified.

D.2.1.2 The solar absorption of external *building elements*, except as specified in Paragraph D1.11.2, shall be modelled in both the proposed *building* and reference *building* as proposed. If solar absorption is not specified, they shall be modelled in both the proposed *building* and reference *building* as 0.7.

D.2.1.3 When the modelling program calculates and adds its own surface resistances to the input *thermal resistance*, the input *thermal resistances* shall be the *construction R-values* derived as specified in this method less the standardised surface resistances of 0.03 $m^2 \cdot K/W$ outside and 0.09 $m^2 \cdot K/W$ inside (0.12 $m^2 \cdot K/W$ total). The same method of calculation shall be used for the proposed *building* and the reference *building*.

D.2.2 External walls

D.2.2.1 *External wall*s of the proposed *building* shall be modelled as proposed.

D.2.2.2 *External wall*s for the reference *building* shall have an *R-value* equal to the values specified in Table 2.1.2.2A or Table 2.1.2.2B.

D.2.2.3 *External walls* for the reference *building* shall the same orientation, tilt and area as the proposed *building*, except as provided in Paragraph D.2.6.3.

D.2.3 Internal walls

D.2.3.1 Walls separating different thermal zones or *conditioned space* and *unconditioned space*s of the proposed *building* and reference *building* shall be modelled as proposed. Other internal walls need not be modelled.

D.2.3.2 The same internal walls as modelled in the proposed *building* shall be modelled in the reference *building*. Other internal *wall*s need not be modelled. In the reference *building*, the *construction R-value*s of walls between *conditioned space* and *unconditioned space*s shall be those specified in Table 2.1.2.2A or Table 2.1.2.2B.

D.2.4 Roofs

D.2.4.1 *Roof*s of the proposed *building* shall be modelled as proposed.

D.2.4.2 *Roof*s for the reference *building* shall have the same area as those for the proposed *building* except where *skylight area*s are modified according to Subsection D.2.7.

D.2.4.3 In all cases the total *roof area* shall be the same as for the proposed *building*.

D.2.4.4 The *roof* of the reference *building* shall have an *R-value* equal to the value specified in Table 2.1.2.2A or Table 2.1.2.2B.

D.2.4.5 The *roof*s of the proposed *building* and reference *building* shall have the same solar absorption (0.7 is an acceptable *default value*).

D.2.5 Floors

D.2.5.1 Floors for the proposed *building* shall be modelled as proposed.

D.2.5.2 Floors for the reference *building* shall have the same area as those in the proposed *building* but shall be modelled with a *construction R-value* as specified in Table 2.1.2.2A or Table 2.1.2.2B.

D.2.5.3 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.

D.2.5.4 Carpets and other floor coverings shall be the same in both the proposed *building* and reference *building* and shall be modelled if present. Any *thermal resistance* provided by carpets or floor coverings shall be in addition to the *R-value*s specified in Table 2.1.2.2A or Table 2.1.2.2B.

D.2.6 Windows

D.2.6.1 Windows in the proposed *building* shall be modelled as proposed.

D.2.6.2 Windows for the reference *building* shall have the same orientation, tilt, and area, as the proposed *building* except as provided in Paragraph D.2.6.3.

D.2.6.3 The *window area* of the reference *building* shall equal that of the proposed *building* unless the proposed *building* has windows which exceed 50% of the *total wall area*, in which case the reference *building* shall use a *window area* of 50% of the *total wall area*. The window distribution shall be modelled as equal to the distribution in the proposed *building* or shall constitute an equal percentage of *wall area* for each zone and orientation's *external wall*.

D.2.6.4 Windows for the reference *building* shall assume a *shading coefficient* of 0.8, a site shading of 0.75, and *R-value* as specified in Table 2.1.2.2B.

D.2.7 Skylights

D.2.7.1 *Skylights* of the proposed *building* shall be modelled as proposed. A total *skylight area* of less than 0.6 m^2 may be ignored for calculation purposes.

D.2.7.2 *Skylights* and *roof*s for the reference *building* shall be modelled such that the total *R-value* of the *roof* is equivalent to a *roof* meeting the requirements specified in Table 2.1.2.2A or Table 2.1.2.2B.

D.2.7.3 This shall be achieved while the *R-value* and *shading coefficient* of the glass remain the same as that proposed. This provision effectively limits the amount of *skylight* that can be included in the reference *building*.

D.2.8 External door

D.2.8.1 The distribution of doors in the reference *building* shall be identical to the distribution of doors in the proposed *building*.

D.2.8.2 Doors in the reference *building* shall have an *R-value* of 0.18 m^2·K/W.

D.3 Space conditioning

D.3.1 Control temperatures

D.3.1.1 In all cases temperatures modelled shall be the same for the proposed *building* and the reference *building*.

D.3.1.2 This specification does not deal specifically with internal conditions, and it is for the designer to judge what appropriate comfort conditions are. It is advisable that the designer considers the maximum acceptable temperature and checks that this is not exceeded. A temperature of between 20°C and 24°C is often used for air-conditioned **commercial** *building*s during occupancy.

D.3.1.3 Unless a different schedule can be justified as a likely schedule for the foreseeable life of the *building*, occupancy for **commercial** *building*s should be 10 hours per day, 5 days per week or as provided for:

CR a) **Communal residential** including hotels, motels, and health consultancies in Table D.5.1.2A; and

CN b) **Communal non-residential** assembly care including schools in Table D.5.1.2B; and

Com c) **Commercial** including offices, restaurants, and retail shops in Table D.5.1.2C.

D.3.2 Fresh air ventilation

D.3.2.1 The fresh air ventilation rate and schedule shall be the same for both the proposed *building* and the reference *building*.

D.3.2.2 Constant ventilation may be modelled.

D.3.2.3 The minimum ventilation rate should be according to G4/AS1 or G4/VM1.

D.3.2.4 Ventilation may be provided mechanically or by natural means.

D.3.3 Conditioning system modelling

Com D.3.3.1 For **commercial** *buildings*, *HVAC systems* shall be simulated in an identical manner in both the proposed *building* and the reference *building* and be consistent with the requirements of Verification Method H1/VM3. Sizing is the only feature that may be changed in response to load requirements.

D.3.3.2 The type of plant in the proposed *building* should represent the type of system proposed. Where such a model is unavailable, use the closest that is available.

D.3.3.3 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 must be clearly and fully stated. The program shall be suitable for the type of system proposed.

D.3.3.4 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.

D.3.3.5 Modelling shall use reasonable assumptions as to equipment performance and control.

D.3.3.6 Sufficient information shall be input to describe the proposed *building*'s plant to permit modelling by the program.

D.4 Internal loads

D.4.1 Lighting

D.4.1.1 For the proposed *building*, the connected lighting load shall be modelled as proposed.

D.4.1.2 For the reference *building*, the connected lighting load shall be modelled as the lighting load permitted in NZS 4243 Part 2. Alternatively, the lighting load of the proposed *building* may be used if this is less than the load permitted by NZS 4243 Part 2. The load from lighting not covered by *lighting power density limits* specified in NZS 4243 Part 2 shall be the same in the proposed *building*.

D.4.1.3 The lighting use schedule shall be the same for both the proposed *building* and the reference *building*. Any assumption regarding the proportion of lights in use shall be reasonable, and shall be recorded. The default lighting schedule is 90% of total lighting connected load during hours of occupancy, and 10% of total connected lighting load on during other hours. Hours of occupancy for the *building* shall be a reasonable approximation of how the *building* is expected to be used. *Default value* is ten hours per day, five days per week for commercial *building*s.

D.4.1.4 Lighting schedules shall use the same references throughout for both the proposed *building* and the reference *building*. The lighting schedule are provided for:

CR a) **Communal residential** including hotels, motels, and health consultancies in Table D.5.1.2A; and

CN b) **Communal non-residential** assembly care including schools in Table D.5.1.2B; and

Com c) **Commercial** including offices, restaurants, and retail shops in Table D.5.1.2C.

D.4.1.5 The lighting schedule may be altered to reflect the type of controls in the proposed *building*, but both the proposed *building* and reference *building* lighting schedules shall be identical. No credit shall be given for the use of any controls, automatic or otherwise.

D.4.1.6 Thermal simulations shall include the heat released into the proposed *building* and reference *building* from lighting. The same loads and schedules as the modelled lighting shall be used in each case.

D.4.2 Domestic hot water

D.4.2.1 Hot water systems shall not be modelled.

D.4.3 Occupants and plug loads

D.4.3.1 The maximum heat release into a *building* from occupants and *plug loads* is provided in Table D.5.1.1 and is modified to provide default values for heat release at different times of day. The modification factors are provided for:

CR a) **Communal residential** including hotels, motels, and health consultancies in Table D.5.1.2A; and

CN b) **Communal non-residential** assembly care including schools in Table D.5.1.2B; and

Com c) **Commercial** including offices, restaurants, and retail shops in Table D.5.1.2C.

D.4.3.2 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 shall be the same for both the proposed *building* and reference *building*. All internal loads are regarded as sensible heat.

D.4.3.3 *Unconditioned space* shall be assigned zero internal loads.

D.4.4 Process loads

D.4.4.1 Process loads are those heat loads that result from the production of goods within a *building*.

D.4.4.2 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 modelling occur. Process loads shall be the same in both the proposed *building* and reference *building*.

D.5 Reference building

D.5.1 Schedules

The default power densities for internal gains from occupants and *plug load* are provided in Table D.5.1.1.

TABLE D.5.1.1: Default power densities for internal gains from occupants and plug loads

Paragraph D.5.1.1

Classified use	Applies to[1]	Occupancy (W/m^2)	Plug load (W/m^2)
CR	Community service –hotels and motels	2.9	2.7
	Community care – Unrestrained – such as health/institutional	3.6	10.7
CN	Assembly care – schools	9.7	5.4
Com	Office	2.7	8.1
	Restaurant	7.3	1.1
	Retail shop	2.4	2.7
	Car park	N/A	N/A

Note:

(1) If an activity for the proposed *building* is not specifically described, use the nearest description for the both the proposed *building* and the reference *building*.

D.5.1.2 The default schedules for occupancy and *plug load*s are provided for:

CR a) **Communal residential** including hotels, motels, and health consultancies in Table D.5.1.2A; and

CN b) **Communal non-residential** assembly care including schools in Table D.5.1.2B; and

Com c) **Commercial** including offices, restaurants, and retail shops in Table D.5.1.2C.

TABLE D.5.1.2A: **Default schedules for occupancy, plug loads and lighting – Percentage of maximum load or percentage of power density for communal residential**

Paragraphs D.3.1.3 a), D.4.1.4 a), D.4.3.1 a), D.5.1.2 a)

Community service – hotels and motels					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
Week	90	40	20	70	90
Saturday	90	50	30	60	70
Sunday	70	70	30	60	80
Plug load and lighting					
Week	10	40	25	60	60
Saturday	10	40	25	60	60
Sunday	10	30	30	50	50
Community service – residential care such as retirement village					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
Week	70	90	90	85	70
Saturday	70	90	90	85	70
Sunday	70	90	90	85	70
Plug load and lighting					
Week	20	90	85	80	20
Saturday	20	90	85	80	20
Sunday	20	90	85	80	20
Community care – Health/ medical specialist					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
Week	0	80	80	30	0
Saturday	0	40	40	0	0
Sunday	0	5	5	0	0
Plug load and lighting					
Week	10	90	90	30	10
Saturday	10	40	40	10	10
Sunday	5	10	10	5	5

TABLE D.5.1.2B: **Default schedules for occupancy, plug loads and lighting – Percentage of maximum load or percentage of power density for communal non-residential – assembly care**

Paragraphs D.3.1.3 b), D.4.1.4 b), D.4.3.1 b), D.5.1.2 b)

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

TABLE D.5.1.2C: Default schedules for occupancy, plug loads and lighting – Percentage of maximum load or percentage of power density for commercial buildings

Paragraphs D.3.1.3 c), D.4.1.4 c), D.4.3.1 c), D.5.1.2 c)

Office					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
Week	0	95	95	5	0
Saturday	0	10	5	0	0
Sunday	0	5	5	0	0
Plug load and lighting					
Week	5	90	90	30	5
Saturday	5	30	15	5	5
Sunday	5	5	5	5	5
Restaurant					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
Week	0	5	50	80	35
Saturday	0	0	45	70	55
Sunday	0	0	20	55	20
Plug load and lighting					
Week	15	40	90	90	50
Saturday	15	30	80	90	50
Sunday	15	30	70	60	50
Retail shop					
Occupancy	**12 am – 8 am**	**8 am – 11 am**	**11 am – 6 pm**	**6 pm – 10 pm**	**10 pm – 12 am**
Week	0	60	70	40	0
Saturday	0	60	80	20	0
Sunday	0	10	40	0	0
Plug load and lighting					
Week	5	90	90	50	5
Saturday	5	90	90	30	5
Sunday	5	40	40	5	5

D.6 Documentation

D.6.1 Documentation of analysis

D.6.1.1 Documentation of computer modelling analysis shall contain:

a) The name of the modeller;

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

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

d) The sum of the *heating load* and *cooling load* for the proposed *building* and reference *building*;

e) Where possible, the *heating load* and *cooling load* for the proposed *building* and the reference *building*; and

f) The calculated annual energy consumption for space heating, space cooling, ventilation/fans, and lighting.

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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

BP 6478

BUILDING PERFORMANCE

H1 Energy Efficiency

Verification Method H1/VM3

Energy efficiency of HVAC systems in commercial buildings

DRAFT FOR PUBLIC CONSULTATION

FIRST EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

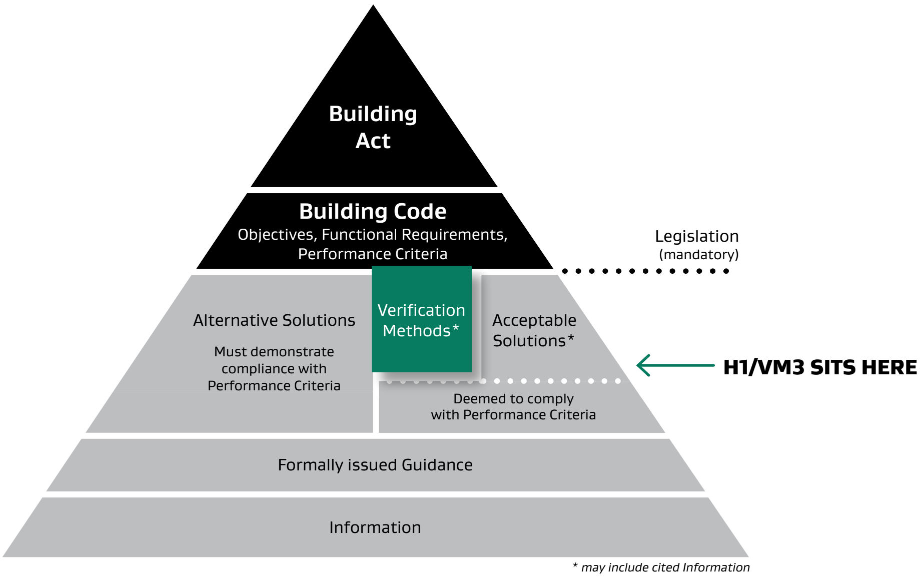
Document status

This document (H1/VM3) is a verification method issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX.

Building Code regulatory system

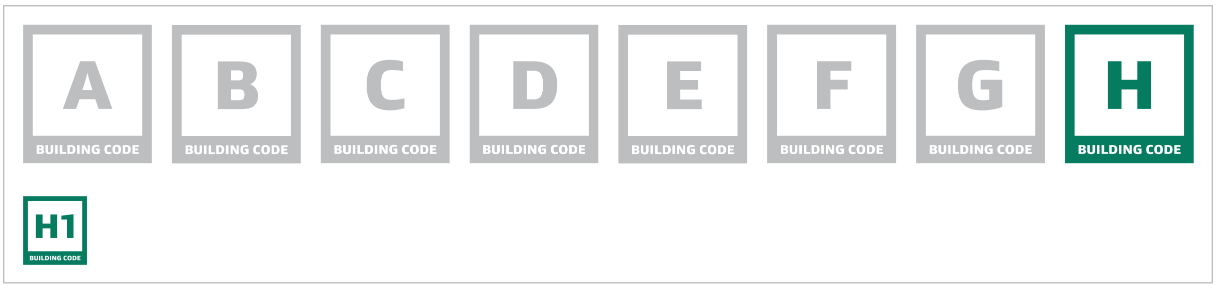
Each verification method outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this verification method relates to is clause H1 Energy Efficiency. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other Acceptable Solutions and Verification Methods are available at www.building.govt.nz

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

Com 1.1.1.1 This verification method can be used for *HVAC systems* in **commercial** *buildings*. It contains requirements for:

a) Air conditioning system controls, and
b) Mechanical ventilation system controls, and
c) Fans, and
d) Ductwork insulation and sealing, and
e) Pumps, and
f) Pipework insulation, and
g) Space heating, and
h) Refrigerant chillers, and
i) Unitary air conditioning equipment, and
j) Heat rejection equipment, and
k) Facilities for energy monitoring, and
l) Maintenance access.

1.1.2 Items outside the scope of this document

1.1.2.1 This verification method does not include requirements for:

a) *HVAC systems* that directly cool cold rooms or heat hot rooms (such as in a butcher's shop, fruit storage rooms or in laboratories); or
b) *HVAC systems* that maintain specialised conditions for equipment or processes, where this is the main purpose of the *HVAC system*.

1.1.2.2 For these, compliance may be demonstrated using an alternative solution.

1.1.3 Compliance pathway

1.1.3.1 This verification method is one option that provides a means of establishing compliance with the performance criteria in Building Code clause H1.3.6.

1.1.3.2 Options for demonstrating compliance with H1 Energy Efficiency through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.2 Using this Verification Method

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

Ind 1.2.1.2 In *buildings* containing both **industrial** and other classified uses, the non-industrial portion shall be treated separately according to its classified use. For example, in a building containing both **industrial** and **commercial** classified uses, the **commercial** area shall meet the relevant NZBC energy efficiency requirements.

TABLE 1.1.3.2: Demonstrating compliance with H1 Energy Efficiency through acceptable solutions and verification methods

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
H1.3.1 (a) and (b) Thermal Envelope	H **Housing** CR **Communal residential** CN **Communal non-residential** (assembly care only) Com **Commercial**	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large *buildings*: H1/AS2 or H1/VM2
H1.3.2E *Building performance index*	H **Housing**	H1/AS1 or H1/VM1
H1.3.3 (a) to (f) Physical conditions	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large buildings: H1/AS2 or H1/VM2
H1.3.4 (a) Heating of hot water	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (b) Storage vessels and distribution systems	Individual storage vessels ≤ 700 L in capacity	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (c) Efficient use of hot water	H **Housing**	H1/AS1
H1.3.5 Artificial lighting	Lighting not provided solely to meet the requirements of Building Code clause F6 in: Com CN **Commercial** and **Communal non-residential** having *occupied space* greater than 300 m²	H1/AS2
H.1.3.6 *HVAC systems*	Com **Commercial**	H1/VM3

1.2.2 Features of this document

1.2.2.1 For the purposes of Building Code compliance, the standards and documents referenced in this verification method must be the editions, along with their specific amendments listed in Appendix A.

