

G7 Natural Light

Acceptable Solution G7/AS2

**Natural Light for simple buildings
excluding those with borrowed daylight**

FIRST EDITION | EFFECTIVE 29 NOVEMBER 2021



Preface

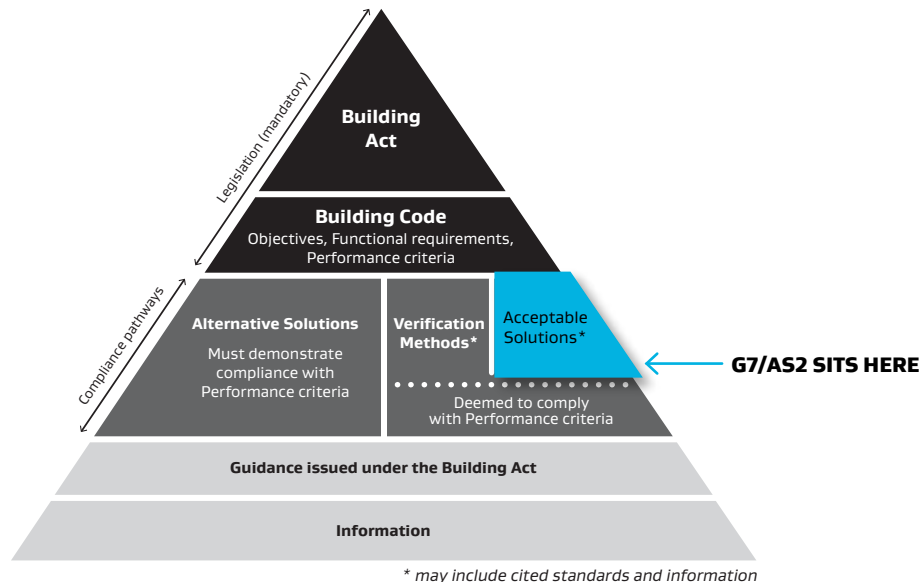
Document status

This document (G7/AS2) is an acceptable solution issued under section 22 (1) of the Building Act 2004 and is effective on 29 November 2021. It does not apply to building consent applications submitted before 29 November 2021. The previous Acceptable Solution G7/AS1 First Edition Amendment 2 can be used to show compliance until 2 November 2022 and can be used for building consent applications submitted before 3 November 2022.

Building Code regulatory system

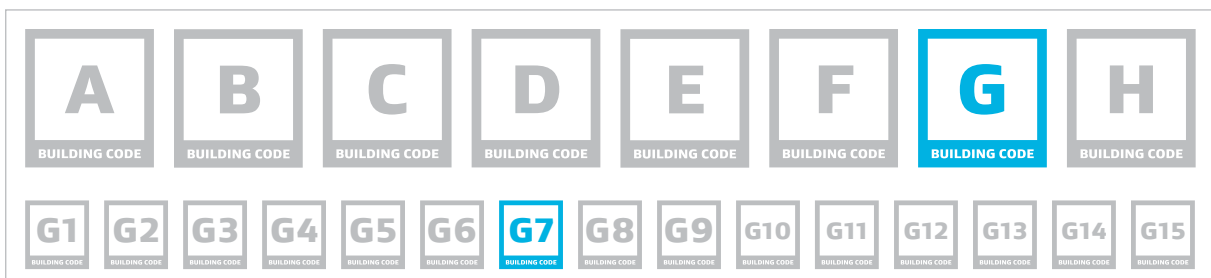
Each acceptable solution outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method is a way of complying with that part of the Building Code. Other options for establishing compliance are listed in [section 19 of the Building Act](#).

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, acknowledgements, and features of this document

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 Method G7/VM1. 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/VM1).
- › 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.

Features of this document

- › There are no standards or other documents referenced in this acceptable solution in [Appendix A](#).
- › Words in *italic* are defined at the end of this document in [Appendix B](#).
- › Hyperlinks are provided to cross-references within this document and to external websites and appear with a [blue underline](#).
- › Classified uses for buildings, as described in clause A1 of the Building Code, are printed in **bold** in this document.
- › 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.

