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BULLETIN

H1 CALCULATION METHOD – HOUSING, AND BUILDINGS UP TO 300 M²

October 2022

- Compliance can be shown for housing, and buildings up to 300 m² with New Zealand Building Code clause H1 *Energy efficiency* by using the 5th edition amendment 1 of Acceptable Solution H1/AS1 or Verification Method H1/VM1.
- With the schedule method of H1/AS1 5th edition amendment 1 becoming more restrictive, it is expected that the calculation method will be increasingly used.
- This bulletin provides an overview of the calculation method of H1/AS1 5th edition amendment 1. It updates and replaces Bulletin 613 *NZS 4218:2009 calculation method*.

1 INTRODUCTION

1.0.1 The 5th edition amendment 1 of H1/AS1 became effective from 4 August 2022.

1.0.2 From 3 November 2022, the 4th edition of H1/AS1 can not be used to show compliance.

1.0.3 NZS 4218:2009 *Thermal insulation – Housing and small buildings* is not cited in the revised H1/AS1, so from 3 November 2022, this standard is not needed.

1.0.4 With the new H1 documents, the climate zones have been modified. There are now six climate zones that (except for Waitaki and Rangitikei) align with the territorial authority boundaries. See Appendix C in H1/AS1 for the list.

1.0.5 The higher insulation requirements for H1/AS1 are being phased in over a number of stages:

- From 3 November 2022, window, skylight and door insulation requirements are increased to an intermediate level. Insulation levels for roof, walls and floors for buildings other than housing will increase to their finalised levels. However, for housing, the insulation levels for roof, walls and floors will be essentially held at the 4th edition levels for a period of 6 months.
- From 1 May 2023, roof, wall, floor and skylight insulation requirements for housing will be set at their finalised level with finalised levels for window and door requirements for climate zones 3–6 coming into force.
- From 2 November 2023, the finalised increase in window and door requirements for climate zones 1 and 2 will take place.

1.0.6 This bulletin outlines the steps to follow when using the calculation method of H1/AS1 5th edition amendment 1. For full details of the new requirements, refer to MBIE's Building Performance website www.building.govt.nz/building-code-compliance/h-energy-efficiency.

1.0.7 This bulletin updates and replaces Bulletin 613 *NZS 4218:2009 calculation method*.

2 FLEXIBILITY OF THE CALCULATION METHOD

2.0.1 Under the calculation method, designers work out the total heat loss of the proposed building from all the areas and construction R-values for the proposed building.

2.0.2 Heat loss calculations are also done for a reference building, which is a design with similar areas but with set values for the R-values.

2.0.3 If the proposed building's heat loss is less than or equal to that of the reference building, the proposed building will comply with H1/AS1. Otherwise, the designer can amend the construction R-values or design of the proposed building until the calculated heat loss of the proposed building is less than or equal to the heat loss of the reference building.

2.0.4 The calculation method offers flexibility for designers:

- It allows glazing up to 40% of the total wall area.
- Different combinations of insulation in the roof, walls, floors and glazing may be used than those listed in the schedule method.

2.0.5 The calculation method can be used for designs outside the scope of the schedule method, such as when:

- the total glazed area of the building is more than 30% (but less than 40%) of the total wall area
- the combined area of glazing on the west, east and south-facing walls is more than 30% of the total wall area of these walls
- the skylight area is larger than the greater of 1.5% of the total roof area or 1.5 m²
- the opaque door area is larger than the greater of 6% of the total wall area or 6 m²
- the building contains decorative glazing or other glazing with a low construction R-value.

2.0.6 For buildings with areas of glazing above 40% of the wall area, designers need to use the modeling method outlined in H1/VM1 5th edition amendment 1 to show that the design complies with H1.

3 CALCULATING CONSTRUCTION R-VALUES

3.0.1 The calculation method uses construction R-values determined for all of the building elements making up the thermal envelope of the building.

3.0.2 H1/AS1 details how these various construction R-values need to be calculated:

- Windows, doors and skylights are discussed in Appendix E.
- Slab-on-ground floors are discussed in Appendix F.
- Walls, roofs and floors other than slab-on-ground floors are calculated using NZS 4214:2006 *Methods of determining the total thermal resistance of parts of buildings*.

3.0.3 Other methods to calculate slab-on-ground floor construction R-values are not permitted under H1/AS1 5th edition amendment 1.