1.2.2.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.2.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.2.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses. These requirements are also denoted with classified use icons for:

H a) **Housing**, and

CR b) **Communal residential**, and

CN c) **Communal non-residential**, and

Com d) **Commercial**.

Ind e) **Industry**, and

Out f) **Outbuildings**, and

Anc g) **Ancillary**.

1.2.2.5 Appendices to this verification method are part of, and have equal status to, the verification method. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Air conditioning system control

2.1 Demonstrating compliance

2.1.1 System design objectives

2.1.1.1 Energy consumption of an *air conditioning* system is to be limited by providing active and passive controls. The control requirements limit the use of energy during the operation of the *air conditioning* system by reducing the energy that would otherwise be wasted.

2.2 Verification of the design

2.2.1 Overview

2.2.1.1 The verification of the design is achieved by providing an *air conditioning* system that complies with the requirements of:

a) Deactivation, and

b) Zoning, and

c) Operating times, and

d) *Outdoor air* economy cycle, and

e) Control of central plant and of the heating and cooling energy medium flow, and

f) Variable speed of fans, and

g) Commissioning.

2.2.2 Deactivation

2.2.2.1 An *air conditioning* system shall be capable of being deactivated when the *building* or the part of a *building* served by that system is not occupied.

> COMMENT: If an *air conditioning* system serves a whole building, it is only required to be capable of being deactivated when the whole *building* is unoccupied. However, if an *air conditioning* system only serves a part of a *building*, the system must be capable of being deactivated when that part of the *building* is unoccupied. The design of the operational arrangements of the *air conditioning* system should be based on logical *building* areas, segments and activities.

2.2.2.2 When deactivated, an *air conditioning* system shall close any motorised damper that is installed within an air pathway between the *conditioned space* and outside and that is not otherwise being actively controlled.

> COMMENT: This requirement is to reduce the infiltration of unconditioned outdoor air when the system is not in use, and reduce the start-up load when the system is next needed.

2.2.3 Zoning

2.2.3.1 When defining *air conditioning* zones, consideration shall be given to how different rooms or areas may require heating or cooling at different rates throughout the day.

COMMENT: For example, if there is only one temperature sensor and it is located in an east-facing room which has become too hot from the morning sun, it may activate more cooling than is needed in other rooms that do not receive morning sun. Using multiple temperature control devices will help prevent this, and mean the building uses less energy overall.

2.2.3.2 When serving more than one *air conditioning* zone or area with different heating or cooling needs, an *air conditioning system* shall:

a) thermostatically control the temperature of each zone or area; and

b) not control the temperature by mixing actively heated air and actively cooled air; and

c) limit reheating to not more than:

i) for a fixed supply air rate, a 7.5K rise in temperature; or

ii) for a variable supply air rate, a 7.5K rise in temperature at the nominal supply air rate but increased or decreased at the same rate that the supply air rate is respectively decreased or increased.

COMMENT:

1. A suitable location of the temperature control devices may be in the ductwork supplying the different spaces.
2. The limits on reheating are intended to encourage the grouping of areas with similar heating and cooling demand, rather than sub-cooling all the supply air and reheating excessively to achieve the desired temperature.
3. The limit on reheating for systems with a variable supply air rate constitutes an inverse relationship between allowable temperature rise and supply air rate. If, during the reheating, the supply air rate is also reduced then the temperature rise can be proportionally increased above 7.5K at the same rate that the supply air rate has been reduced. For example, the reheat temperature could be increased to 10K when the supply air rate is reduced by 25% or increased to 15K if the supply air rate is reduced by 50%.

2.2.3.3 When two or more *air conditioning* systems serve the same *air conditioning* zone they shall use control sequences that prevent the systems from operating in opposing heating and cooling modes within the same *air conditioning* zone.

2.2.3.4 An *air conditioning* system shall have a control dead band of not less than 2°C, except where a smaller range is required for specialised applications.

2.2.4 Operating times

2.2.4.1 An *air conditioning* system shall ensure that each independently operating space of more than 1000 m^2 and every separate floor of the *building* has provision to terminate airflow independently of the remainder of the system sufficient to allow for different operating times.

2.2.4.2 Except where *air conditioning* is needed for 24 hour continuous use, a time switch shall be provided to control:

a) an *air conditioning* system of more than 2 kWr (kilowatts of refrigeration); and

b) a heater of more than 1 kWheating (kilowatt of heating) used for *air conditioning*.

2.2.4.3 The time switch shall be capable of switching electric power on and off at variable pre-programmed times and on variable pre-programmed days.

2.2.5 Outdoor air economy cycle

2.2.5.1 If providing mechanical ventilation, other than where dehumidification control is needed, an *air conditioning* system shall have an *outdoor air economy cycle* if the total air flow rate of any single airside component of an *air conditioning* system is greater than or equal to 2500 L/s.

2.2.6 Control of central plant and of the heating and cooling energy medium flow

2.2.6.1 An *air conditioning* system which contains more than one water heater, chiller or coil, shall be capable of automatically stopping the flow of water to system components that are not operating.

> COMMENT: This requirement aims to reduce the amount of pump energy needed and reduce the thermal loss through system components like *piping*.

2.2.6.2 An *air conditioning* system shall have the ability to use direct signals from the control components responsible for maintaining the internal environmental conditions in the *building* to regulate the operation of the central plant.

> COMMENT: This requirement enables regulating the operation and set-points of central plant in coordination with the needs of the building, rather than operating central services as a continuous provision.

2.2.7 Variable speed of fans

2.2.7.1 An *air conditioning* system with an airflow of more than 1000 L/s shall have a variable speed fan when its supply air quantity is to be capable of being varied.

> COMMENT: A variable speed fan is a more energy efficient method of reducing air flow than throttling the air supply with dampers.

2.2.8 Commissioning

2.2.8.1 An *air conditioning* system shall be provided with balancing dampers, balancing valves and/or variable speed fans that ensure the maximum design air or fluid flow is achieved but not exceeded by more than 15% above design at each:

a) component; or

b) group of components operating under a common control in a system containing multiple components, as required to meet the needs of the system at its maximum operating condition.

Part 3. Mechanical ventilation system control

3.1 Demonstrating compliance

3.1.1 System design objectives

3.1.1.1 Energy consumption of a mechanical ventilation system is to be limited by providing active and passive controls. The control requirements limit the use of energy during the operation of the mechanical ventilation system by reducing the energy which will be otherwise wasted.

3.2 Verification of the design

3.2.1 Overview

3.2.1.1 The verification of the design is achieved by providing a mechanical ventilation system that complies with the requirements of:

a) Deactivation; and

b) Operating times; and

c) Limiting *outdoor air* flow; and

d) Variable speed of fans.

3.2.2 Deactivation

3.2.2.1 A mechanical ventilation system for the provision of *outdoor air*, including one that is part of an *air conditioning* system, shall be capable of being deactivated when the *building* or the part of the *building* served by that system is not occupied.

> COMMENT: If a mechanical ventilation system serves a whole building, it is only required to be capable of being deactivated when the whole building is unoccupied. However, if a mechanical ventilation system only serves a part of a building, the system must be capable of being deactivated when that part of the building is unoccupied. The design of the operational arrangements of the mechanical ventilation system should be based on logical building areas, segments and activities.

3.2.2.2 An exhaust system with an air flow rate of more than 250 L/s shall be capable of stopping the motor when the system is not needed.

> COMMENT:
>
> 1. Examples for exhaust systems include toilet extracts, kitchen hoods and laundry hoods.
> 2. Consideration should be given to situations where safety is an issue, such as the exhaust from a chemical storage cabinet. In some situations, it may be more appropriate for fume hoods to operate on a reduced flow rather than stop entirely. An alternative solution may be considered more appropriate in such situations.

3.2.3 Operating times

3.2.3.1 Except where mechanical ventilation is needed for 24 hour continuous use, a time switch shall be provided to a mechanical ventilation system with an air flow rate of more than 250 L/s.

3.2.3.2 Where required, the time switch shall be capable of switching electric power on and off at variable pre-programmed times and on variable pre-programmed days.

3.2.4 Limiting outdoor air flow

3.2.4.1 When serving a *conditioned space*, except in periods when evaporative cooling is being used, a mechanical ventilation system, including one that is part of an *air conditioning* system, shall:

a) If the *outdoor air* flow rate is more than 1000 L/s, have demand control ventilation in accordance with AS 1668.2, except where an energy reclaiming system preconditions all the *outdoor air* at a minimum sensible heat transfer effectiveness of 60%; and

b) Not exceed the minimum *outdoor air* quantity required by G4/AS1 by more than 20%, except where:

   i) additional unconditioned *outdoor air* is supplied for free cooling; or

   ii) additional mechanical ventilation is needed to balance the required exhaust or process exhaust; or

   iii) an energy reclaiming system preconditions all the *outdoor air* at a minimum sensible heat transfer effectiveness of 60%.

> COMMENT: Common situations that require additional mechanical ventilation to balance the required exhaust include areas such as toilets or bathrooms which have high exhaust rates to remove contaminated air or to balance process exhausts. In such situations, an equivalent level of supply air maybe required to balance the system.

3.2.5 Variable speed of fans

3.2.5.1 Where a mechanical ventilation system, including one that is part of an *air conditioning* system, has a design airflow greater than 1000 L/s, the fan shall be a variable speed fan, unless the downstream airflow is required to be constant.

3.2.5.2 Car park exhaust systems shall have a control system in accordance with AS 1668.2 section 4.11.2 using a variable speed fan, or in accordance AS 1668.2 section 4.11.3.

Part 4. Fans

4.1 Demonstrating compliance

4.1.1 System design objectives

4.1.1.1 Energy consumption of fans in *air conditioning* systems or mechanical ventilation systems is to be limited. This is to be achieved by the use of energy efficient motors with a maximum allowable *fan motor power*.

4.1.2 Design applications and exemptions

4.1.2.1 These requirements apply to fans used as part of an *air conditioning* system or a mechanical ventilation system.

4.1.2.2 The requirements do not apply to:

a) fans in *unducted air conditioning* systems with a supply air capacity of less than 1000 L/s; and
b) fans in an energy reclaiming system that preconditions outside air; and
c) fans for specialised applications.

4.2 Verification of the design

4.2.1 Fan motor power

4.2.1.1 The verification of the design is achieved by providing a fan with a fan motor power that complies with the requirements of the following paragraphs.

4.2.1.2 An *air conditioning* system with a sensible heat load less or equal to 400W/m² shall be designed so that the *fan motor power* of the supply and return air fans as a combined total is in accordance with Table 4.2.1.2. The maximum allowable *fan motor power* is related to the floor area served by the *air conditioning* unit or system which does not include non-conditioned corridors, toilets, plant rooms and the like.

TABLE 4.2.1.2: Maximum *fan motor power* for supply and return air fans

Paragraph 4.2.1.2

Air conditioning sensible heat load (W/m² of the floor area of the conditioned space)	Maximum fan motor power (W/m² of the floor area of the conditioned space)	
	For an air conditioning system serving and area ≤ 500 m²	For an air conditioning system serving an area > 500 m²
≤ 100	5.3	8.3
≤ 101 to ≤ 150	9.5	13.5
≤ 151 to ≤ 200	13.7	18.3
≤ 201 to ≤ 300	22.2	28.0
≤ 301 to ≤ 400	30.7	37.0

4.2.1.3 Where the *air conditioning* sensible heat load is more than 400 W/m², the maximum *fan motor power* is 0.09 W for each watt of *air conditioning* sensible heat load in buildings of not more than 500 m² floor area. This increases to 0.12 W of *fan motor power* per watt of air conditioning sensible heat load for buildings above 500 m² floor area.

4.2.1.4 When the air flow rate of a mechanical ventilation system is more than 250 L/s, or more than 1,000 L/s for *car park* exhaust, the system shall have a *fan motor power* to air flow rate ratio in accordance with:

a) For general mechanical ventilation systems, Table 4.2.1.4a; or
b) For car park mechanical ventilation systems, Table 4.2.1.4b.

TABLE 4.2.1.4A: Maximum fan motor power to air flow rate ratio – General mechanical ventilation systems

Paragraph 4.2.1.4 a)

Filtration	Maximum fan motor power to air flow rate ratio (W/(L/s))
With filters	0.98
Without filters	0.65

TABLE 4.2.1.4B: Maximum fan motor power to air flow rate ratio – Car park mechanical ventilation systems

Paragraph 4.2.1.4 b)

Filtration	Maximum fan motor power to air flow rate ratio (W/(L/s))		
	> 1000 and ≤ 5000	> 5000 and ≤ 50000	> 50000
With filters	0.78	1.12	1.81
Without filters	0.52	0.74	1.2

Part 5. Ductwork insulation and sealing

5.1 Demonstrating compliance

5.1.1 System design objectives

5.1.1.1 Energy losses through ductwork are to be limited by providing insulation and sealing of ductwork and fittings in an *air conditioning* system.

5.1.2 Design applications and exemptions

5.1.2.1 The ductwork insulation requirements apply to passive and static components of a ductwork system, but do not apply to:

a) Ductwork and fittings located within the only or last room served by the system; and
b) Fittings that form part of the interface with the *conditioned space*; and
c) Return air ductwork in, or passing through, a *conditioned space*; and
d) Ductwork for *outdoor air* and exhaust air associated with an *air conditioning* system; and
e) The floor of an in-situ air handling unit; and
f) Packaged air conditioners, split systems, and variable refrigerant flow *air conditioning* equipment complying with *Minimum Energy Performance Standards (MEPS)*; and
g) Flexible fan connections; and
h) Active components of a ductwork system.

5.1.2.2 The ductwork sealing requirements apply to active, passive and static components of a ductwork system, but do not apply to:

a) *Air conditioning* systems with a capacity of less than 1000 L/s; and
b) Ductwork and fittings located within the only or last room served by the system.

5.1.2.3 Active components of a ductwork system may include air-handling unit components, electric duct heaters, actuated volume control dampers, access panels and doors, fire and smoke dampers, fans or humidifiers.

5.1.2.4 Passive or static components of a ductwork system may include plenums, bends, branches, transitions, reducers, offsets, spigots, cushion heads, attenuators or fixed air balance dampers.

5.2 Verification of the design

5.2.1 Ductwork insulation

5.2.1.1 Verification of the design is achieved by providing ductwork and fittings in an *air conditioning system* with insulation that:

a) complies with AS/NZS 4859.1; and
b) has an insulation *R-value* greater than or equal to:
   i) for flexible ductwork, 1.0 m^2K/W; and
   ii) for cushion boxes, that of the connecting ductwork; and
   iii) for rigid ductwork and fittings that specified in Table 5.2.1.1; and
c) is protected against the effects of weather and sunlight to reduce the likelihood of affecting the insulation properties over time; and
d) is installed so that it:
   i) abuts adjoining insulation to form a continuous barrier; and
   ii) maintains its position and thickness, other than at flanges and supports; and
e) when conveying cooled air:
   i) is protected by a vapour barrier on the outside of the insulation to avoid condensation forming within the insulation; and
   ii) where the vapour barrier is a membrane, is installed so that adjoining sheets of the membrane overlap by at least 50 mm and are bonded or taped together.

TABLE 5.2.1.1: Ductwork and fittings – Minimum insulation R-value

Paragraph 5.2.1.1

Location of ductwork and fittings	Minimum insulation R-value (m2 K/W)
Within a *conditioned space*	1.2
Where exposed to direct sunlight	3.0
All other locations	2.0

5.2.2 Ductwork sealing

5.2.2.1 Verification of the design is achieved by providing ductwork sealing to ductwork and fittings in an *air conditioning* system in accordance with the duct sealing requirements of AS 4254.1 and AS 4254.2 for the static pressure in the system.

Part 6. Pumps

6.1 Demonstrating compliance

6.1.1 System design objectives

6.1.1.1 Energy consumption of pumps that form part of an *air conditioning* system is to be limited by the use of energy efficient motors and by keeping within a limited pipework average pressure drop.

6.1.2 Design applications and exemptions

6.1.2.1 The average pipework pressure drop requirements do not apply:

a) To valves and fittings; and

b) Where the smallest pipe size compliant with Paragraph 6.2.2.1 results in a velocity of 0.7 m/s or less at design flow.

6.2 Verification of the design

6.2.1 Pump motor efficiency

6.2.1.1 The verification of the design of pumps that form part of an *air conditioning* system is achieved when:

a) Circulator pumps that are glandless impeller pumps with a rated hydraulic power output of less than 2.5 kW and used in closed loop systems meet an energy efficiency index (EEI) of 0.27 or less when calculated in accordance with European Union Commission Regulation No. 622/2012.

b) Other pumps that are in accordance with Articles 1 and 2 of European Union Commission Regulation No. 547/2012 meet a minimum efficiency index (MEI) of 0.4 or more when calculated in accordance with European Union Commission Regulation No. 547/2012.

6.2.2 Pipework pressure loss

6.2.2.1 The verification of the design of a pipework network that forms part of an *air conditioning* system is achieved by providing pipework that:

a) in pipework systems that do not have branches and have the same flow rate throughout the entire pipe network, achieve an average pressure drop in straight segments along the index run of not more than:

   i) for constant speed systems, the values nominated in Table 6.2.2.1A; or

   ii) for variable speed systems, the values nominated in Table 6.2.2.1B; and

b) in any other pipework system, achieve an average pressure drop in straight segments along the index run of not more than:

   i) for constant speed systems, the values nominated in Table 6.2.2.1C; or

   ii) for variable speed systems, the values nominated in Table 6.2.2.1D.

TABLE 6.2.2.1A: **Maximum pipework pressure drop – Non-distributive constant speed systems**

Paragraph 6.2.2.1 a) i)

Nominal pipe diameter (mm)	Maximum pressure drop (Pa/m)	
	Systems operating ≤ 5000 hours/annum	Systems operating > 5000 hours/annum
≤ 20	400	400
25	400	400
32	400	400
40	400	400
50	400	350
65	400	350
80	400	350
100	400	200
125	400	200
≥ 150	400	200

TABLE 6.2.2.1B: **Maximum pipework pressure drop – Non-distributive variable speed systems**

Paragraph 6.2.2.1 a) ii)

Nominal pipe diameter (mm)	Maximum pressure drop (Pa/m)	
	Systems operating ≤ 5000 hours/annum	Systems operating > 5000 hours/annum
≤ 20	400	400
25	400	400
32	400	400
40	400	400
50	400	400
65	400	400
80	400	400
100	400	300
125	400	300
≥ 150	400	300

TABLE 6.2.2.1C: **Maximum pipework pressure drop – Distributive constant speed systems**

Paragraph 6.2.2.1 b) i)

Nominal pipe diameter (mm)	Maximum pressure drop (Pa/m)		
	Systems operating ≤2000 hours/annum	Systems operating > 2000 hours/annum and ≤ 5000 hours/annum	Systems operating > 5000 hours/annum
≤ 20	400	300	150
25	400	220	100
32	400	220	100
40	400	220	100
50	400	220	100
65	400	400	170
80	400	400	170
100	400	400	170
125	400	400	170
≥ 150	400	400	170

TABLE 6.2.2.1D: **Maximum pipework pressure drop – Distributive variable speed systems**

Paragraph 6.2.2.1 b) ii)

Nominal pipe diameter (mm)	Maximum pressure drop (Pa/m)	
	Systems operating ≤ 5000 hours/annum	Systems operating > 5000 hours/annum
≤ 20	400	250
25	400	180
32	400	180
40	400	180
50	400	180
65	400	300
80	400	300
100	400	300
125	400	300
≥ 150	400	300

Part 7. Pipework insulation

7.1 Demonstrating compliance

7.1.1 System design objectives

7.1.1.1 Energy losses through pipework that forms part of an *air conditioning* system are to be limited by providing insulation to *piping*, vessels, heat exchangers and tanks that contain heating or cooling fluid.