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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) Vertical windows in *external walls* that can be described by a *glazing-to-wall ratio (GWR)*; and
- c) Typical room heights (2.4 m to 3.0 m); and
- d) Vertical windows with a glazing *visible light transmittance (VLT)*; and
- e) No shading from overhangs or with simple horizontal overhangs.



COMMENT: Old people's homes includes 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 at least one window in external walls; 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.



COMMENT: For example, a simple volume such as a rectangular bedroom or living room with floor area uninterrupted by built-in furniture or cabinets 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/VM1 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.

General

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 <i>Illuminance</i>	Housing , old people's homes, and <i>early childhood centres</i>	For simple <i>buildings</i> up to 3 storeys in low density developments without borrowed light: G7/AS1
G7.3.2 Awareness of the outside environment		For simple <i>buildings</i> in low, medium and high density developments (including higher rise <i>buildings</i> and apartments) without borrowed light: G7/AS2 For all <i>buildings</i> including complex higher rise <i>building</i> , apartments, and those with borrowed light: G7/VM1

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. 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.

1.2.2 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.

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 table provided in [Subsection 2.1.4](#).

2.1.2 Limitations regarding the maximum permitted room depth table

2.1.2.1 The maximum permitted room depth table is 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) Spaces with vertical windows in *external walls* that can be described by a *glazing-to-wall ratio* (GWR); and
- d) Vertical windows with a glazing *visible light transmittance* (VLT) between 40% and 80%; and
- e) A *glazing-to-wall ratio* (GWR) between 10% and 90%; and
- f) Spaces with simple exterior soffit or overhangs or no shading devices; and
- g) Relatively unobstructed spaces with *average exterior obstruction angle* (AEOA) less than or equal to 60°.

2.1.2.2 Each *habitable space* must be assessed individually.

2.1.2.3 When using the maximum permitted room depth table, the following limitations apply:

- a) For *habitable spaces* with more than one window in *external walls*, the table assumes natural light ingress from window(s) on one wall creating a side-lit space. If there are spaces with two or more windows on two opposing walls, window(s) on one of the two walls must be excluded to comply with the table. If the designed room depth exceeds the maximum permitted values, use G7/AS1, G7/VM1, or an alternative solution to demonstrate compliance.
- b) For *habitable spaces* that do not have a window in *external walls* and rely on daylight borrowed from another space, G7/VM1 or an alternative solution shall be used to determine the minimum *illuminance* within secondary spaces and demonstrate compliance.
- c) For daylight *habitable spaces* of unusual heights, use G7/VM1 to perform a detailed daylighting simulation or use an alternative solution to demonstrate compliance.



COMMENT: Windows on adjacent walls, roof windows, skylights and/or clerestory windows could be added in excess of the required area of glazing. However, these could lead to overheating and over lighting. In those scenarios, G7/VM1 or an alternative solution may be more appropriate to demonstrate compliance.

2.1.3 Input parameters to the maximum permitted room depth table

2.1.3.1 The maximum permitted room depth table requires 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 table: 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 table. The GWR is calculated using Equation 1.

Illuminance

Equation 1:
$$GWR = \frac{\text{Total area of glazing}}{\text{Area of wall containing the glazing (including windows)}} \times 100\%$$



COMMENT: A fully glazed *building* has a *GWR* less than 100% as mullions and spandrels take up some area of the wall.