3.0.4 Guidance for windows and doors is given in BRANZ Bulletin 670 *Specifying windows and doors under H1* while floors are discussed in BRANZ Bulletin 672 *Specifying floors under H1*.

3.0.5 The 6th edition of the BRANZ *House insulation guide* provides construction R-values for a range of common forms of building insulation and construction. It allows designers to easily determine the construction R-value of the assemblies incorporated in the thermal envelope of the proposed building. The BRANZ *House insulation guide* is available in digital format as an Excel spreadsheet, which provides more flexibility than earlier hardcopy editions.

4 PROPOSED BUILDING HEAT LOSS CALCULATION

4.0.1 The heat loss through a building element is calculated by dividing the area of the building element by its construction R-value. For example:

- the heat loss from a wall that is 66 m² with a construction R-value of R2.6 is 25.3 W/K (66 ÷ 2.6)
- the heat loss from 40 m² of double glazing with an R-value of R0.37 is 108.1 W/K (40 ÷ 0.37).

4.0.2 The heat loss through multiple building elements is calculated by combining the heat loss through each of the elements separately.

4.0.3 The heat loss for a proposed building ($HL_{proposed}$) in H1/AS1 5th edition amendment 1 should follow the format below, replacing the areas and construction R-values with the actual values for the proposed building.

$$HL_{proposed} = \frac{A_{roof}}{R_{roof}} + \frac{A_{wall}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{glazing}}{R_{glazing}} + \frac{A_{door,\ opaque}}{R_{door,\ opaque}} + \frac{A_{skylight}}{R_{skylight}}$$

4.0.4 Where a proposed building element is constructed with different parts with different R-values, the relevant term in the $HL_{proposed}$ equation should be split into separate parts. For example:

$$\frac{A_{wall}}{R_{wall}} \text{ becomes } \frac{A_{wall[1]}}{R_{wall[1]}} + \frac{A_{wall[2]}}{R_{wall[2]}}$$

5 REFERENCE BUILDING HEAT LOSS CALCULATION

5.0.1 The heat loss equations for the reference building follows the general form

$$HL_{reference} = \frac{A_{roof} + A_{skylight}}{R_1} + \frac{A_{70\%\ of\ the\ total\ wall\ area}}{R_2} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{R_3} + \frac{A_{other\ floor}}{R_4} + \frac{A_{30\%\ of\ total\ wall\ area}}{R_5}$$

where the construction R-values R_1–R_5 have prescribed values set out in H1/AS1 5th edition amendment 1.

5.0.2 These prescribed construction R-values vary depending on the climate zone the proposed building is located within but also change over time until H1/AS1 is finalised.

5.0.3 In colder climates, the temperature difference between indoors and outdoors will be larger so higher values are used for the prescribed construction R-values to limit overall heat loss from the proposed building.

5.0.4 Points to note when doing reference building calculations:

- Separate calculations are made for slab-on-ground floors and for other floor types.
- Skylights are not considered separately and are added to the roof area.
- Windows, the glazed part of doors and non-opaque door areas are not specifically identified – 30% of the total wall area is set to a concessionary level to account for these elements.

5.0.5 Through reference to NZS 4218:2009 Appendix A, the 4th edition of H1 provided guidance on determining areas based on the use of internal dimensions. H1/AS1 5th edition amendment 1 no longer refers to NZS 4218:2009. However, the tables for the thermal resistance of slab-on-ground floors in H1/AS1 5th edition are based on internal dimensions (floor area). BRANZ strongly recommends the continued use of internal dimensions for all construction elements. The BRANZ *House insulation guide* and the BRANZ calculation method tools are based on internal dimensions.

6 UNDERTAKING THE CALCULATION METHOD

6.0.1 The H1 Energy Efficiency Support page on the BRANZ website [www.branz.co.nz/H1_support] provides links to Excel spreadsheet tools that automate the process of undertaking the calculation method for a proposed building. These tools allow for the areas and construction R-values to be entered so that the heat loss from the proposed building can be determined. The spreadsheets then calculate the appropriate reference building heat loss for the selected climate zone and compliance with H1/AS1 5th edition amendment 1.