7.1.2 Design applications and exemptions

7.1.2.1 For the purposes of these requirements, heating fluids include heated water, steam and condensate. Cooling fluids include chilled water, brines and glycol mixtures, but do not include condenser cooling water.

7.1.2.2 Condenser cooling water is exempt from the minimum insulation requirements of this section due to the limited temperature difference between the *piping* contents and the surrounding space. However, insulation may be installed for reasons other than energy efficiency such as for acoustics, or to minimise the risk of condensation forming.

7.1.2.3 The required *R-value* is that of the insulation and not the total *R-value* of the wall, air film and insulation of the item.

i

COMMENT: Typical examples of R-values for pipe insulation materials averaged over a number of nominal pipe diameters are:

a) 13 mm of closed cell polymer R=0.6 $m^2 \cdot K/W$
b) 19 mm of closed cell polymer R=0.9 $m^2 \cdot K/W$
c) 25 mm of closed cell polymer R=1.3 $m^2 \cdot K/W$
d) 25 mm of glasswool R=1.3 $m^2 \cdot K/W$.

7.1.2.4 The requirements for pipework insulation do not apply to *piping*, vessels, heat exchangers and tanks that are in appliances covered by *Minimum Energy Performance Standards (MEPS)* or for *piping*, vessels or heat exchangers that are:

a) located within the only or last room served by the system and downstream of the control device for the regulation of heating or cooling service to that room; or
b) encased within a concrete slab or panel which is part of a heating or cooling system; or
c) supplied as an integral part of a chiller, boiler or *unitary air conditioner* complying with the requirements of Part 8, Part 9, and Part 10; or
d) inside an air handling unit, fan-coil unit, or the like.

7.2 Verification of the design

7.2.1 Piping, vessels, heat exchangers and tanks insulation

7.2.1.1 Verification of the design is achieved by providing insulation to *piping*, vessels, heat exchangers and tanks that form part of an *air conditioning* system and that contain heating or cooling fluid or refrigerant, where the fluid or refrigerant is held at a heated or cooled temperature.

7.2.1.2 The insulation shall:

a) comply with AS/NZS 4859.1; and
b) for *piping* of heating and cooling fluids or refrigerants, have an insulation *R-value* in accordance with Table 7.2.1.2A; and
c) for vessels, heat exchangers or tanks, have an insulation *R-value* in accordance with Table 7.2.1.2B; and
d) for refill or pressure relief *piping*, have an insulation *R-value* equal to the required insulation *R-value* of the connected pipe, vessel or tank within 500 mm of the connection; and
e) be protected against the effects of weather and sunlight; and
f) be able to withstand the temperatures within the *piping*, vessel, heat exchanger or tank; and
g) when containing cooling fluid or refrigerant, be protected by a vapour barrier on the outside of the insulation.

TABLE 7.2.1.2A: Piping — Minimum insulation R-value

Paragraph 7.2.1.2 b)

Fluid / refrigerant temperature range	Minimum insulation R-value			
	Nominal pipe diameter ≤ 40 mm	Nominal pipe diameter > 40 mm and ≤ 80 mm	Nominal pipe diameter between > 80 mm and ≤ 150 mm	Nominal pipe diameter > 150 mm
≤ 2°C	1.3	1.7	2.0	2.7
> 2°C but ≤ 20°C	1.0	1.5	2.0	2.0
> 30°C but ≤ 85°C	1.7	1.7	1.7	1.7
> 85°C	2.7	2.7	2.7	2.7

Note: The minimum required *R-value* may be halved for *piping* penetrating a structural member.

TABLE 7.2.1.2B: Vessels, heat exchangers and tanks — Minimum insulation R-value

Paragraph 7.2.1.2 c)

Fluid / refrigerant temperature range	Minimum insulation R-value
≤ 2°C	2.3
> 2°C but ≤ 20°C	1.8
> 30°C but ≤ 85°C	2.3
> 85°C	3.0

Part 8. Space heating

8.1 Demonstrating compliance

8.1.1 System design objectives

8.1.1.1 The use of energy that is sourced from a network utility operator or depletable energy resource and used for space heating is to be limited by the selection of appropriate space heating equipment.

8.1.2 Design applications and exemptions

8.1.2.1 These requirements apply to heaters that provide heat directly or indirectly to the space(s) or area(s) they serve. Examples include:

a) An electric oil-column heater; and/or

b) A flued gas convection heater; and/or

c) An air to-air single-split heat pump; and/or

d) A water heater connected to radiators, radiant heaters or underfloor heating; and/or

e) A biomass boiler with its heat being distributed as warm air via ducting.

8.1.2.2 Where an electric heater is an in-duct heater, the amount of reheat is limited by Paragraph 2.2.3.2 c).

8.2 Verification of the design

8.2.1 Heaters

8.2.1.1 Verification of the design is achieved by providing space heaters that comply with the requirements of Paragraph 8.2.1.2, Paragraph 8.2.1.3, and Paragraph 8.2.1.4.

8.2.1.2 A heater used for *air conditioning* or as part of an *air conditioning* system must be:

a) a solar heater, or

b) a flued gas heater, or

c) a heat pump heater, or

d) a biomass heater, or

e) a heater using reclaimed heat from another process such as reject heat from a refrigeration plant, or

f) an electric heater, or

g) any combination of a) to f).

8.2.1.3 A fixed heating appliance that moderates the temperature of an outdoor space shall be configured to automatically shut down when:

a) there are no occupants in the space served; or

b) a period of one hour has elapsed since the last activation of the heater; or

c) the space served has reached the design temperature.

> COMMENT: Automatic shutdown may be achieved by an outdoor temperature sensor, timer, motion detector or the like.

8.2.1.4 A gas water heater that is used as part of an *air conditioning system* shall achieve a minimum gross thermal efficiency of 90% when tested under conditions that mirror the expected typical operating conditions, including the expected water inlet/outlet temperatures.

COMMENT: There are a number of testing standards that can be used to demonstrate compliance with the gross thermal efficiency requirement for gas water heaters. These include BS 7190, ANSI/AHRI 1500 and AS/NZS 5263.1.2. Testing under the expected typical operating conditions is especially important for condensing boilers, where the inlet/outlet temperature of water will greatly impact the overall efficiency.

Part 9. Refrigerant chillers

9.1 Demonstrating compliance

9.1.1 System design objectives

9.1.1.1 Energy consumption by refrigerant chillers is to be limited by the selection of equipment that meets *Minimum Energy Performance Standards (MEPS)* and certain energy efficiency ratio requirements.

9.1.1.2 This applies to air cooled and water-cooled refrigerant chillers that form part of an *air conditioning* system.

9.2 Verification of the design

9.2.1 Air cooled and water cooled refrigerant chillers

9.2.1.1 Verification of the design is achieved by providing a refrigerant chiller that:

a) complies with *Minimum Energy Performance Standards (MEPS);* and

b) complies with the minimum full load operation energy efficiency ratio and the minimum integrated part load energy efficiency ratio in Table 9.2.1.1A or Table 9.2.1.1B when determined in accordance with AHRI 551/591.

> i
>
> COMMENT: Table 9.2.1.1A contains higher full-load performance values, intended to be applicable to chillers which are more likely to operate at full load, while Table 9.2.1.1B contains higher part-load performance values, intended to be applicable to chillers which are more likely to operate at part-load. A designer may choose whether to comply with Table 9.2.1.1A or Table 9.2.1.1B.

Refrigerant chillers

TABLE 9.2.1.1A: Minimum energy efficiency ratio for refrigerant chillers — Option 1

Paragraph 9.2.1.1 b)

Chiller type	Full load operation (W_r / $W_{input\ power}$)	Integrated part load (W_r / $W_{input\ power}$)
Air cooled chiller with a capacity ≤ 528 kW_r	2.985	4.048
Air cooled chiller with a capacity > 528 kW_r	2.985	4.137
Water-cooled positive displacement chiller with a capacity ≤ 264 kW_r	4.694	5.867
Water-cooled positive displacement chiller with a capacity > 264 kW_r but ≤ 528 kW_r	4.889	6.286
Water-cooled positive displacement chiller with a capacity > 528 kW_r but ≤ 1055 kW_r	5.334	6.519
Water-cooled positive displacement chiller with a capacity > 1055 kW_r but ≤ 2110 kW_r	5.800	6.770
Water-cooled positive displacement chiller with a capacity > 2110 kW_r	6.286	7.041
Water-cooled centrifugal chiller with a capacity ≤ 528 kW_r	5.771	6.401
Water-cooled centrifugal chiller with a capacity > 528 kW_r but ≤ 1055 kW_r	5.771	6.519
Water-cooled centrifugal chiller with a capacity > 1055 kW_r but ≤ 1407 kW_r	6.286	6.770
Water-cooled centrifugal chiller with a capacity > 1407 kW_r	6.286	7.041

Note: W_r means watt(s) of refrigeration

TABLE 9.2.1.1B: Minimum energy efficiency ratio for refrigerant chillers — Option 2

Paragraph 9.2.1.1 b)

Chiller type	Full load operation (W_r / $W_{input\ power}$)	Integrated part load (W_r / $W_{input\ power}$)
Air cooled chiller with a capacity ≤ 528 kW_r	2.866	4.669
Air cooled chiller with a capacity > 528 kW_r	2.866	4.758
Water-cooled positive displacement chiller with a capacity ≤ 264 kW_r	4.513	7.041
Water-cooled positive displacement chiller with a capacity > 264 kW_r but ≤ 528 kW_r	4.694	7.184
Water-cooled positive displacement chiller with a capacity > 528 kW_r but ≤ 1055 kW_r	5.177	8.001
Water-cooled positive displacement chiller with a capacity > 1055 kW_r but ≤ 2110 kW_r	5.633	8.586
Water-cooled positive displacement chiller with a capacity > 2110 kW_r	6.018	9.264
Water-cooled centrifugal chiller with a capacity ≤ 528 kW_r	5.065	8.001
Water-cooled centrifugal chiller with a capacity > 528 kW_r but ≤ 1055 kW_r	5.544	8.001
Water-cooled centrifugal chiller with a capacity > 1055 kW_r but ≤ 1407 kW_r	5.917	9.027
Water-cooled centrifugal chiller with a capacity > 1407 kW_r	6.018	9.264

Note: W_r means watt(s) of refrigeration

Part 10. Unitary air conditioning equipment

10.1 Demonstrating compliance

10.1.1 System design objectives

10.1.1.1 Energy consumption is to be limited by the use of u*nitary air conditioners* that meet *Minimum Energy Performance Standards (MEPS)* and certain energy efficiency ratio requirements.

10.1.2 Design applications and exemptions

10.1.2.1 These requirements apply to air cooled and water cooled *unitary air conditioners* including packaged air conditioners, split systems, and variable refrigerant flow systems.

10.2 Verification of the design

10.2.1 Air cooled and water cooled unitary air-conditioners

10.2.1.1 Verification of the design is achieved by providing *unitary air conditioners* that:

a) comply with *Minimum Energy Performance Standards (MEPS)*; and

b) for a capacity greater than or equal to 65 kW_r (kilowatts of refrigeration), when tested in accordance with AS/NZS 3823.1.2 at test condition T1, have a minimum energy efficiency ratio of:

i) 4.0 W_r / $W_{input\ power}$ when water cooled; and

ii) 2.9 W_r / $W_{input\ power}$ where air cooled.

10.2.1.2 The input power includes both compressor and fan input power.

Part 11. Heat rejection equipment

11.1 Demonstrating compliance

11.1.1 System design objectives

11.1.1.1 Energy consumption is to be limited by the use of heat rejection equipment with a fan that does not exceed a maximum allowable fan motor input power.

11.1.2 Design applications and exemptions

11.1.2.1 These requirements apply to fans of cooling towers, closed circuit coolers, evaporative condensers and air cooled condensers.

11.1.2.2 These requirements exclude:

a) a refrigerant chiller in an *air conditioning* system that complies with the energy efficiency ratios in Part 9; and

b) packaged air conditioners, split systems, and variable refrigerant flow *air conditioning* equipment that complies with the energy efficiency ratios in Part 10.

11.2 Verification of the design

11.2.1 Fan of Heat rejection equipment

11.2.1.1 Verification of the design is achieved by providing heat rejection equipment with a fan that:

a) for a cooling tower, closed circuit cooler and evaporative condenser does not exceed the relevant maximum *fan motor power* in Table 11.2.1.1; and

b) for an air cooled condenser, does not exceed a maximum *fan motor power* of 42 W for each kW of heat rejected from the refrigerant, when determined in accordance with AHRI 460.

> i
>
> COMMENT: The performance of cooling tower fans, closed circuit cooler fans and evaporative condenser fans can be determined using any nationally or internationally accepted standard such as:
>
> a) CTI STD-201RS(13) and ATC-105(00) which can be used to determine the performance of cooling tower fans; and
>
> b) CTI STD-201RS(13) and ATC-105S(11) which can be used for closed circuit cooler fans; and
>
> c) ATC-106(11) can be used to determine the performance of evaporative condenser fans.

TABLE 11.2.1.1: Maximum fan motor power — Cooling towers, closed circuit coolers and evaporative condensers

Paragraph 11.2.1.1 a)

Type	Maximum fan motor input power (W/kW_{rej})(1)		
	Cooling tower	Closed circuit cooler	Evaporative condenser
Induced draft	10.4	16.9	11.0
Forced draft	19.5	(2)	11.0

Note:

(1) kW_{rej} means kilowatt(s) of heat rejected from the refrigerant.

(2) A closed circuit, forced draft cooling tower shall not be used.

Part 12. Facilities for energy monitoring

12.1 Demonstrating compliance

12.1.1 System design objectives

12.1.1.1 To enable the required level of energy efficiency of *HVAC systems* to be maintained, certain equipment is to be provided that enables excessive energy use to be detected.

12.2 Verification of the design

12.2.1 Energy meters and energy recording

12.2.1.1 For buildings with a floor area of *occupied space* greater than 500 m^2, verification of the design is achieved by providing energy meters configured to record the time-of-use consumption of gas and electricity.

12.2.1.2 For buildings with a floor area of *occupied space* greater than 2500 m^2, verification of the design is achieved by:

a) providing energy meters configured to enable individual time-of-use energy consumption data recording of *air conditioning* plant including, where appropriate:
   - i) individual time-of-use energy consumption data recording of heating plant; and
   - ii) individual time-of-use energy consumption data recording of cooling plant; and
   - iii) individual time-of-use energy consumption data recording of air handling fans; and

b) interlinking the required energy meters by a communication system that collates the time-of-use energy consumption data to a single interface monitoring system where it can be stored, analysed and reviewed; and

c) ensuring the single interface monitoring system is able to store the individual time-of-use energy consumption data records of *air conditioning* plant over a minimum period of 12 months.

Part 13. Maintenance access

13.1 Demonstrating compliance

13.1.1 Description/Outcome/Required Outcome

13.1.1.1 To enable the required level of energy efficiency of *HVAC systems* to be maintained, sufficient access for commissioning, maintenance and replacement of equipment is to be provided.

13.2 Verification of the design

13.2.1 Equipment access

13.2.1.1 Verification of the design is achieved by providing sufficient access for commissioning and maintenance of *HVAC system* equipment.

> COMMENT: Good practice guidance on designing for safe maintenance and repair can be found in Section 3.4 of 'Safe access for maintenance and repair. Guidance for designers second edition 2009 (C686)' published by the UK's Construction Industry Research and Information Association (CIRIA).

Appendix A. References

For the purposes of Building Code compliance, the Standards and documents referenced in this Acceptable Solution must be the editions, along with their specific amendments, listed below.

Standards New Zealand		Where quoted
AS/NZS 3823:-	Performance of electrical appliances – air conditioners and heat pumps	10.2.1.1 b)
Part 1.2: 2012	Ducted air conditioners and air to-air heat pumps - testing and rating for performance	
AS/NZS 4859:-	Thermal insulation materials for buildings	
Part 1: 2018	General criteria and technical provisions	5.2.1.1 a), 7.2.1.2 a)
AS/NZS 5263:-	Gas appliances	
Part 1.2: 2020	Gas fired water heaters for hot water supply and/or central heating	8.1.2.4 Comment

These standards can be accessed from standards.govt.nz

Standards Australia		
AS 1668:-	The use of ventilation and airconditioning in buildings	
Part 2: 2012	Mechanical ventilation in buildings Amend 1 and 2	3.2.4.1 a), 3.2.5.2
AS 4254:-	Ductwork for air handling systems in buildings	
Part 1: 2012	Flexible duct	5.2.2.1
Part 2: 2012	Rigid duct	5.2.2.1

These standards can be accessed from standards.org.au

British Standards		
BS 7190: 1989	Method for assessing thermal performance of low temperature hot water boilers using a test rig	8.1.2.4

This standard can be accessed from standards.govt.nz

Air Conditioning, Heating and Refrigeration Institute		
AHRI 460: 2005	Performance rating of remote mechanical-draft air cooled refrigerant condensers	11.2.1.1 b)
AHRI 551/591: 2015	Performance rating of water-chilling and heat pump water-heating packages using the vapour compression cycle.	9.2.1.1 b)
ANSI/AHRI 1500: 2015	Performance rating of commercial space heating boilers	8.1.2.4 Comment

These standards can be accessed from ahrinet.org

References

Cooling Technology Institute

CTI STD 201 RS: 2013	Performance Rating of Evaporative Heat Rejection Equipment	11.2.1.1 Comment
CTI ATC 105S: 2011	Acceptance Test Code for Closed Circuit Cooling Towers	11.2.1.1 Comment
CTI 106: 2011	Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers	11.2.1.1 Comment

These standards can be accessed from coolingtechnology.org

Construction Industry Research and Information Association

Safe access for maintenance and repair. Guidance for designers. 2nd edition 2009	13.2.1.1 Comment

This document can be accessed from ciria.org

European Union

Commission Regulation (EU) No. 547/2012	6.2.1.1 b)
Commission Regulation (EU) No. 622/2012	6.2.1.1 a)

These regulations can be accessed from eur-lex.europa.eu

Appendix B. Definitions

These definitions are specific to this verification method. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Air conditioning	Means an *HVAC system* that actively cools or heats the air within a space, but does not include an *HVAC system* that directly: a) cools cold rooms or heats hot rooms (such as in a butcher's shop, fruit storage rooms or in laboratories); or b) maintains specialised conditions for equipment or processes, where this is the main purpose of the *HVAC system*. The *air conditioning* may be achieved without treating the air forced into and through the space. The air in the space may also be conditioned by hot or cool surfaces. This includes residential-type heating systems, such as gas and combustion appliances, that are not always considered to be *air conditioning* in the traditional sense. The conditioning may also be achieved by evaporative coolers.
Building	Has the meaning given to it by sections 8 and 9 of the *Building Act 2004*.
Car park	Means a *building* that is used for the parking of motor vehicles but is not used for the servicing of vehicles, other than washing, cleaning or polishing.
Conditioned space	Means a space within a *building*, including a ceiling or under-floor supply air plenum or return air plenum, where the environment is likely, by the *intended use* of the space, to have its temperature controlled by *air conditioning*.
Fan motor power	Means the power delivered to a motor of a fan, including the power needed for any drive and impeller losses.
HVAC system	For the purposes of performance NZBC H1.3.6 and in relation to a *building*, means a mechanical, electrical, or other system for modifying air temperature, modifying air humidity, providing ventilation, or doing all or any of those things, in a space within the building.
Intended use	In relation to a *building*, — a) includes any or all of the following: i) any reasonably foreseeable occasional use that is not incompatible with the intended use; ii) normal maintenance; iii) activities undertaken in response to *fire* or any other reasonably foreseeable emergency; but b) does not include any other maintenance and repairs or rebuilding.
Minimum Energy Performance Standards (MEPS)	Means the minimum energy performance standards for energy using products established through the Energy Efficiency (Energy Using Products) Regulations 2002, amended by the Energy Efficiency (Energy Using Products) Amendment Regulations 2020.
Occupied space	Any space within a *building* in which a person will be present from time to time during the *intended use* of the *building*.
Outdoor air	Means air outside the building, typically comprising by volume: i) oxygen 20.94%, and ii) carbon dioxide 0.03%, and iii) nitrogen and other inert gases 79.03%.
Outdoor air economy cycle	Means a mode of operation of an *air-conditioning* system that, when the *outdoor air* thermodynamic properties are favourable, increases the quantity of *outdoor air* used to condition the space.