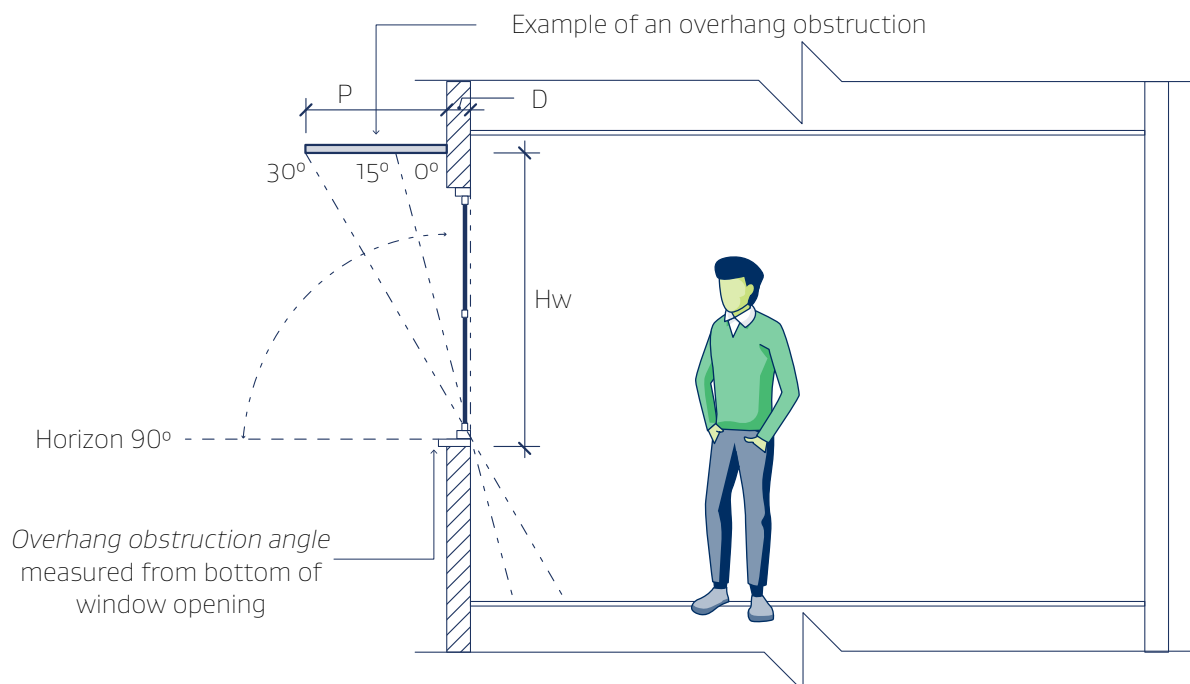
- 2.1.3.3 Five *visible light transmittance (VLT)* values are represented in the maximum permitted room depth table: 40%, 50%, 60%, 70, and 80% for different glazing types.
- 2.1.3.4 *VLT* values shall be derived from the actual glazing specifications for the *building*, and the closest value contained in the maximum permitted room depth table shall be used.
- 2.1.3.5 Three *overhang obstruction angles (OOAs)* are included in the maximum permitted room depth table: 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 overhang obstruction.

FIGURE 2.1.3.5: Overhang obstruction angle (OOA)

Paragraph 2.1.3.5



Illuminance

2.1.3.6 OOA shall be calculated using Equation 2.

$$\text{Equation 2: } \text{OOA} = \arctan\left(\frac{H_w}{P+D}\right)$$

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).

2.1.3.7 There are three ranges of *average exterior obstruction angle (AEOA)* values in the maximum permitted room depth table:

- a) For $\geq 0^\circ$ to $< 20^\circ$, and
- b) For $\geq 20^\circ$ to $< 40^\circ$, and
- c) For $\geq 40^\circ$ to $\leq 60^\circ$.



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 3. The maximum permitted *building* dimensions by the district plan shall be assumed on empty lots.

$$\text{Equation 3: } \text{AEOA} = \arctan\left(\frac{H-h}{W}\right)$$

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).