6.0.2 Fishhooks to consider when using the calculation method:

- Ensure the correct reference building heat loss equations are used. Changes in insulation requirements take place on 3 November 2022, 1 May 2023 and 2 November 2023.
- The construction R-value of roofs, walls and floors in the proposed building must be at least 50% of the R-value for that component in the reference building.
- Construction R-values in the proposed building cannot be less than the R-values required to comply with clause E3.
- Where the construction R-value is not known, use R0.18 as a default for opaque elements and R0.15 for glazing.
- When building elements contain embedded heating, the minimum construction R-value for that element is to be determined through the schedule method and cannot be reduced by trade-offs within the calculation method.

6.1 EXAMPLES USING THE CALCULATION METHOD

6.1.1 The worked examples at the end of this bulletin show a number of uses of the calculation method.

6.1.2 Example 1a is a calculation for a 180 m² house to be constructed in Christchurch (climate zone 5). The date of this is expected to be after 1 May 2023 when the complete insulation changes apply for Christchurch. The construction R-values for the proposed building are close to the construction R-values for the reference building. One feature of the proposed building is a 1.9 m² entrance door. As the R-value of this door is presumed to be unknown, the construction R-value for the door is taken as R0.18.

6.1.3 Example 1b modifies this design by changing half of the pitched roof (R6.6) to a skillion roof (R3.3). In addition to the reduced R-value the skillion roof imposes, the skillion roof also increases the area of the roof as well as increasing the area of walls bordering the room covered by the skillion roof. With the increase in surface areas in the room covered by the skillion roof, an additional 5 m² of windows were added to the design as were 3 m² of skylights. To balance out the increased heat

loss from these actions, two contrasting approaches to improving the performance of the building are used. One approach is to make a small increase in the construction R-value of a large element (in this case, the raft floor). The change illustrated would represent an improvement such as adding edge insulation to the raft floor (increasing the construction R-value from R1.7 to R1.9). The other approach would be to increase the construction R-value for a building element more significantly. The example for this approach is to make an improvement to the entrance door from using a generic value of R0.18 to use a much higher value of R0.40. These two approaches both contribute to balancing out the additional heat loss introduced from the skillion roof and additional glazing.

6.1.4 Example 2 is for a Whangārei (climate zone 1) house built after the final updates to H1/AS1 5th edition amendment 1 take place from 3 November 2023. Buildings in Northland have previously used BRANZ (Annual Loss Factor) ALF to provide for single-glazed windows within the design. This example looks to examine the opportunity to relax the glazing R-value requirements. To examine these issues, it is convenient to use electronic versions of the calculation method so that multiple calculations can be made relatively quickly and the design optimised. The house is 192 m² with higher R-values for the suspended timber floor, the walls and the roof to allow for the concessionary performance of the glazing. The glazing area is set to 40 m² (26% of the total wall area). Setting all of this 40 m² glazing to a double-glazed basic aluminium-framed window (R0.26) results in a non-compliant design. After some experimentation, changing 25 m² of the window area to a well-performing low-E coated double-glazed unit with an argon fill in a basic aluminium frame (R0.37) resulted in a design that meets the H1/AS1 requirements.

6.1.5 Example 3 is for an improved performance design for a house in Auckland. The floor area of the design is 122.4 m². The design specifies a well-insulated slab floor (R2.8), 140 mm thick external walls (R2.9), a pitched roof with insulation covering the joists and double glazing with a good performance low-E coating, argon fill in a thermally broken aluminium window frame. This house has a low heat loss value, which is more apparent when comparing with the other example proposed houses rather than with the reference building for this design.

7 FURTHER INFORMATION

Ministry of Business, Innovation and Employment (MBIE)

H1 Energy Efficiency, Acceptable Solution H1/AS1 Energy efficiency for all housing, and buildings up to 300 m², 5th Edition Amendment 1.

H1 Energy Efficiency, Verification Method H1/VM1 Energy efficiency for all housing, and buildings up to 300 m², 5th Edition Amendment 1.

www.building.govt.nz/building-code-compliance/h-energy-efficiency/h1-energy-efficiency/

Standards New Zealand

NZS 4214:2006 *Methods of determining the total thermal resistance of parts of buildings*

NZS 4246: 2016 *Energy efficiency – Installing bulk thermal insulation in residential buildings*

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House insulation guide (6th edition)