Definitions

Piping	Means an assembly of pipes, with or without valves or other fittings, connected together for the conveyance of liquids and gases.
R-value ($m^2 \cdot K/W$)	Means the thermal resistance of a component calculated by dividing its thickness by its thermal conductivity.
Unitary air conditioner	Means a modular factory assembled *air conditioning* unit. These units are self-contained and include within the unit all the components for heating and/or cooling such as fans, controls, a refrigeration system, heating coil and sometimes the heater. Split systems, packaged air conditioners, variable refrigerant flow and variable refrigerant volume air conditioners are all types of *unitary air conditioners*.

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Appendix B. Draft acceptable solution and verification methods for G7 Natural Light

As part of Proposal 4, there are four draft acceptable solutions and verification methods proposed for G7 Natural Light. These are:

- › Acceptable Solution G7/AS1 Natural light for simple buildings up to 3 storeys excluding those with borrowed daylight
- › Acceptable Solution G7/AS2 Natural light for simple buildings excluding those with borrowed daylight
- › Verification Method G7/VM1 Natural light for complex buildings excluding those with borrowed daylight
- › Verification Method G7/VM2 Natural light for all buildings including those with borrowed daylight

BUILDING PERFORMANCE

G7

G7 Natural Light

Acceptable Solution G7/AS1

Natural Light for simple buildings up to three storeys excluding those with borrowed daylight

DRAFT FOR PUBLIC CONSULTATION

SECOND EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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New Zealand Government

Preface

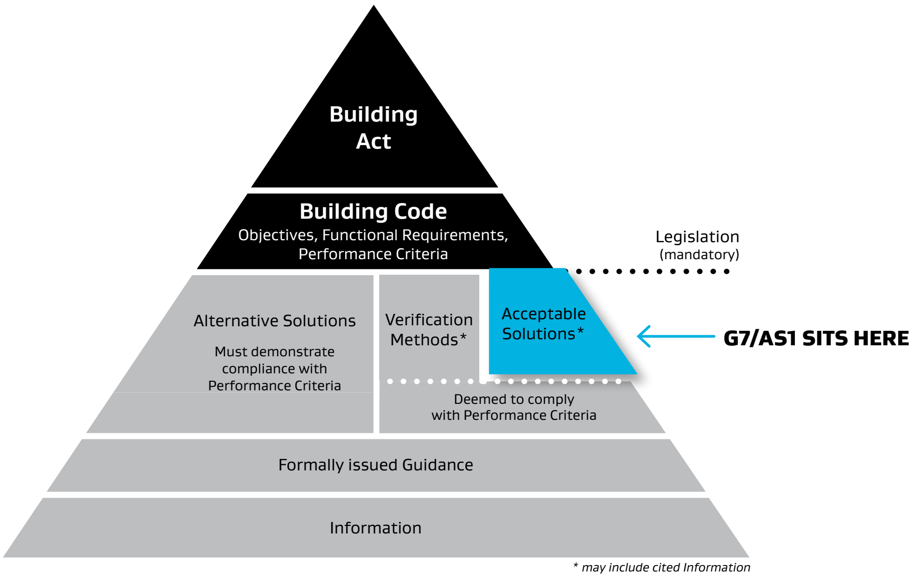
Document status

This document (G7/AS1) is an acceptable solution issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX. The previous Acceptable Solution G7/AS1, as amended, can be used to show compliance until X XXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX.

Building Code regulatory system

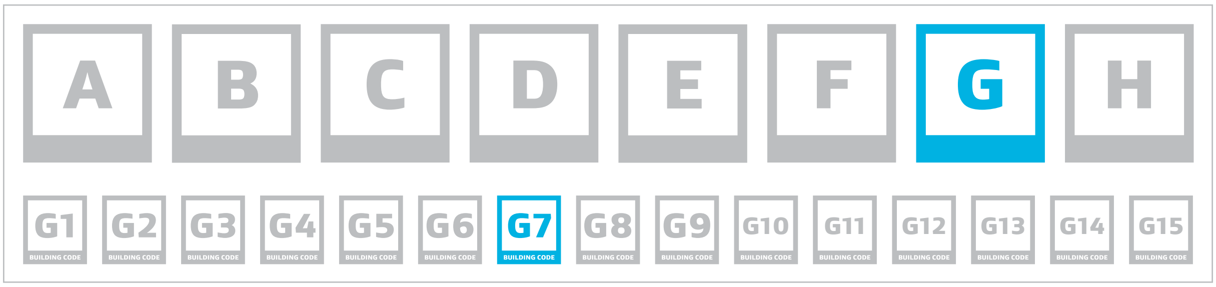
Each acceptable solution outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this acceptable solution relates to is clause G Services and facilities and specifically G7 Natural Light. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This acceptable solution is the second edition of G7/AS1. The main changes from the previous version of G7/AS1 are:

- The scope of G7/AS1 has been reduced to cover only simple buildings up to 3 storeys in low density developments. Requirements applicable for simple and complex high rise buildings and apartments have combined into the new Acceptable Solution G7/AS2 and Verification Methods G7/VM1 and G7/VM2. To reflect the new scope of the documents and the new document layout, a new introduction and scope has been provided in Part 1. General.
- The scope of G7/AS1 has been reduced and is no longer applicable for awareness of the outside through another space. The applicable requirements can be found in Verification Method G7/VM2.
- Portions of text have been re-written to enhance clarity in the document and provide consistent language with other acceptable solutions and verification methods.
- The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solutions and verification methods are available from www.building.govt.nz.

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This acceptable solution applies to **housing**, old people's homes, and *early childhood centres*, up to 3 storeys that are:

a) Detached; or

b) Attached side by side multi-unit *buildings* including townhouses.

COMMENT: Old people's homes also refers to all aged care facilities, rest homes and retirement complexes.

1.1.1.2 This acceptable solution applies to *habitable spaces* with simple façade designs and external windows that can be described by their *glazing-to-wall ratio (GWR).*

1.1.1.3 For *buildings* that do not meet this requirement, refer to the Acceptable Solution G7/AS2 or Verification Methods G7/VM1 and G7/VM2 as a means to demonstrate compliance or use an alternative means to demonstrate compliance.

1.1.2 Items outside the scope of this document

1.1.2.1 This acceptable solution does not include solutions for:

a) *habitable spaces* that rely on daylight borrowed from another space; or

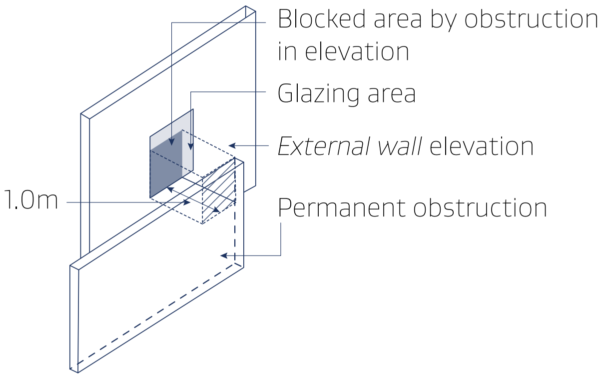
b) *habitable spaces* that do not have external vertical windows; or

c) *habitable spaces* that include non-standard features such as advanced daylight redirection systems, complex facades, top lighting strategies, double-height spaces, internal divisions, internal obstructions or other specialized designs; or

d) *habitable spaces* where more than 50% of the area of glazing are blocked by permanent external obstructions that are less than 1.0 m from the area of glazing (see Figure 1.1.2.1).

FIGURE 1.1.2.1: Maximum permitted area blocked by obstruction

Paragraph 1.1.2.1



COMMENT: The distance between the obstruction and the glazing area is measured to the closest point of obstruction.

1.1.2.2 For buildings that have more complex configuration or internal rooms with borrowed light, Verification Method G7/VM2 or an alternative means may be used as a means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This acceptable solution provides a solution for demonstrating compliance with the performance criteria in Building Code clauses G7.3.1 and G7.3.2.

1.1.3.2 Options for demonstrating compliance with G7 Natural Light through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2**.** Compliance may also be demonstrated using an alternative solution.

TABLE 1.1.3.2: Demonstrating compliance with G7 Natural Light through acceptable solutions and verification methods

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
G7.3.1 *Illuminance*	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise *buildings* and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2
G7.3.2 Awareness of the outside environment	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise buildings and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2

1.2 Using this acceptable solution

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

1.2.2 Determining the habitable space

1.2.2.1 For the purpose of determining the *habitable space* for compliance with Building Code clause G7 Natural Light; a *habitable space* is one used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods. The intent is to ensure occupants within *buildings* are able to have access to *adequate* natural light and to have an awareness of the outside to maintain their health and wellbeing.

1.2.3 Features of this document

1.2.3.1 There are no standards or other documents referenced in this acceptable solution in Appendix A.

1.2.3.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.3.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.3.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses.

1.2.3.5 Appendices to this acceptable solution are part of, and have equal status to, the acceptable solution. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Illuminance

2.1 Illuminance of habitable spaces

2.1.1 Demonstrating compliance

2.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, natural light shall provide an *illuminance* of no less than 30 lux at floor level for 75% of the *standard year*. This is demonstrated through the use of the simple calculation method described in Section 2.1.2.

2.1.2 Calculation of vertical windows in external walls

2.1.2.1 Vertical windows in *external walls* shall have:

a) An area of glazing of no less than 10% of the floor area,

> COMMENT: An area of glazing of 10% of the floor area equates to approximately 33 lux at floor level for 75% of the *standard year*.

b) A glazing transmittance of no less than 0.7, and

c) A head height of at least:

   i) half the room width for windows on the same side or adjacent sides of a room (see Figure 2.1.2.1A), and

   ii) one quarter the room width for windows on opposite sides of the room (see Figure 2.1.2.1B).

> COMMENT: In large rooms where the suggested head height is impractical, an area of glazing in excess of 10% of the floor area may be necessary.

2.1.2.2 High *reflectance* surfaces are required where:

a) Parts of the floor fall beyond the no-sky line (see Figure 2.1.2.2), and

b) where only the minimum area of glazing is provided (see Paragraph 2.1.2.1 a)).

2.1.2.3 Medium *reflectance* surfaces are acceptable in other cases with minimum areas of glazing.

2.1.2.4 *Reflectances* of interior surfaces shall meet the minimum requirements specified in Table 2.1.2.4.

2.1.2.5 For approximate *reflectance* of typical New Zealand *building* finishes, refer to Table 2.1.2.5.

FIGURE 2.1.2.1A: **Window head height for a window on one side or adjacent sides of a room**

Paragraph 2.1.2.1 c) i)

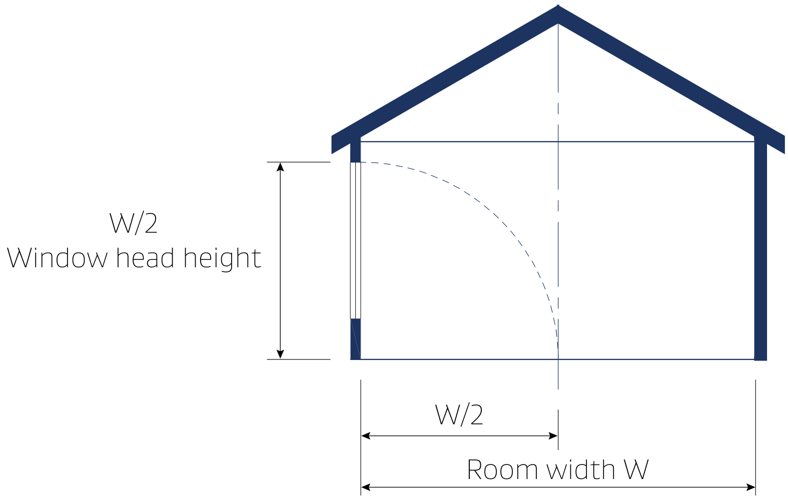


FIGURE 2.1.2.1B: **Window head heights for windows on opposite side of a room**

Paragraph 2.1.2.1 c) ii)

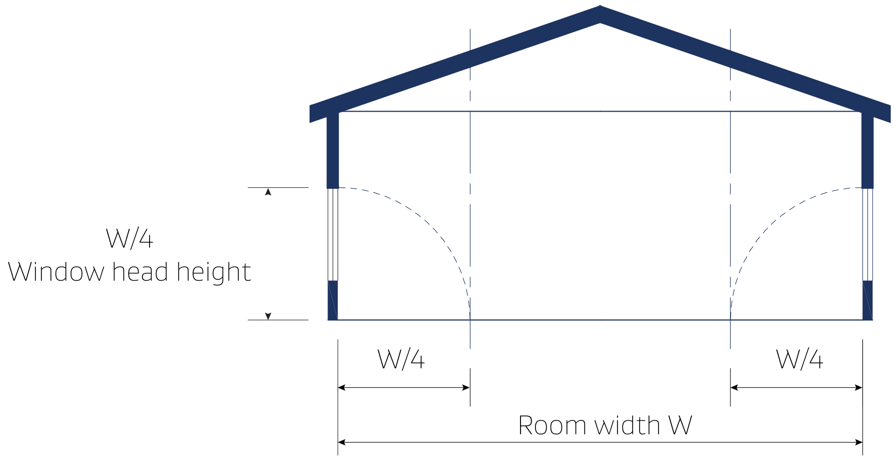


FIGURE 2.1.2.2: No-sky line condition

Paragraph 2.1.2.2 a)

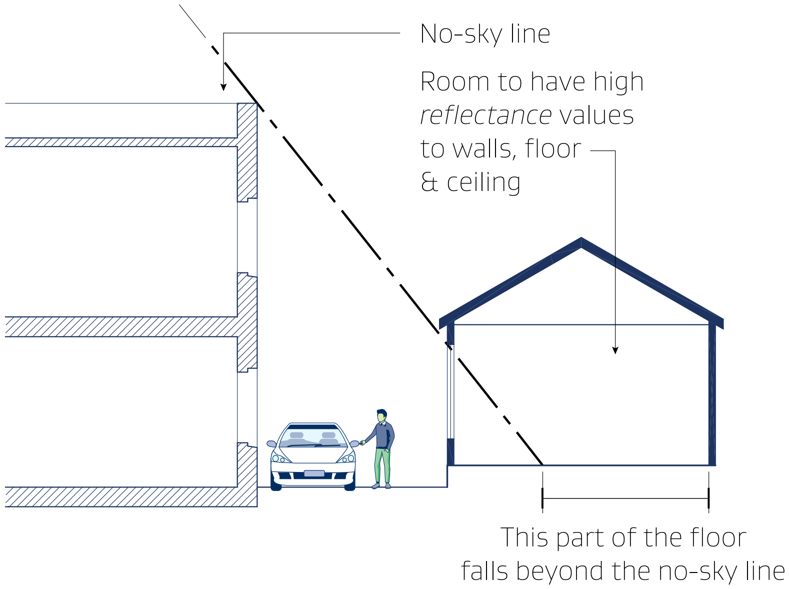


TABLE 2.1.2.4: Acceptable reflectance for interior surface finishes

Paragraph 2.1.2.4

Reflectance level required	Minimum surface reflectance		
	Ceilings	Walls (1)	Floor
Medium *reflectance*	0.7	0.4	0.2
High *reflectance*	0.7	0.6	0.4

Note:

(1) Does not include windows

TABLE 2.1.2.5: Approximate reflectance of typical New Zealand building finishes reproduced from NZS 6703

Paragraph 2.1.2.5

Building finish	Approximate reflectance	Building finish	Approximate reflectance
White emulsion paint on plain plaster surface White glazed tiles	0.8	Fibre cement sheet Portland cement (smooth) Natural particle board	0.4
White emulsion paint on acoustic tile	0.7	Natural rimu (dressed) Varnished Pinus radiata[1]	0.3
White emulsion paint on no-fines concrete	0.6	Concrete (light grey) Portland cement (rough) Natural mahogany (dressed) Varnished particle board	0.25
Natural pine plywood	0.55	Varnished rimu (dressed)[1] Varnished mahogany (dressed)[1]	0.15
White emulsion paint on wood-wool slab	0.5		
Varnished pine plywood[1] Natural Pinus radiata	0.45	Quarry tiles: Red, heather brown	0.1

Notes:

(1) Typical varnishing would be two coats of clear gloss polyurethane varnish.

Part 3. Awareness of the outside environment

3.1 Clear area of glazing

3.1.1 Demonstrating compliance

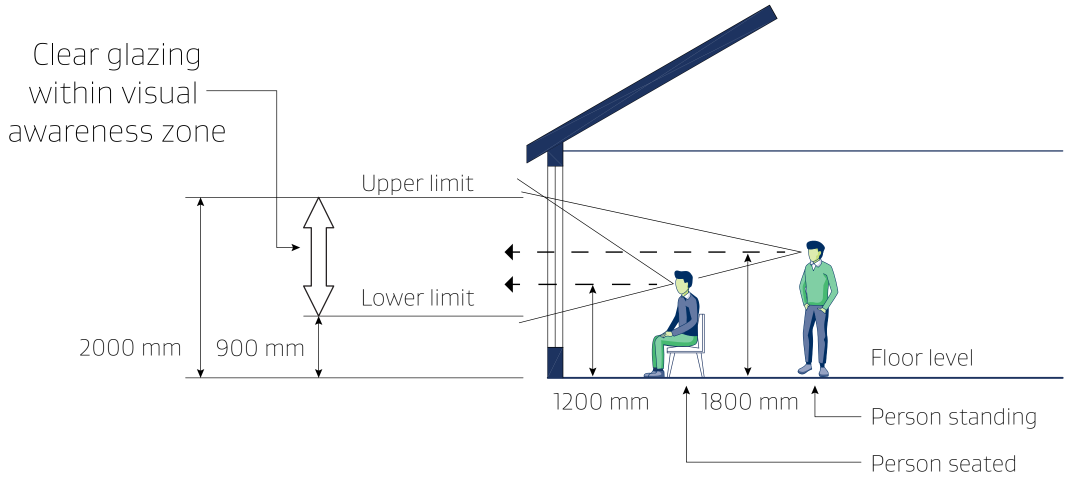
3.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, openings of the outside shall have clear area of glazing suitable to give awareness of the outside. This is demonstrated through the use of a calculation method described in Subsection 3.1.2.

3.1.2 Calculation of the area of glazing

3.1.2.1 At least 50% of the area of glazing provided for natural light in *habitable spaces* shall be clear glazing. The clear glazing shall be located in the zone between the levels 900 mm and 2000 mm from floor level (see Figure 3.1.2.1).

FIGURE 3.1.2.1: Visual awareness zone

Paragraph 3.1.2.1



Appendix A. References

For purposes of compliance with the Building Code, the standard referenced in this acceptable solution must be the edition, along with the specific amendment, listed below.

Standards New Zealand		Where quoted
NZS 6703: 1984	Code of practise for interior lighting design Amend C1: 1985	Table 2.1.2.5

This standard can be accessed from www.standards.govt.nz

Appendix B. Definitions

These definitions are specific to this acceptable solution. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	*Adequate* to achieve the objectives of the Building Code.
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Early childhood centre (ECC)	Premises used regularly for the education or care of three or more children (not being children of the persons providing the education or care, or children enrolled at a school being provided with education or care before or after school) under the age of six years old— a) by the day or part of a day; but b) not for any continuous period of more than seven days. ECC does not include home based early childhood services.
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment
Glazing-to-wall ratio (GWR)	The percentage of glazing, not including framing and mullions, relative to the area of the wall containing the vertical exterior window.
Habitable space	A space used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods.
Illuminance	The luminous flux falling onto unit area of surface (lumen/m^2).
Reflectance	The ratio of the flux reflected from a surface to the flux incident on it.
Standard year	For the purposes of determining natural lighting, the hours between 8 am and 5 pm each day with an allowance being made for daylight saving.

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BUILDING PERFORMANCE

G7

G7 Natural Light

Acceptable Solution G7/AS2

Natural Light for simple buildings excluding those with borrowed daylight

DRAFT FOR PUBLIC CONSULTATION

FIRST EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

Document status

This document (G7/AS2) is an acceptable solution issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX. The previous Acceptable Solution G7/AS1, as amended, can be used to show compliance until X XXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX.

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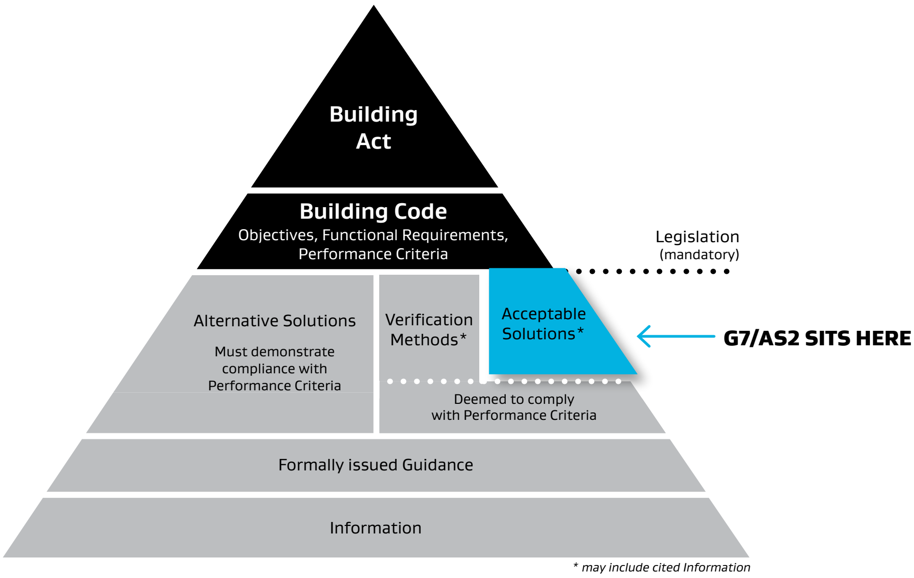
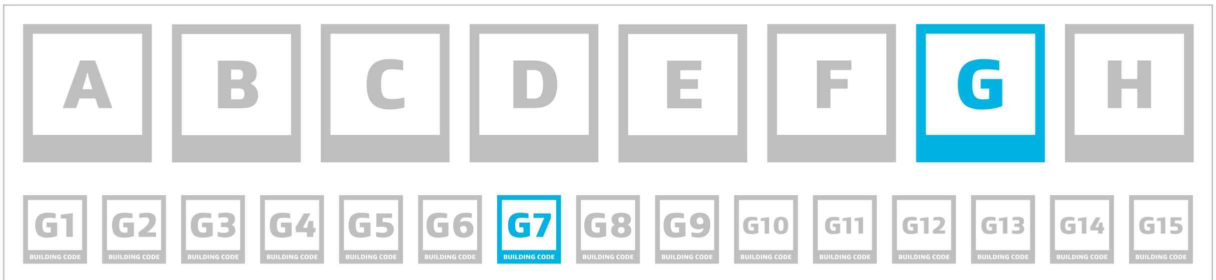
Each acceptable solution outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this acceptable solution relates to is clause G Services and facilities and specifically G7 Natural Light. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This is the first edition of G7/AS2. However, prior to its release, similar requirements were previously found within G7/AS1. The main changes from the previous version of G7/AS1 are:

› The scope of G7/AS1 has been reduced to cover only simple buildings up to 3 storeys in low density developments. G7/AS2 applies to simple buildings in low, medium and high density developments. However, it is more suitable for simple higher rise buildings and apartments. Requirements for complex buildings including higher rise buildings and apartments can be found in the Verification Methods G7/VM1 and G7/VM2. To reflect the new scope of the documents and the new document layout, a new introduction and scope has been provided in Part 1. General.

› Requirements for illuminance in habitable spaces in G7/AS1 have been replaced with new text in Part 2. Illuminance.

› Requirements for awareness of the outside environment in G7/AS2 has been reproduced from G7/AS1. However, it is no longer applicable for awareness of the outside through another space (Refer to Verification Method G7/VM2).

› The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any verification method or acceptable solution at any time. Up-to-date versions of verification methods and acceptable solutions are available from www.building.govt.nz.

Acknowledgements

MBIE would like to acknowledge the assistance of the Singaporean Building and Construction Authority for the permission for using content from Annex B of GM RB: 2016: Green Mark for residential buildings - Technical Guide and Requirements.

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This acceptable solution applies to **housing**, old people's homes, and *early childhood centres* that have *habitable spaces* with:

a) simple façade designs; and

b) external vertical windows; and

c) typical room heights (2.4 m to 3.0 m) that can be described by their *glazing-to-wall ratio (GWR);* and

d) glazing *visible light transmission* (*VLT*); and

e) simple horizontal overhang shading devices.

> COMMENT: Old people's homes also refers to all aged care facilities, rest homes and retirement complexes.

1.1.2 Items outside the scope of this document

1.1.2.1 This acceptable solution does not include solutions for:

a) *habitable spaces* that rely on daylight borrowed from another space; or

b) *habitable spaces* that do not have external vertical windows; or

c) *habitable spaces* that include non-standard features such as advanced daylight redirection systems, complex facades, top lighting strategies, double-height spaces, internal divisions, internal obstructions or other specialized designs; or

d) Spaces with more than one external vertical glazing element.

> COMMENT: For example, a simple volume such as a rectangular bedroom or living room with no internal fixed structural complexities may be assessed using G7/AS2. A more complex space such as a combined living-kitchen-dining area with an intervening part height fixed work bench could not be assessed using G7/AS2.

1.1.2.2 For *buildings* that have more complex configuration or internal rooms with borrowed light, Verification Method G7/VM2 or an alternative means may be used to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This acceptable solution provides a solution for demonstrating compliance with the performance criteria in Building Code clauses G7.3.1 and G7.3.2.

1.1.3.2 Options for demonstrating compliance with G7 Natural Light through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

TABLE 1.1.3.2: **Demonstrating compliance with G7 Natural Light through acceptable solutions and verification methods**

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
G7.3.1 *Illuminance*	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise *buildings* and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2
G7.3.2 Awareness of the outside environment	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise *buildings* and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2

1.2 Using this acceptable solution

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

1.2.2 Determining the habitable *space*

1.2.2.1 For the purpose of determining the *habitable space* for compliance with Building Code clause G7 Natural Light; a *habitable space* is one used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods. The intent is to ensure occupants within *buildings* are able to have access to *adequate* natural light and to have an awareness of the outside to maintain their health and wellbeing.

1.2.3 Features of this document

1.2.3.1 There are no standards or other documents referenced in this acceptable solution in Appendix A.

1.2.3.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.3.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.3.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses.

1.2.3.5 Appendices to this acceptable solution are part of, and have equal status to, the acceptable solution. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Illuminance

2.1 Illuminance of habitable spaces

2.1.1 Demonstrating compliance

2.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, natural light shall provide an *illuminance* of no less than 30 lux at floor level for 75% of the *standard year*. This is demonstrated by limiting the maximum permitted room depth of standard *habitable spaces* using the tables provided in Subsection 2.1.4.

2.1.2 Limitations regarding the maximum permitted room depth tables

2.1.2.1 The maximum permitted room depth tables are suitable for standard *habitable spaces*. Standard *habitable spaces* have the following characteristics:

a) A plain rectangular shape with a constant (flat) ceiling height, and

b) Spaces with typical room floor-to-ceiling heights between 2.4 m and 3.0 m, and

c) Internal spaces with external vertical windows that can be described by *glazing-to-wall* ratio (GWR) and glazing *visible light transmittance* (*VLT*), and

d) A *glazing-to-wall ratio* (*GWR*) between 10% and 90%, and

e) Spaces with simple exterior soffit or overhang shading devices or no shading devices, and

f) Relatively unobstructed spaces with *average exterior obstruction angle* (*AEOA*) less than or equal to 57.25°.

2.1.2.2 Each *habitable space* must be assessed individually.

2.1.2.3 When using the maximum permitted room depth tables, the following limitations apply:

a) For spaces with more than one external vertical window, the tables assume natural light ingress from window(s) on one wall creating a side-lit space. Spaces with two opposing windows shall use G7/AS1, G7/VM2, or an alternative solution to demonstrate compliance.

b) For internal rooms that do not have a direct external vertical window and rely on daylight borrowed from another space, G7/VM2 or an alternative solution shall be used to determine the minimum *illuminance* within secondary spaces and demonstrate compliance.

c) For daylit spaces of unusual heights, use G7/VM2 to perform a detailed daylighting simulation or use an alternative solution to demonstrate compliance.

2.1.3 Input parameters to the maximum permitted room depth tables

2.1.3.1 The maximum permitted room depth tables require the specified inputs of the *glazing-to-wall ratio* (*GWR*), *visible light transmittance* (*VLT*), *overhang obstruction angle* (*OOA*), and *average exterior obstruction angle* (*AEOA*). These parameters must be identified for each floor level and each *habitable space* of a *building*.

2.1.3.2 There are nine *glazing-to-wall ratios (GWRs)* included in the maximum permitted room depth tables: 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 90%. The closest *GWR* value to the actual room *GWR* from this list shall be chosen for utilizing the tables. The GWR is calculation using Equation 1.

Equation 1:

$$GWR = \frac{\Sigma \text{ Area of glazing}}{\text{Area of wall containing the windows}} \times 100$$

COMMENT: A fully glazed *building* has a *GWR* less than 100% as mullions and spandrels take up some area of the wall.

2.1.3.3 Five *visible light transmittance (VLT)* values are represented in the maximum permitted room depth tables: 43% and 89% for single glazing, and 39%, 70%, 80% for double glazing.

2.1.3.4 *VLT* values shall be derived from the actual glazing specifications for the *building*, and the closest value contained in the maximum permitted room depth tables shall be used.

2.1.3.5 Three *overhang obstruction angles* (*OOAs*) are included in the maximum permitted room depth tables: 0°, 15°, and 30°. The closest value to the actual *building OOA* value shall be used (see Figure 2.1.3.5).

> COMMENT: The overhang obstruction angle (OOA) is a number in degrees describing the portion of the sky blocked by a horizontal overhang measured from the bottom of the window assembly. The angle describes the obstructed portion of sky from the zenith (directly overhead) to the outside edge of the shading device.

2.1.3.6 *OOA* shall be calculated using Equation 1.

Equation 1: $$OOA = \arctan\left(\frac{H_W}{P+D}\right)$$

where:

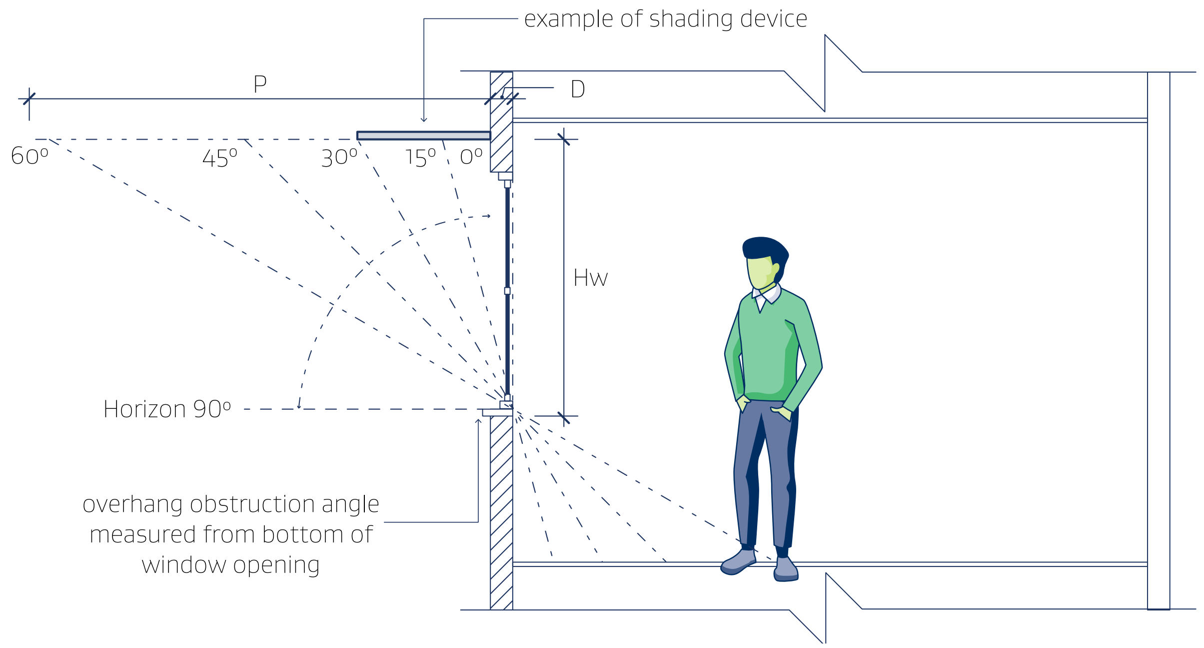
H_w is the height measured from the bottom of the window opening to the underside of the overhang obstruction (m), and

P is the length of projection from the window opening to the edge of the overhang obstruction (m), and

D is the thickness depth of the *external wall* (m).

FIGURE 2.1.3.5: Overhang obstruction angle (OOA)

Paragraph 2.1.3.5



2.1.3.7 There are three ranges of *average exterior obstruction angle (AEOA)* values in the maximum permitted room depth tables:

a) For ≥ 0° to < 11.25°, and
b) For ≥ 11.25° to < 33.75°, and
c) For ≥ 33.75° to < 57.25°.

COMMENT: *AEOA* describes the portion of the sky blocked by surrounding urban *buildings* as measured from the finished floor height of the space being assessed.

2.1.3.8 *AEOA* can be determined from the average urban construction height in metres, the height of the *building* floor level above ground, and the distance between neighbouring *buildings*. See Figure 2.1.3.8.

2.1.3.9 *AEOA* shall be calculated using Equation 2. The maximum permitted *building* dimensions by the district plan shall be assumed on empty lots.

Equation 2: $$\text{AEOA} = \arctan\left(\frac{H-h}{W}\right)$$

where:

H is the average height of surrounding exterior obstructions measured from the ground (m), and

h is the height of the assessed space's floor level above ground (m), and

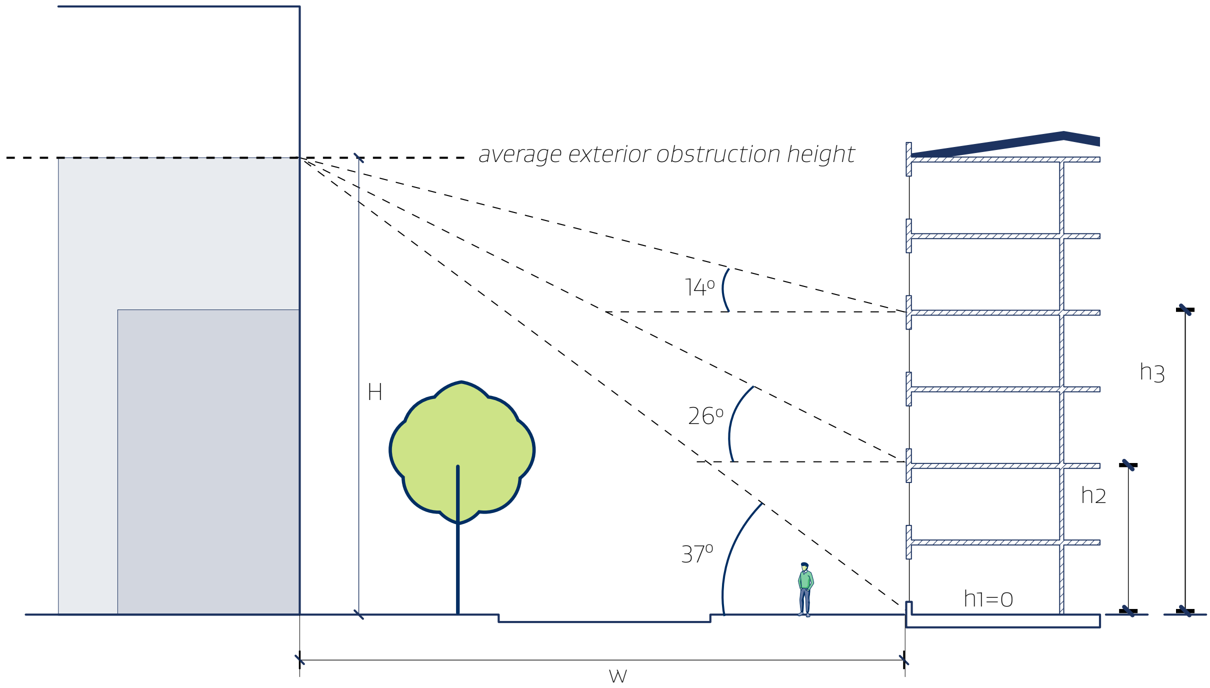
W is the width of the street or distance between the *building* and its surrounding obstructions (m).