Bulletin 676 *Complying with H1 – housing and buildings up to 300 m²*

Bulletin 670 *Specifying windows and doors under H1*

Bulletin 672 *Specifying floors under H1*

www.branz.co.nz/H1_support – H1 *Energy efficiency* support

www.level.org.nz – BRANZ website on sustainable construction

Example 1a. Christchurch – zone 5	
Reference/proposed building heat loss (HL) calculation	
Date	After November 2023
Proposed building dimension	15 m long x 12 m wide x 2.4 m stud
Floor area	180 m²
Roof area	180 m²
Roof glazing area (skylights)	0 m²
Perimeter	(15 x 2) + (12 x 2) = 54 m
Total wall area	(54 x 2.4) = 129.6 m²
Glazing area including door glazing	35.0 m²
% glazing to total wall area	35.0/129.6 = 27.0%
Opaque door area	1.9 m² entrance door
Actual wall area	129.6 – 35.0 – 1.9 = 92.7 m²
Proposed calculation (proposed R-values)	
HL proposed	$HL_{proposed} = \frac{A_{roof}}{R_{roof}} + \frac{A_{wall}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{glazing}}{R_{glazing}} + \frac{A_{door,\ opaque}}{R_{door,\ opaque}} + \frac{A_{skylight}}{R_{skylight}}$ $= \frac{180.0}{6.6} + \frac{92.7}{1.9} + \frac{180.0}{1.7} + \frac{35.0}{0.50} + \frac{1.9}{0.18} + 0$ $= 27.3 + 48.8 + 105.9 + 70.0 + 10.6 + 0$ $= 262.6$
The heat loss is 262.6 W/K for the proposed building.	
Reference building calculation	
HL reference	$HL_{reference} = \frac{A_{roof}+A_{skylight}}{6.6} + \frac{A_{70\%\ of\ the\ total\ wall\ area}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.6} + \frac{A_{other\ floor}}{3.0} + \frac{A_{30\%\ of\ total\ wall\ area}}{0.50}$ $= \frac{180.0}{6.6} + \frac{90.7}{2.0} + \frac{180.0}{1.6} + \frac{0}{3.0} + \frac{38.9}{0.50}$ $= 27.3 + 45.4 + 112.5 + 0 + 77.8$ $= 263.0$
The heat loss is 263.0 W/K for the reference building. The heat loss of 262.6 W/K for the proposed building is less than the heat loss of 263.0 W/K for the reference building, so the proposed construction complies.	

Example 1b. Christchurch – zone 5 – modified for skillion roof	
Reference/proposed building heat loss (HL) calculation	
Date	After November 2023
Proposed building dimension	15 m long x 12 m wide x 2.4 m stud
Floor area	180 m² (now with edge insulation)
Roof area	90 m² pitched roof (R6.6) + 100.9 m² skillion roof (R3.3)
Roof glazing area (skylights)	3 m² (R0.37)
Perimeter	(15 x 2) + (12 x 2) = 54 m
Total wall area	129.6 + 20.8 (both R.1.9) + 20.8 (R1.7) wall between living space and roof space = 171.2 m²
Glazing area including door glazing	35.0 + 5.0 = 40.0 m²
% glazing to total wall area	40.0 / 171.2 = 23.4 % (less than 40% so can use calculation method)
Opaque door area	1.9 m² entrance door (now improved to R.40)
Proposed calculation (proposed R-values)	
HL proposed	$HL_{proposed} = \frac{A_{roof}}{R_{roof}} + \frac{A_{skillion}}{R_{skillion}} + \frac{A_{wall1}}{R_{wall1}} + \frac{A_{wall2}}{R_{wall2}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{glazing}}{R_{glazing}} + \frac{A_{door}}{R_{door}} + \frac{A_{skylight}}{R_{skylight}}$ $= \frac{90.0}{6.6} + \frac{100.9}{3.3} + \frac{108.5}{1.9} + \frac{20.8}{1.7} + \frac{180.0}{1.9} + \frac{40.0}{0.50} + \frac{1.9}{0.40} + \frac{3.0}{0.37}$ $= 13.6 + 30.6 + 57.1 + 12.2 + 94.7 + 80.0 + 4.8 + 8.1$ $= 301.1$
The heat loss is 301.1 W/K for the proposed building.	
Reference building calculation	
HL reference	$HL_{reference} = \frac{A_{roof}+A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.6} + \frac{A_{other\ floor}}{3.0} + \frac{A_{30\% \text{ of total wall area}}}{0.50}$ $= \frac{193.9}{6.6} + \frac{119.8}{2.0} + \frac{180.0}{1.6} + \frac{0}{3.0} + \frac{51.4}{0.50}$ $= 29.4 + 59.9 + 112.5 + 0 + 102.7$ $= 304.5$
The heat loss is 304.5 W/K for the reference building. The heat loss of 301.1 W/K for the proposed building is less than the heat loss of 304.5 W/K for the reference building, so the proposed construction complies.	