2.1.3.10 Where an exterior obstruction varies in distance from the *building* being assessed, the average distance, measured over the width of the *building* being assessed, shall be used. Spaces with an AEOA of greater than 57.25° shall employ detailed daylight simulation using Verification Method G7/VM2.

2.1.3.11 Where trees are known or anticipated to be present, the general form and size of the mature tree shall be included in the model as a solid object. It shall be treated the same as a *building*.

FIGURE 2.1.3.8: **Average exterior obstruction angle (AEOA)**

Paragraph 2.1.3.8



2.1.4 Maximum permitted room depth for standard habitable spaces

2.1.4.1 The maximum permitted room depth for standard *habitable spaces* for minor, medium and high obstructions shall be determined from Table 2.1.4.1.

2.1.4.2 The maximum permitted room depth shown in the table is the room depth measured from the interior face of the *external wall* containing the vertical window. This is deemed to achieve the requirement of no less than 30 lux at floor level for 75% of a *standard year.*

COMMENT: The tables give the distance from vertical external windows where the *illuminance* from natural light exceeds the minimum requirement from G7.3.1 of 30 lux. These have been derived from extensive computer-based simulations using a standardised room model and the CIE 110: 1994 - Type 1 Overcast Sky.

TABLE 2.1.4.1: Maximum permitted room depth tables for standard habitable spaces

Paragraph 2.1.4.1

Minor obstructed exterior context (≥ 0 to < 11.25° AEOA)[(1),(2)]																												
VLT%		**0° Overhang obstruction angle**									**15° Overhang obstruction angle**									**30° Overhang obstruction angle**								
Single	**89**	4.0	5.1	5.6	6.5	7.3	8.1	8.9	9.7	7.1	3.7	4.7	5.4	5.5	5.8	5.6	5.8	6.0	6.5	3.3	4.3	5.0	5.0	5.4	5.0	5.2	5.4	5.9
	43	3.0	4.0	4.5	4.6	5.0	4.8	5.0	5.2	5.6	2.7	3.6	4.2	4.2	4.6	4.3	4.5	4.7	5.1	2.3	3.2	3.9	3.9	4.1	3.8	4.0	4.2	4.1
Double	**80**	3.8	4.8	5.6	5.6	6.0	5.9	6.2	6.4	6.9	3.5	4.5	5.2	5.3	5.6	5.4	5.6	5.8	6.3	3.2	4.1	4.8	4.8	5.2	4.8	5.0	5.3	5.7
	70	3.6	4.6	5.3	5.4	5.8	5.6	5.9	6.1	6.6	3.4	4.3	4.9	5.0	5.4	5.1	5.3	5.6	6.0	3.0	4.0	4.6	4.6	5.0	4.6	4.8	5.0	5.4
	39	2.8	3.8	4.3	4.4	4.8	4.6	4.8	5.1	5.4	2.6	3.5	4.1	4.1	4.4	4.1	4.3	4.6	4.9	2.2	3.1	3.7	3.7	4.0	3.6	3.8	4.1	4.4
Medium obstructed exterior context (≥ 11.25 to < 33.75° AEOA)[(1),(2)]																												
VLT%		**0° Overhang obstruction angle**									**15° Overhang obstruction angle**									**30° Overhang obstruction angle**								
Single	**89**	3.3	3.9	4.1	4.2	4.4	4.4	4.5	4.5	4.9	3.0	3.5	3.7	3.7	3.8	3.7	3.7	3.9	4.2	2.6	3.2	3.3	3.3	3.4	3.0	3.1	3.2	3.6
	43	2.6	3.2	3.5	3.6	3.8	3.8	3.9	4.0	4.3	2.4	2.9	3.2	3.2	3.3	3.2	3.2	3.4	3.7	2.1	2.6	2.9	2.8	2.9	2.5	2.7	2.9	3.1
Double	**80**	3.2	3.7	4.0	4.1	4.3	4.3	4.3	4.5	4.8	2.9	3.4	3.7	3.7	3.7	3.5	3.7	3.7	4.1	2.5	3.0	3.3	3.2	3.3	2.9	3.1	3.2	3.6
	70	3.1	3.6	3.9	4.0	4.1	4.1	4.2	4.4	4.7	2.7	3.3	3.5	3.5	3.7	3.5	3.5	3.7	4.0	2.4	2.9	3.1	3.1	3.2	2.8	3.0	3.1	3.5
	39	2.6	3.1	3.5	3.5	3.7	3.6	3.8	3.9	4.2	2.3	2.8	3.2	3.1	3.3	3.1	3.1	3.3	3.6	2.0	2.5	2.7	2.7	2.9	2.5	2.6	2.7	3.0
Highly obstructed exterior context (≥ 33.75 to < 57.25° AEOA)[(1),(2)]																												
VLT%		**0° Overhang obstruction angle**									**15° Overhang obstruction angle**									**30° Overhang obstruction angle**								
Single	**89**	2.5	2.7	2.9	2.9	2.9	2.9	3.0	3.4	3.7	2.1	2.4	2.5	2.5	2.5	2.4	2.3	2.4	2.7	1.9	2.0	2.1	2.0	2.1	1.7	1.8	2.1	2.4
	43	2.1	2.5	2.6	2.7	2.7	2.7	2.8	2.8	3.0	1.9	2.2	2.3	2.2	2.3	2.1	2.1	2.2	2.4	1.5	1.7	1.9	1.8	1.9	1.5	1.6	1.8	2.0
Double	**80**	2.5	2.7	2.8	2.9	2.9	2.9	2.9	3.1	3.5	2.1	2.4	2.5	2.4	2.5	2.3	2.3	2.3	2.6	1.7	1.9	1.9	1.9	2.0	1.7	1.8	2.0	2.3
	70	2.4	2.6	2.6	2.8	2.9	2.9	2.9	3.0	3.4	2.1	2.3	2.4	2.4	2.4	2.2	2.3	2.3	2.5	1.7	1.9	2.0	1.9	2.0	1.7	1.7	1.9	2.2
	39	2.1	2.4	2.6	2.6	2.7	2.7	2.7	2.8	3.0	1.8	2.1	2.3	2.2	2.3	2.1	2.1	2.2	2.4	1.5	1.7	1.9	1.8	1.9	1.5	1.5	1.7	1.9
		10	20	30	40	50	60	70	80	90	10	20	30	40	50	60	70	80	90	10	20	30	40	50	60	70	80	90
		Glazing-to-wall ratio %									**Glazing-to-wall ratio %**									**Glazing-to-wall ratio %**								

Notes:

(1) Refer to the limitations on the use of these tables outlined in Subsection 2.1.2.

(2) Extrapolation of the values in the table is not permitted. The values of *GWR, VLT, OOA* and *AEOA* shall be within the ranges given in Subsection 2.1.3.

Part 3. Awareness of the outside environment

3.1 Clear area of glazing

3.1.1 Demonstrating compliance

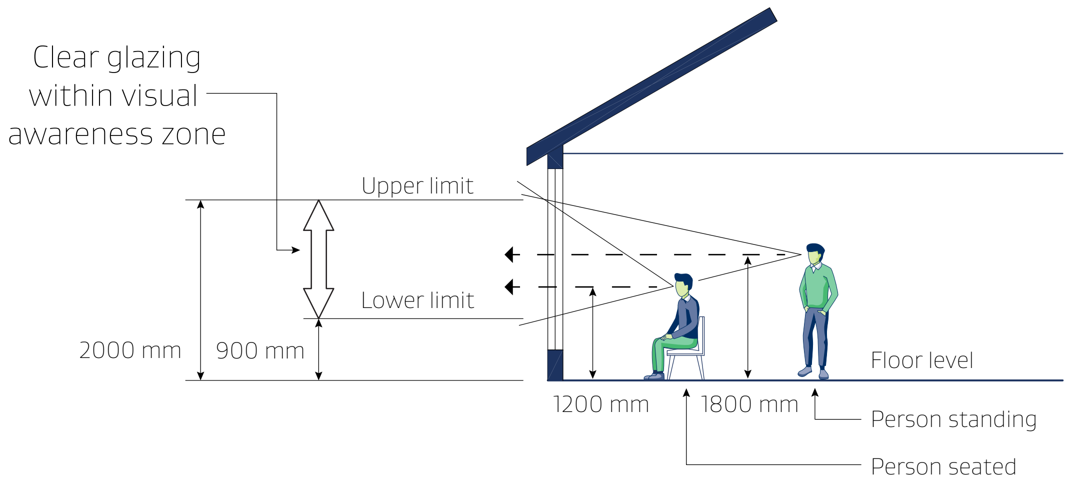
3.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, openings of the outside shall have clear area of glazing suitable to give awareness of the outside. This is demonstrated through the use of a calculation method described in Subsection 3.1.2.

3.1.2 Calculation of the area of glazing

3.1.2.1 At least 50% of the area of glazing provided for natural light in *habitable spaces* shall be clear *glazing*. The clear glazing shall be located in the zone between the levels 900 mm and 2000 mm from floor level (see Figure 3.1.2.1).

FIGURE 3.1.2.1: Visual awareness zone

Paragraph 3.1.2.1



Appendix A. References

There are no standards or other documents referenced in this acceptable solution.

Appendix B. Definitions

These definitions are specific to this acceptable solution. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	*Adequate* to achieve the objectives of the Building Code.
Average exterior obstruction angle (AEOA)	The average angle from the horizon to the lower extent of the visible sky measured at floor level of the assessment space.
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Early childhood centre (ECC)	Premises used regularly for the education or care of three or more children (not being children of the persons providing the education or care, or children enrolled at a school being provided with education or care before or after school) under the age of six years old— a) by the day or part of a day; but b) not for any continuous period of more than seven days. ECC does not include home based early childhood services.
External wall	Any vertical exterior face of a *building* consisting of *primary* and/or *secondary elements* intended to provide protection against the outdoor environment
Glazing-to-wall ratio (GWR)	The percentage of glazing, not including framing and mullions, relative to the area of the wall containing the vertical exterior window.
Habitable space	A space used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods.
Illuminance	The luminous flux falling onto unit area of surface (lumen/m^2).
Overhang obstruction angle (OOA)	Average angle from the zenith of the sky at the inside face of the exterior wall of the space being assessed to the furthest extent of the object obstructing the visible sky.
Standard year	For the purposes of determining natural lighting, the hours between 8 am and 5 pm each day with an allowance being made for daylight saving.
Visible light transmittance (VLT)	The ratio of luminous flux (light) passing through a translucent surface (e.g., glazing). It is expressed as a percentage of the flux incident upon the surface. A higher value means a greater percentage of visible light passes through the surface.

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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

BP 6479

BUILDING
PERFORMANCE

G7

G7 Natural Light

Verification Method G7/VM1

Natural light for complex buildings excluding those with borrowed daylight

DRAFT FOR PUBLIC CONSULTATION

SECOND EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

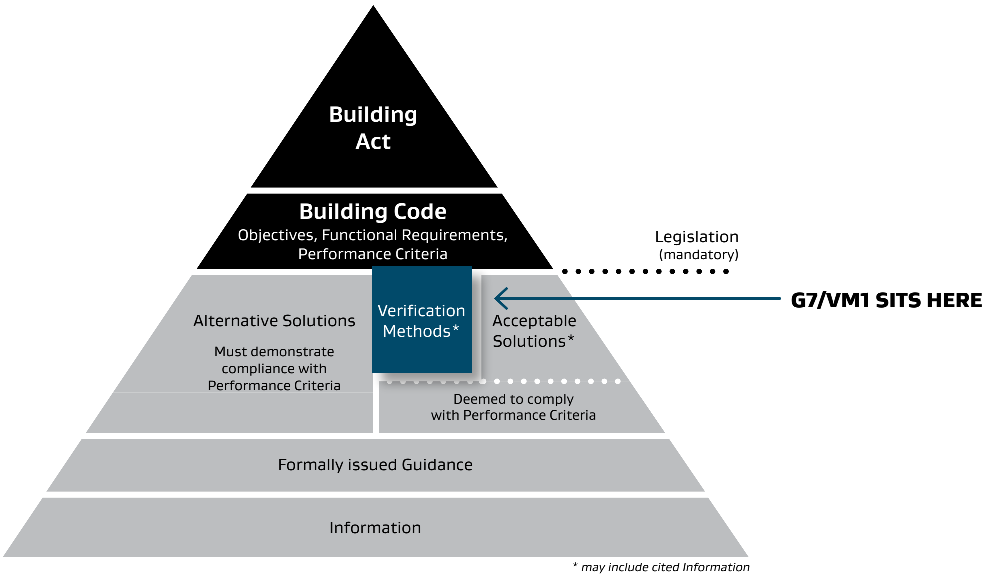
Document status

This document (G7/VM1) is a verification method issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX. The previous Verification Method G7/VM1, as amended, can be used to show compliance until X XXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX.

Building Code regulatory system

Each verification method outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this verification method relates to is clause G Services and facilities and specifically G7 Natural Light. Further information on the scope of this document is provided in Part 1. General.

Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This is the second edition of G7/VM1. The main changes from the previous versions of G7/VM1 are:

› The scope of G7/VM1 has been explicitly stated with a new introduction and scope provided in Part 1. General.

› The requirements for awareness of the outside environment has been reproduced from G7/AS1 in Part 3. Awareness of the outside environment. However, these requirements are no longer applicable for awareness of the outside through another space. The applicable requirements can be found in Verification Method G7/VM2.

› References have been revised to include only documents within the scope of G7/VM1 in Appendix A.

› The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solutions and verification methods are available from www.building.govt.nz

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This verification method applies to **housing**, old people's homes, and *early childhood centres* that have *habitable spaces* with:

a) simple façade designs; and

b) external vertical and inclined windows; and

c) rectangular windows; and

d) glazing *visible light transmission (VLT)*; and

e) simple horizontal overhang shading devices; and

f) external obstruction which can be reduced to an equivalent rectangle.

> COMMENT: Old people's homes also refers to all aged care facilities, rest homes and retirement complexes.

1.1.2 Items outside the scope of this document

1.1.2.1 This verification method does not include solutions for:

a) *habitable spaces* that rely on daylight borrowed from another space; or

b) *habitable spaces* that do not have external vertical windows; or

c) *habitable spaces* that include non-standard features such as advanced daylight redirection systems, complex facades, top lighting strategies, double-height spaces, internal divisions, internal obstructions or other specialized designs; or

d) Spaces with more than one external glazing element.

1.1.2.2 For buildings that have more complex configuration or internal rooms with borrowed light, Verification Method G7/VM2 may be used as a means to demonstrate compliance or use an alternative means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This verification method provides a solution for demonstrating compliance with the performance criteria in Building Code clauses G7.3.1 and G7.3.2.

1.1.3.2 Options for demonstrating compliance with G7 Natural Light through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.2 Using this verification method

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

1.2.2 Determining the habitable space

1.2.2.1 For the purpose of determining the *habitable space* for compliance with Building Code clause G7 Natural Light; a *habitable space* is one used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods. The intent is to ensure occupants within buildings are able to have access to *adequate* natural light and to have an awareness of the outside to maintain their health and wellbeing.

TABLE 1.1.3.2: Demonstrating compliance with G7 Natural Light through acceptable solutions and verification methods
Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
G7.3.1 *Illuminance*	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise *buildings* and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2
G7.3.2 Awareness of the outside environment	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise *buildings* and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2

1.2.3 Features of this document

1.2.3.1 For the purposes of compliance with the Building Code, the standards and documents referenced in this verification method must be the editions, along with their specific amendments listed in Appendix A.

1.2.3.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.3.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.3.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses.

1.2.3.5 Appendices to this verification method are part of, and have equal status to, the verification method. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Illuminance

2.1 Illuminance of habitable spaces

2.1.1 Demonstrating compliance

2.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, natural light shall provide an *illuminance* of no less than 30 lux at floor level for 75% of the *standard year*. This is demonstrated using the tabular and graphic methods described in Subsection 2.1.2.

2.1.2 Verification of the design

2.1.2.1 *Illuminance* may be assessed by using one of the BRE calculation methods described in Appendix A of NZS 6703.

Part 3. Awareness of the outside environment

3.1 Clear area of glazing

3.1.1 Demonstrating compliance

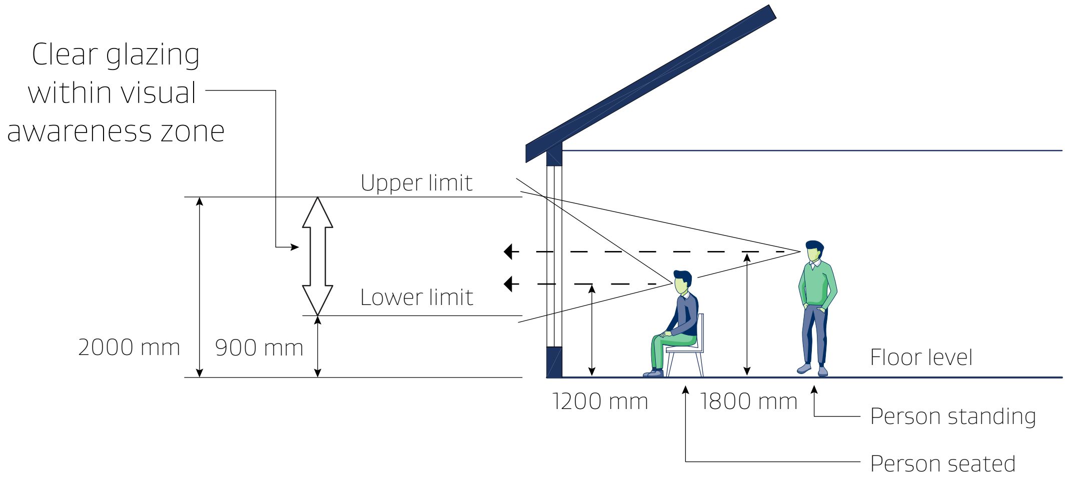
3.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, openings of the outside shall have clear glazed area suitable to give awareness of the outside. This is demonstrated using the method described in Subsection 3.1.2.

3.1.2 Verification of the design

3.1.2.1 A *habitable space* with an *external wall* shall have a clear area of glazing no less than 5% of the floor area of the space.

3.1.2.2 The clear glazing shall be located in the visual awareness zone between the levels 900 mm and 2000 mm from floor level (see Figure 3.1.2.2).

FIGURE 3.1.2.2: Visual awareness zone
Paragraph 3.1.2.2



Appendix A. References

For purposes of compliance with the Building Code, the standard referenced in this verification method must be the edition, along with the specific amendment, listed below.

Standards New Zealand		**Where quoted**
NZS 6703: 1984	Code of practise for interior lighting design Amend C1: 1985	2.1.2.1

This standard can be accessed from www.standards.govt.nz

Appendix B. Definitions

These definitions are specific to this verification method. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	*Adequate* to achieve the objectives of the Building Code.
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Early childhood centre (ECC)	Premises used regularly for the education or care of three or more children (not being children of the persons providing the education or care, or children enrolled at a school being provided with education or care before or after school) under the age of six years old— a) by the day or part of a day; but b) not for any continuous period of more than seven days. ECC does not include home based early childhood services.
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment
Habitable space	A space used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods.
Illuminance	The luminous flux falling onto unit area of surface (lumen/m^2).
Standard year	For the purposes of determining natural lighting, the hours between 8 am and 5 pm each day with an allowance being made for daylight saving.
Visible light transmittance (VLT)	The ratio of luminous flux (light) passing through a translucent surface (e.g., glazing). It is expressed as a percentage of the flux incident upon the surface.

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New Zealand Government

BP 6430

BUILDING PERFORMANCE

G7

G7 Natural Light

Verification Method G7/VM2

Natural Light for all buildings
including those with borrowed daylight

DRAFT FOR PUBLIC CONSULTATION

FIRST EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Preface

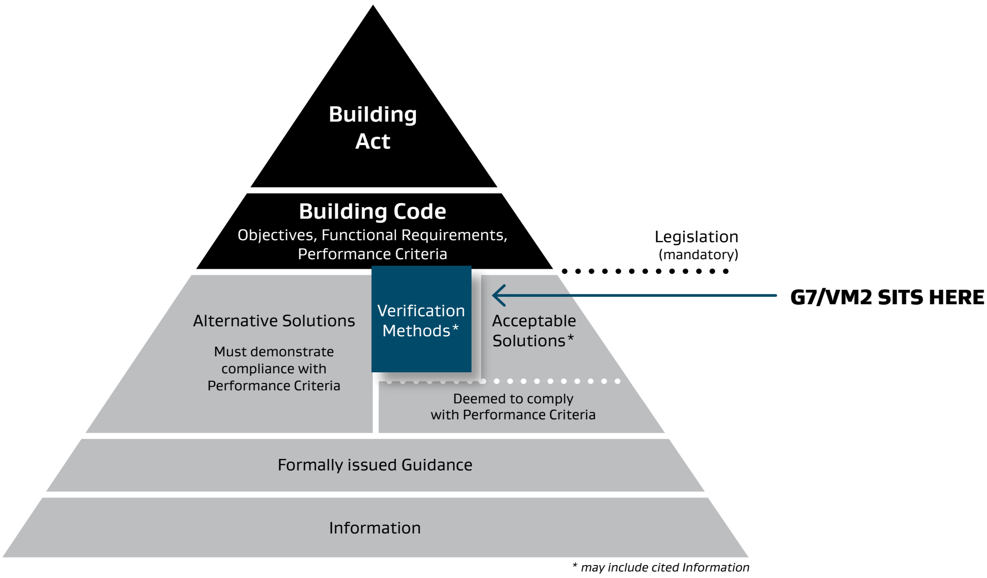
Document status

This document (G7/VM2) is a verification method issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX. The previous Acceptable Solution G7/AS1 and Verification Method G7/VM1, as amended, can be used to show compliance until X XXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX.

Building Code regulatory system

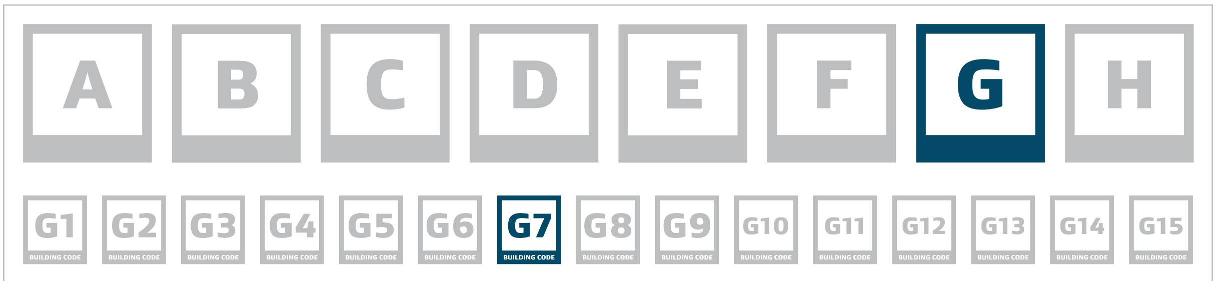
Each verification method outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this verification method relates to is clause G Services and facilities and specifically G7 Natural Light. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This is the first edition of G7/VM2. However, prior to its release, similar requirements were previously found within G7/AS1 and G7/VM1. The main changes from the previous versions of G7/AS1 and G7/VM1 are:

› The scope of G7/AS1 has been reduced to cover only simple buildings up to 3 storeys in low density developments. Requirements applicable for simple and complex high rise buildings and apartments have combined into the new Acceptable Solution G7/AS2 and Verification Methods G7/VM1 and G7/VM2. To reflect the new scope of the documents and the new document layout, an introduction and scope has been provided in Part 1. General.

› Requirements for computer modelling to demonstrate compliance with illuminance in habitable spaces are provided in Part 2. Illuminance.

› The scope of G7/AS1 and G7/VM1 has been reduced and are no longer applicable for awareness of the outside environment through another space. The applicable requirements for awareness of the outside environment through another space are found in Part 3. Awareness of the outside environment.

› References for standards and documents are provided in Appendix A.

› The definitions page has been revised to include all defined terms used in this document in Appendix B.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solutions or verification methods are available from www.building.govt.nz

Acknowledgements

MBIE would like to acknowledge the assistance of the Singaporean Building and Construction Authority for the permission for using content from Annex B of GM RB: 2016: Green Mark for residential buildings - Technical Guide and Requirements.

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This verification method applies to all **housing**, old people's homes, and *early childhood centres* including those that have *habitable spaces* with:

a) complex room shapes, and

b) rooms with borrowed daylight, and

c) rooms with multiple windows, and

d) other room scenarios not covered by G7/AS1, G7/AS2 and G7/VM1.

> COMMENT: Old people's homes also refers to all aged care facilities, rest homes and retirement complexes.

1.1.2 Items outside the scope of this document

1.1.2.1 This verification method does not consider the detrimental effects of 'over lighting' as this is not a requirement to demonstrate compliance with G7 Natural Light.

1.1.2.2 For *buildings* that cannot be simulated using the requirements of this document, use an alternative means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This verification method provides a solution for demonstrating compliance with the performance criteria in Building Code clauses G7.3.1 and G7.3.2.

1.1.3.2 Options for demonstrating compliance with G7 Natural Light through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.2 Using this verification method

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code.

1.2.2 Determining the habitable space

1.2.2.1 For the purpose of determining the *habitable space* for compliance with Building Code clause G7 Natural Light; a *habitable space* is one used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods. The intent is to ensure occupants within *buildings* are able to have access to *adequate* natural light and to have an awareness of the outside to maintain their health and wellbeing.

TABLE 1.1.3.2: Demonstrating compliance with G7 Natural Light through acceptable solutions and verification methods
Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
G7.3.1 *Illuminance*	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise *buildings* and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2
G7.3.2 Awareness of the outside environment	**Housing**, old people's homes, and *early childhood centres*	For simple *buildings* up to 3 storeys in low density developments without borrowed light: G7/AS1 For simple *buildings* in low, medium and high density developments (including higher rise *buildings* and apartments) without borrowed light: G7/AS2 For more complex *buildings* (including higher rise *buildings* and apartments) without borrowed light: G7/VM1 For all *buildings* (including complex higher rise *buildings* and apartments) with borrowed light: G7/VM2

1.2.3 Features of this document

1.2.3.1 For the purposes of compliance with the Building Code, the standards and documents referenced in this verification method must be the editions, along with their specific amendments listed in Appendix A.

1.2.3.2 Words in *italic* are defined at the end of this document in Appendix B.

1.2.3.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.3.4 Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses.

1.2.3.5 Appendices to this verification method are part of, and have equal status to, the verification method. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Illuminance

2.1 Illuminance of habitable spaces

2.1.1 Demonstrating compliance

2.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, natural light shall provide an *illuminance* of no less than 30 lux at floor level for 75% of the *standard year*. This is demonstrated through the use of the computer-based daylight modelling described in Section 2.1.2.

2.1.2 Modelling method for verification of the design

2.1.2.1 Verification of the design is achieved by demonstrating that natural light provides the required *illuminance* by using either:

a) *Climate based daylight modelling (CBDM)*; or

b) *Daylight factor (DF)* modelling.

2.1.2.2 *Climate based daylight modelling (CBDM)* provides outputs as absolute quantities expressed in lux (*illuminance*).

2.1.2.3 When *daylight factor (DF)* modelling is used to determine sufficient level of natural light, outputs are expressed in terms of percentage of outside available daylight. The calculated *Daylight Factor (DF)* shall be equal or more than the values of Table 2.1.2.3 for minimum Daylight Factor (DF) values.

TABLE 2.1.2.3: Minimum Daylight Factors

Paragraph 2.1.2.3

Climate region[1]	Daylight factor (%)[2],[3]
Auckland	0.26
Wellington	0.32
Christchurch	0.27
Invercargill	0.34

Notes:

(1) For locations not listed, use the *daylight factor* value for the geographically closest location.

(2) These *daylight factors* are the minimum values based on 75% of a *standard year*

(3) These *daylight factors* are calculated by using Equation 1 of Paragraph C 4.3.1.

2.1.2.4 The computer model shall simulate ingress of daylight into *habitable spaces* of the *building* and shall accurately represent the geometry, *reflectance*, and *visible light transmittance* (*VLT*) properties of the *building* and spaces.

2.1.2.5 The orientation, with respect to north, and location (including latitude, longitude, and altitude) used in the simulation shall accurately represent that of the *building*.

2.1.2.6 Any change of plane (such as a step change in alignment) shall be included in the simulation if it exceeds 100 mm. This includes coves and dropped ceilings, steps in floors, steps/alcoves in walls, and the like.

2.1.2.7 Additional requirements for the use of computer modelling including required inputs is provided in Appendix C.

2.1.2.8 Modelling of architectural features smaller than 100 mm in any dimension is not required. Dimensions of *building elements* and furniture in the simulation shall be simulated accurately to the nearest 100 mm increment except for windows, *skylights*, and openings as specified in Paragraph C.2.4.1.

Part 3. Awareness of the outside environment

3.1 Clear area of glazing

3.1.1 Demonstrating compliance

3.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, openings of the outside shall have clear area of glazing suitable to give awareness of the outside. This is demonstrated through the use of a calculation method described in Subsection 3.1.2.

3.1.2 Calculation method for verification of the design

3.1.2.1 Verification of the design is achieved by demonstrating that the clear area of glazing of the proposed *building* design is dimensioned and located as described in this subsection.

3.1.2.2 A *habitable space* with an external wall shall have a clear area of glazing no less than;

a) 5% of the floor area of the space, (where there is no habitable space borrowing light); or

b) 5% of the total floor area of the space plus the floor area of any adjacent *habitable space* that is borrowing natural light via the space (see Figure 3.1.2.2) (where there is habitable space borrowing light).

3.1.2.3 A *habitable space* that borrows natural light from another space with an *external wall* shall have a clear area of glazing no less than 10% of the floor area of the space.

3.1.2.4 Any other space with an *external wall*, other than a habitable space, that is used to borrow natural light from shall have a clear area of glazing no less than 5% of the total floor area of the space and the adjacent room that is borrowing natural light via the space.

3.1.2.5 The clear area of glazing shall be located in the visual awareness zone between the levels 900 mm and 2000 mm from floor level (see Figure 3.1.2.5).

3.1.2.6 When a *habitable space* is borrowing natural light via an adjacent space with an *external wall*, an observer in the space shall be able to directly see the full required clear glazed area of the *external wall* via the internal glazed area when the observer is;

a) located at a perpendicular distance of 2000 mm from the internal wall containing the clear area of glazing; or

b) located centrally on the opposite wall (for rooms with a depth less than 2000 mm from the clear area of glazing of the internal wall); and

c) located at a height from the floor of 1200 mm (seated position), and

d) located at a height from the floor of 1800 mm (standing position) (see Figure 3.1.2.5).

FIGURE 3.1.2.2: Clear area of glazing

Paragraph 3.1.2.2

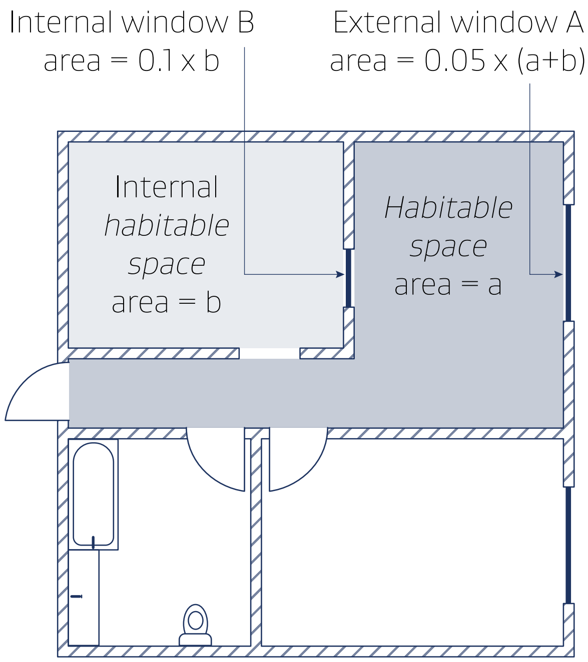
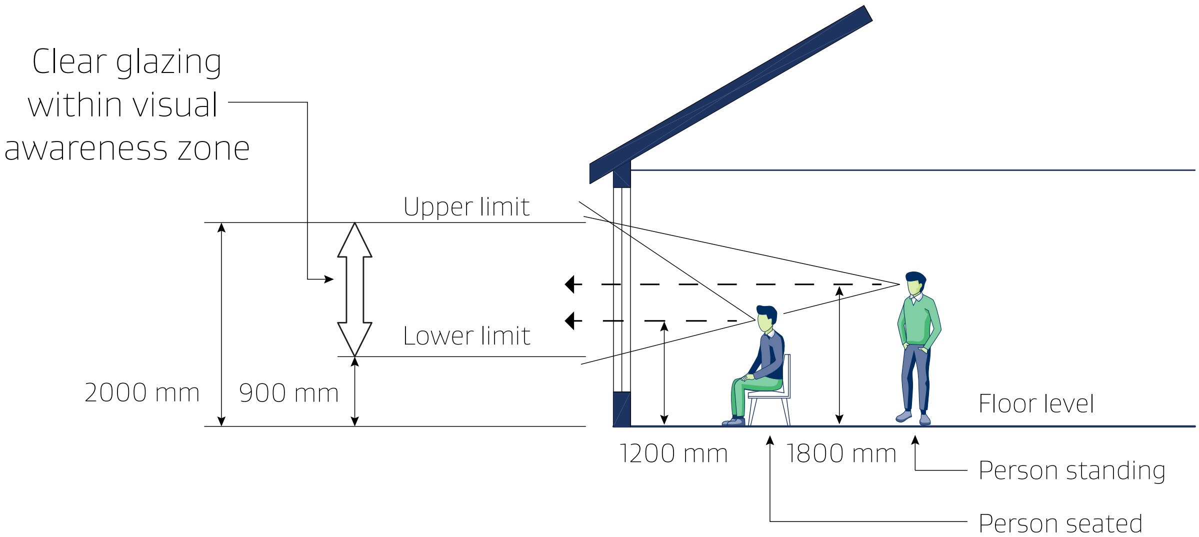


FIGURE 3.1.2.5: Visual awareness zone

Paragraphs 3.1.2.5, 3.1.2.6



Appendix A. References

For the purposes of compliance with the Building Code, the standards and documents referenced in this verification method must be the editions, along with their specific amendments, listed below.

Standards New Zealand		Where quoted
AS/NZS 1680:-	Interior and workplace lighting	
Part 1: 2006	General Principles and Recommendations	C.3.4.1, C.4.2.1 and C.4.3.1
NZS 6703: 1984	Code of Practise for Interior Lighting Design	Table C.2.5.1B

These standards can be accessed from www.standards.govt.nz

International Commission on Illumination		Where quoted
CIE 171: 2006	Test cases to assess the accuracy of lighting computer programs	C.3.3.1
CIE 110: 1994	Spatial distribution of daylight – Luminance distributions of various reference skies	C.3.3.2, C.4.1.1

These documents can be accessed from www.cie.co.at

Appendix B. Definitions

These definitions are specific to this verification method. Other defined terms found in italics are provided in clause A2 of the Building Code.

Adequate	*Adequate* to achieve the objectives of the Building Code.
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Building element	Any structural or non-structural component or assembly incorporated into or associated with a *building*. Included are *fixtures*, services, *drains*, permanent mechanical installations for access, glazing, partitions, ceilings and temporary supports.
Climate based daylight modelling (CBDM)	The prediction of lighting qualities and quantities within a space using conditions derived from standard meteorological datasets. Climate-based modelling delivers predictions of absolute quantities (e.g., illuminance) that are dependent on the location and the building orientation, in addition to the building's composition and configuration.
Daylight factor (DF)	The ratio of natural light within a space as a percentage of the available daylight outside of a *building*.
Early childhood centre (ECC)	Premises used regularly for the education or care of three or more children (not being children of the persons providing the education or care, or children enrolled at a school being provided with education or care before or after school) under the age of six years old— a) by the day or part of a day; but b) not for any continuous period of more than seven days. ECC does not include home based early childhood services.
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment
Habitable space	A space used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods.
Illuminance	The luminous flux falling onto unit area of surface (lumen/m^2).
Luminance (cd/m^2)	Described as the visual brightness of an object. The luminous flux emitted (or reflected) from an object's surface are and measured as candelas per metre squared (cd/m^2).
Reflectance	The ratio of the flux reflected from a surface to the flux incident on it.
Roof	That part of a *building* having its upper surface exposed to the outside and at an angle of 60° or less to the horizontal.
Skylight	Translucent or transparent parts of the *roof*.
Standard year	For the purposes of determining natural lighting, the hours between 8 am and 5 pm each day with an allowance being made for daylight saving.
Visible light transmittance (VLT)	The ratio of luminous flux (light) passing through a translucent surface (e.g., glazing). It is expressed as a percentage of the flux incident upon the surface. A higher value means a greater percentage of visible light passes through the surface.

Appendix C. Computer modelling of natural light

C.1 Modelling requirements

C.1.1 Overview

C.1.1.1 This appendix provides details on the use of computer modelling to determine the level of natural light provided in a *building*. It includes requirements for the inputs used in the simulation of specific elements along with requirements for the use of *Climate Based Daylight Modelling (CBDM)* and *Daylight Factor (DF)* calculations.

C.2 Simulation of specific elements

C.2.1 Walls

C.2.1.1 All offsets larger than 100 mm in any dimensions shall be included in the simulation. Curved surfaces shall be simulated as smooth surfaces and may be faceted with a maximum facet dimension of 100 mm.

C.2.2 Internal details

C.2.2.1 All Internal partitions, fixed furniture, and joinery elements that are a permanent part of the internal area shall be included in the simulation. Loose furniture is not required to be included in the simulation.

C.2.3 External details

C.2.3.1 All fixed overhangs, louvres, balconies, and fins that are a permanent part of the *building*, and which restrict natural light entering the *building*, shall be included in the simulation.