Example 2. Whangārei - zone 1 - exploring lower requirements for glazing	
Reference/proposed building heat loss (HL) calculation	
Proposed building dimension	24 m long x 8 m wide x 2.4 m stud
Total wall area	(24 x 2 x 2.4) + (8 x 2 x 2.4) = 153.6 m²
Floor	192 m² (R3.4)
Roof	192 m² (R7.0)
Roof glazing area (skylights)	0
Glazing area including door glazing	25 m² (R0.37) 15 m² (R.26)
% glazing to wall area	40/153.6 = 26.0%
Actual wall area	153.6 – 40 = 113.6 m²
Proposed calculation (proposed R-values)	
HL proposed	$HL_{proposed} = \frac{A_{roof}}{R_{roof}} + \frac{A_{wall}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{glazing1}}{R_{glazing1}} + \frac{A_{glazing2}}{R_{glazing2}}$ $= \frac{192.0}{7.0} + \frac{113.6}{2.5} + \frac{192.0}{3.4} + \frac{25.0}{0.37} + \frac{15.0}{026}$ $= 27.4 + 45.4 + 56.5 + 67.6 + 57.7$ $= 254.6$
The heat loss is 254.6 W/K for the proposed building.	
Reference heat loss calculation	
HL reference	$HL_{reference} = \frac{A_{roof}+A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.5} + \frac{A_{other\ floor}}{2.5} + \frac{A_{30\% \text{ of total wall area}}}{0.46}$ $= \frac{192.0}{6.6} + \frac{107.5}{2.0} + \frac{0}{1.5} + \frac{192.0}{2.5} + \frac{40.0}{0.46}$ $= 29.1 + 53.8 + 0 + 76.8 + 100.2$ $= 259.9$
The heat loss is 259.9 W/K for the reference building. The heat loss of 254.6 W/K for the proposed building is less than the heat loss of 259.9 W/K for the reference building, so the proposed construction complies.	

Example 3. Auckland – zone 1 – better performance	
Reference/proposed building heat loss (HL) calculation	
Proposed building dimension	17 m long x 7.2 m wide x 2.4 m stud
Total wall area	(17 x 2 x 2.4) + (7.2 x 2 x 2.4) = 116.2 m²
Floor area	122.4 m² insulated slab (R2.8)
Roof area	122.4 m² (R7.5)
Roof glazing area (skylights)	0
Glazing area including door glazing	26 m² reduced area of glazing (R0.50)
% glazing to wall area	26/116.2 = 22.4
Actual wall area	116.2 – 26 = 90.2 m²
Proposed calculation (proposed R-values)	
HL proposed	$HL_{proposed} = \frac{A_{roof}}{R_{roof}} + \frac{A_{wall}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{glazing}}{R_{glazing}}$ $= \frac{122.4}{7.5} + \frac{90.2}{2.5} + \frac{122.4}{2.8} + \frac{26.0}{0.50}$ $= 16.3 + 36.1 + 43.7 + 52.0$ $= 148.1$
The heat loss is 148.1 W/K for the proposed building.	
Reference heat loss calculation	
HL reference	$HL_{reference} = \frac{A_{roof}+A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.5} + \frac{A_{other\ floor}}{2.5} + \frac{A_{30\% \text{ of total wall area}}}{0.46}$ $= \frac{122.4}{6.6} + \frac{81.3}{2.0} + \frac{122.4}{1.5} + \frac{0}{2.5} + \frac{34.9}{0.46}$ $= 18.5 + 40.7 + 0 + 81.6 + 75.8$ $= 216.6$
The heat loss is 216.6 W/K for the reference building. The heat loss of 148.1 W/K for the proposed building is less than the heat loss of 216.6 W/K for the reference building, so the proposed construction complies.	

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HEAD OFFICE AND RESEARCH STATION
1222 Moonshine Road, Judgeford, Porirua, New Zealand
Private Bag 50 908, Porirua 5240, New Zealand
Telephone 04 237 1170 - Fax 04 237 1171
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