C.2.3.2 Where the natural light entering a *building* is restricted by other structures or natural land features these shall be included in the simulation.

C.2.3.3 Where trees are known or anticipated to be present, the general form and size of the mature tree should be included in the simulation. For simplicity, it is suggested that these are represented as solid objects.

C.2.4 Windows, skylights and openings

C.2.4.1 The dimensions of windows and daylight openings shall be simulated to the nearest 10 mm. Window opening details such as wall thickness, sills, projections, frames, and mullions shall be simulated to the nearest 10 mm.

C.2.4.2 Glazing shall be simulated with a *visible light transmittance* (*VLT)* based on manufacturer's data. If manufacturer's data is not available, it is permitted to use the values in Table C.2.4.2.

C.2.4.3 Glazing light transmission used in the modelling must have a *VLT* no less than 0.70 (or 0.65 for low E glazing) and in no case shall the *VLT* be simulated with values exceeding those in Table C.2.4.2.

TABLE C.2.4.2: Visible light transmission values for openings and glazing

Paragraph C.2.4.2, C2.4.3

Exterior daylight openings	Transmissivity (%)
Unobstructed opening with no glazing	1.0
Glazing material	**Transmissivity (%)**
Vertical window glazing – clear	0.90
Roof window and *skylight* glazing – clear	0.85
Roof window and *skylight* glazing – translucent	0.70

C.2.5 Reflectance Factors

C.2.5.1 *Reflectance* factors used in the simulation shall be based on manufacturer's product *reflectance* data and be the same for the final finishes of the *building*. If manufacturer's data is not available, it is permitted to use the values in:

a) For interior surfaces finishes, Table C.2.5.1A; and

b) For other typical New Zealand building finishes, Table C.2.5.1B.

TABLE C.2.5.1A: Acceptable reflectance for interior surface finishes

Paragraph C.2.5.1 a)

Reflectance level required	Minimum surface reflectance		
	Ceilings	Walls (1)	Floor
Medium *reflectance*	0.7	0.4	0.2
High *reflectance*	0.7	0.6	0.4

Note:

(1) Does not include windows

TABLE C.2.5.1B: Approximate reflectance of typical New Zealand building finishes reproduced from NZS 6703

Paragraph C.2.5.1 b)

Building finish	Approximate reflectance	Building finish	Approximate reflectance
White emulsion paint on plain plaster surface White glazed tiles	0.8	Fibre cement sheet Portland cement (smooth) Natural particle board	0.4
White emulsion paint on acoustic tile	0.7	Natural rimu (dressed) Varnished Pinus radiata(1)	0.3
White emulsion paint on no-fines concrete	0.6	Concrete (light grey) Portland cement (rough) Natural mahogany (dressed) Varnished particle board	0.25
Natural pine plywood	0.55	Varnished rimu (dressed)(1) Varnished mahogany (dressed)(1)	0.15
White emulsion paint on wood-wool slab	0.5		
Varnished pine plywood(1) Natural Pinus radiata	0.45	Quarry tiles: Red, heather brown	0.1

Note:

(1) Typical varnishing would be two coats of clear gloss polyurethane varnish.

C.3 Climate based daylight modelling

C.3.1 Modelling software requirements

C.3.3.1 The computer modelling software used for *climate based daylight modelling* must be validated in accordance with CIE 171: 2006.

C.3.3.2 The computer modelling software shall use sky luminance based on either the CIE 110: 1994 Overcast Sky, or the Perez All-Weather Sky Model. International Weather for Energy Calculation (IWEC) data for the closest weather station shall be used as an input to the software.

C.3.2 Weather data

C.3.2.1 Weather data shall be derived from a weather station that best represents where the *building* is located and shall represent an average year for the site over at least a 10-year period. Weather data is available online in digital form from the National Institute for Water and Atmospheric Research (NIWA).

C.3.3 Time step

C.3.3.1 *Illuminance* values shall be calculated at a minimum for each hour between 8 am and 5 pm and at a minimum for the 21st day of each month of the *standard year*.

C.3.4 Calculation grids

C.3.4.1 *Illuminance* calculation grid placement shall be applied in accordance with AS/NZS 1680.1: 2006 Appendix B2 “Calculation Grids”. Where an interior *habitable space* is less than 2000 mm in width, a single line of calculation points shall be placed centrally in the area to be calculated.

C.4 Daylight factor

C.4.1 Modelling software requirements

C.4.1.1 The computer modelling software shall use sky luminance based on the CIE 110: 1994 Overcast Sky.

C.4.2 Calculation grids

C.4.2.1 *Daylight factor* calculation grid placement shall be applied in accordance with AS/NZS 1680.1: 2006 Appendix B2 “Calculation Grids”. Where an interior *habitable space* is less than 2000 mm in width, a single line of calculation points shall be placed centrally in the area to be calculated.

C.4.3 Minimum daylight factor calculation

C.4.3.1 Minimum *daylight factor (DF)* is calculated as:

Equation 1: $$DF = \left(\frac{30 \text{ lux} \times 100}{\text{External Skylight Illuminance (lux) for 75\% of the Standard Year}} \right)$$

where:
DF is the minimum *daylight factor* (%); and
External *skylight illuminance* is measured in lux (Refer to Table 9.1 of AS/NZS 1680.1: 2006).

C.5 Documentation

C.5.1 Documentation of analysis

C.5.1.1 Documentation of computer modelling analysis shall contain:

a) The name of the modeller; and

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

c) A list of inputs used in the model; and

d) Technical detail on the proposed *building* design; and

e) The results of the analysis to demonstrate compliance with G7/VM2.

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BP 6430

Appendix C. Draft Verification Method E2/VM2

As part of Proposal 5, there is a new draft edition proposed for Verification Method E2/VM2 Cladding systems for buildings up to 25 m in height – including junctions with windows, door and other penetrations.

BUILDING PERFORMANCE

E2

E2 External Moisture

Verification Method E2/VM2

Cladding systems for buildings up to 25 m in height – including junctions with windows, door and other penetrations

DRAFT FOR PUBLIC CONSULTATION

SECOND EDITION | EFFECTIVE XX XXXX XXXX

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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New Zealand Government

Preface

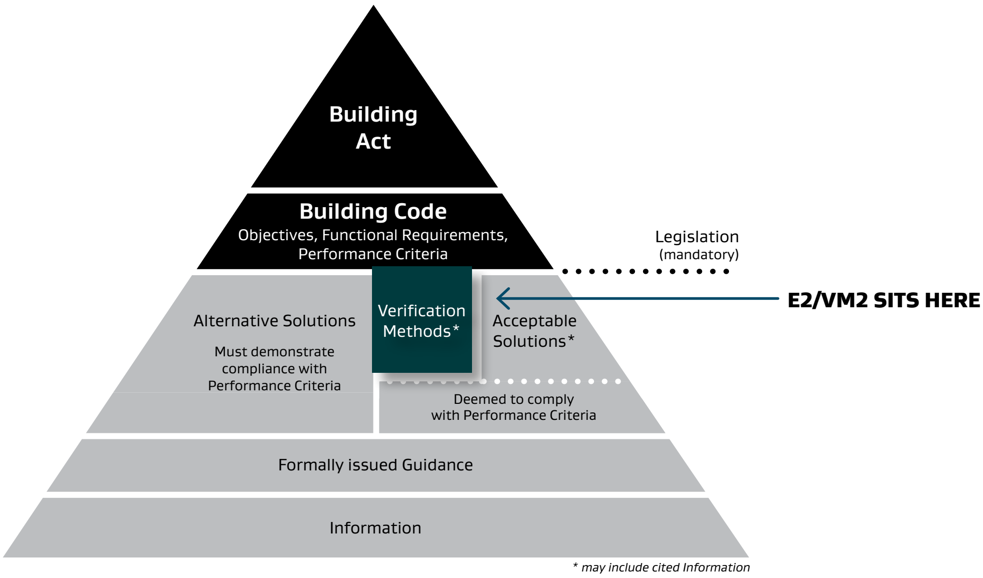
Document status

This document (E2/VM2) is a verification method issued under section 22 (1) of the Building Act 2004 and is effective from X XXXXXXXX XXXX. It does not apply to building consent applications submitted before X XXXXXXXX XXXX. The previous Verification Method E2/VM2 can be used to show compliance until X XXXXXXXX XXXX and can be used for building consent applications submitted before X XXXXXXXX XXXX.

Building Code regulatory system

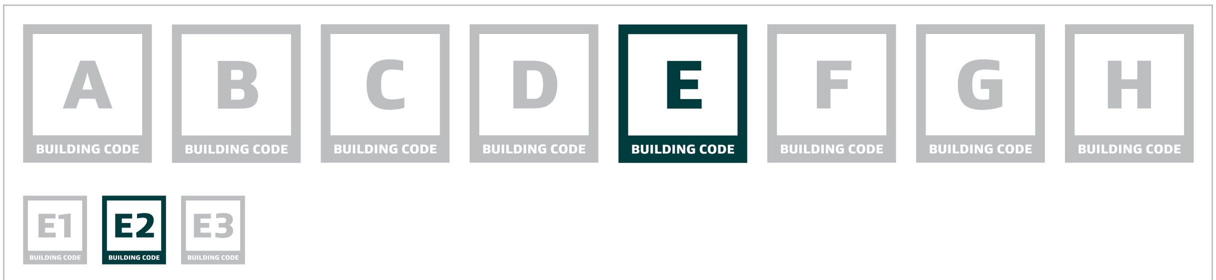
Each verification method outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method are ways of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

Schematic of the Building Code System



A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this verification method relates to is clause E Moisture and specifically E2 External moisture. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This is the second edition of E2/VM2. The main changes from the previous version are:

- The document layout has been revised to improve clarity with additional information on the document and its scope provided in Part 1. General.
- Reference to the BRANZ EM7 test method for evaluating *cladding* performance has been amended to the most recent version of the document (version 3) in Appendix A.
- The new edition allows *cladding systems* that have already demonstrated compliance under the previous edition to be used without retesting as stated in Part 2. Cladding systems.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any verification method or acceptable solution at any time. Up-to-date versions of verification methods and acceptable solutions are available from www.building.govt.nz

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 E2/VM2 is a means of testing and demonstrating that a wall *cladding system* will prevent the penetration of water to the extent required by clause E2.3.2 of the Building Code.

1.1.1.2 E2/VM2 applies to buildings that fit within the scope of BRANZ EM7.

> COMMENT: BRANZ EM7 applies to buildings of certain height, forms of construction and structural behaviour. It also has limitations on Inter-storey deflections and peak positive wind pressures on the *cladding system*. Building consent authorities should accept building consent applications from designers who can demonstrate that the building in the application falls within those limitations. BRANZ EM7 does not have any limits on the negative pressure on the *cladding system*.

1.1.2 Items outside the scope of this document

1.1.2.1 E2/VM2 does not demonstrate the water penetration resistance of window and exterior door units used with the wall *cladding system*.

> COMMENT: E2/VM2 assesses the junctions of window and exterior door units with other elements of the *cladding system*, but not the units themselves. Instead it relies on the units having been manufactured to resist water penetration when subject to the relevant design parameters for the building.
>
> Although there is currently no verification method or acceptable solution for the window and exterior door units for mid-rise buildings, window suppliers may be able to demonstrate, through testing, water penetration resistance of the windows when subject to:
>
> › Peak positive and peak negative wind pressures acting on the window or exterior door unit (typically calculated in accordance with AS/NZS 1170.2 including all local pressure factors and internal pressures relevant to the location of the window on the building); and
> › The maximum in-plane horizontal movement to which the window or exterior door could be subject.

1.1.2.2 E2/VM2 does not advise quality assurance or inspection procedures to be followed during construction.

> COMMENT: As with other building work, a building consent authority should approve appropriate inspection procedures when issuing a building consent for *cladding systems* whose compliance is based on E2/VM2.

1.1.3 Compliance pathway

1.1.3.1 This verification method is one option that provides a means of establishing compliance with Building Code clause E2.3.2.

> COMMENT: Building Code clause E2.3.2 is reproduced below:
>
> E2.3.2 Roofs and exterior walls must prevent the penetration of water that could cause undue dampness, damage to building elements, or both.

1.1.3.2 Options for demonstrating compliance with the performance criteria of Building Code clause E2 External Moisture through the acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

> COMMENT: In addition to demonstrating that the requirements of this Verification Method are met, its users will need to identify how the building work addresses the following requirements of clause E2:
>
> › Requirements for roof *cladding systems,* including requirements for shedding water (E2.3.1) and water penetration (E2.3.2).
> › Requirements to address moisture absorbed or transmitted due to ground contact or proximity (E2.3.3).
> › Requirements to address the effects of moisture in subfloor spaces (E2.3.4).
> › Requirements to prevent moisture problems in concealed spaces (E2.3.5).
> › Requirements to address construction moisture (E2.3.6).
> › Requirements to make due allowances for consequences, uncertainties and variations (E2.3.7)

> COMMENT: Other Building Code clauses may be relevant to the cladding system in addition to clause E2, including clauses:
>
> › B1 Structure (for the *cladding system* as well as the building's primary structure)
> › B2 Durability
> › C1 – C6 Protection from fire
> › E3 Internal moisture
> › F2 Hazardous building materials
> › G6 Airborne and impact sound
> › H1 Energy efficiency
>
> Technical information provided by the suppliers of wall *cladding systems* should include information that explains how compliance can be achieved.
>
> Building Consent Authorities should accept building consent applications from designers who can demonstrate that the requirements of all relevant Building Code clauses have been integrated into the design proposal for a *cladding system.*

TABLE 1.1.3.2: Demonstrating compliance with E2 External Moisture through acceptable solutions and verification methods
Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
E2.3.1 Shedding water	All roofs, except for buildings where external moisture is unlikely to cause significant impairment	For timber framed buildings up to 3 storeys, within specific limitations: E2/AS1. For single- and two-storey concrete roofs and decks with membranes, within specific limitations: E2/AS3. For light steel framed buildings up to 3 storeys, within specific limitations: E2/AS4.
E2.3.2 Penetration of water	All roofs and exterior walls, except for buildings where external moisture is unlikely to cause significant impairment	For wall *cladding systems* of timber framed buildings up to 3 storeys, within specific limitations: E2/VM1 Paragraph 1.0. For pitched roofing systems above a roof space, within specific limitations: E2/VM1 Paragraph 2.0. For wall *cladding systems* of buildings up to 25 m in height, within specific limitations: E2/VM2. For timber framed buildings up to 3 storeys, within specific limitations: E2/AS1. For earth building within specific limitations: E2/AS2 For single- and two-storey concrete and concrete masonry construction within specific limitations: E2/AS3. For light steel framed buildings up to 3 storeys, within specific limitations: E2/AS4.
E2.3.3 Ground contact or proximity	All walls, floors and structural elements in ground contact or proximity, except for buildings where external moisture is unlikely to cause significant impairment	For timber framed buildings up to 3 storeys, within specific limitations: E2/AS1. For earth building within specific limitations: E2/AS2 For single- and two-storey concrete and concrete masonry construction within specific limitations: E2/AS3. For light steel framed buildings up to 3 storeys, within specific limitations: E2/AS4.
E2.3.4 Suspended floors	All building elements susceptible to damage, except for buildings where external moisture is unlikely to cause significant impairment	For timber framed buildings up to 3 storeys, within specific limitations: E2/AS1. For earth building within specific limitations: E2/AS2 For single- and two-storey concrete and concrete masonry construction within specific limitations: E2/AS3. For light steel framed buildings up to 3 storeys, within specific limitations: E2/AS4.

Performance clause	Applies to	Relevant acceptable solutions and verification methods
E2.3.5 Concealed spaces and cavities	Building elements associated with concealed elements and cavities, except for buildings where external moisture is unlikely to cause significant impairment	For timber framed buildings up to 3 storeys, within specific limitations: E2/AS1. For earth building within specific limitations: E2/AS2 For single- and two-storey concrete and concrete masonry construction within specific limitations: E2/AS3. For light steel framed buildings up to 3 storeys, within specific limitations: E2/AS4.
E2.3.6 Construction moisture	All building elements, except for buildings where external moisture is unlikely to cause significant impairment	For timber framed buildings up to 3 storeys, within specific limitations: E2/AS1. For earth building within specific limitations: E2/AS2 For single- and two-storey concrete and concrete masonry construction within specific limitations: E2/AS3. For light steel framed buildings up to 3 storeys, within specific limitations: E2/AS4.
E2.3.7 Due allowances	All building elements. except for buildings where external moisture is unlikely to cause significant impairment	For timber framed buildings up to 3 storeys, within specific limitations: E2/AS1. For earth building within specific limitations: E2/AS2 For single- and two-storey concrete and concrete masonry construction within specific limitations: E2/AS3. For light steel framed buildings up to 3 storeys, within specific limitations: E2/AS4.

1.2 Using this verification method

1.2.1 Features of this document

1.2.1.1 For the purposes of Building Code compliance, the standards and documents referenced in this verification method must be the editions, along with their specific amendments listed in Appendix A.

1.2.1.2 Words in *italics* are defined at the end of this document in Appendix B.

1.2.1.3 Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.

1.2.1.4 Appendices to this verification method are part of, and have equal status to, the verification method. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Part 2. Cladding systems

2.1 Test specifications

2.1.1 Demonstrating compliance

2.1.1.1 BRANZ EM7 is a means of demonstrating that a wall *cladding system* meets the performance requirements of Building Code clause E2.3.2.

> COMMENT: BRANZ EM7 prescribes a series of tests from AS/NZS 4284:2008 with specific nominated values for the performance levels.

2.1.1.2 E2/VM2 testing must be carried out by a facility that has IANZ or equivalent accreditation for AS/NZS 4284:2008 testing procedures.

2.1.2 Existing verification certificates

2.1.2.1 Wall *cladding systems* that meet the requirements of the previous version of E2/VM2, and for which the test certificate was issued during the period in which that version of E2/VM2 was in force, meet the performance requirements of Building Code clause E2.3.2.

2.1.2.2 Any verification certificates issued under E2/VM2 from X XXXXXXXXX XXXX must be under E2/VM2 Second Edition.

> COMMENT: Retesting is not required for *wall cladding* systems which have already passed testing in accordance with the previous version of E2/VM2.

Appendix A. References

For the purposes of Building Code compliance, the standards and documents referenced in this verification method must be the editions, along with their specific amendments, listed below.

Standards New Zealand		**Where quoted**
AS/NZS 4284: 2008	Testing of building facades	2.1.1.2

This standard can be accessed from www.standards.govt.nz

BRANZ		
BRANZ EM7 [version 3, June 2020]	Evaluation Method 7 – Performance of mid-rise cladding systems	1.1.1.2, 2.1.1.1

This document can be accessed from www.branz.co.nz

Appendix B. Definitions

Cladding	The exterior weather-resistant surface of a building. It includes any supporting substrate and, if applicable, surface treatment.
Cladding system	The outside or exterior weather-resistant surface of a building; including roof *cladding* and roof underlays, wall *cladding* and wall underlays, and cavity components, rooflights, windows, doors and all penetrations, flashings, seals, joints and junctions. This verification method requires the *cladding system* to include a drained cavity.

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