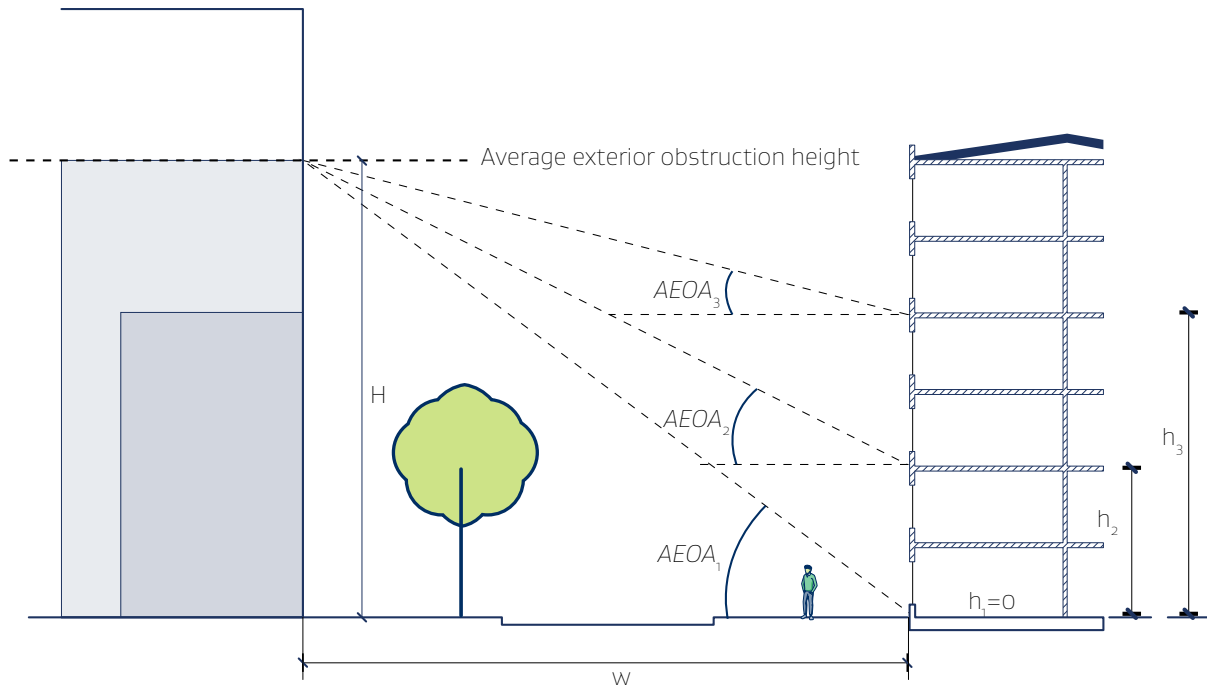
2.1.3.10 Where an exterior obstruction varies in distance from the *building* being assessed, the average distance, measured over the width of the *building* being assessed, shall be used. Spaces with an *AEOA* of greater than 60° shall employ detailed daylight simulation using Verification Method G7/VM1.

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*.

Illuminance

FIGURE 2.1.3.8: Average exterior obstruction angle (AEOA)

Paragraph 2.1.3.8



Note:

Examples are shown for the AEOA at three different heights (h_1 , h_2 , and h_3).

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: Table 2.1.4.1 gives the distance from *external wall* containing the vertical windows where the *illuminance* from natural light meets or 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.

Illuminance

TABLE 2.1.4.1: Maximum permitted room depth table for standard habitable spaces

Paragraph 2.1.4.1

VLT % (3)		Maximum permitted room depth (m) for different overhang obstruction angles and glazing-to-wall ratios ^{(1),(2),(4)}																										
		0° Overhang obstruction angle									15° Overhang obstruction angle									30° Overhang obstruction angle								
		Glazing-to-wall ratio %									Glazing-to-wall ratio %									Glazing-to-wall ratio %								
		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
Minor obstructed exterior context (≥ 0° to < 20° AEOA)																												
Thermal - Low-E - Clear glazing	80	4.2	5.4	6.3	6.6	7.0	7.2	7.4	7.5	7.8	3.9	5.1	6.0	6.3	6.8	6.9	7.0	7.2	7.6	3.6	5.0	5.8	6.1	6.6	6.7	6.8	7.0	7.4
	70	4.0	5.2	6.0	6.2	6.6	6.8	6.9	7.2	7.6	3.8	5.0	5.8	6.0	6.6	6.6	6.7	6.8	7.2	3.5	4.8	5.6	5.8	6.2	6.3	6.4	6.6	7.0
	60	3.7	4.7	5.6	6.0	6.4	6.5	6.6	6.8	7.2	3.4	4.4	5.4	5.6	6.0	6.1	6.2	6.4	6.7	3.2	4.4	5.2	5.5	5.9	6.0	6.1	6.3	6.7
	50	3.4	4.4	5.2	5.6	6.0	6.0	6.1	6.4	6.8	3.2	4.2	5.0	5.4	5.7	5.8	6.0	6.2	6.5	3.0	4.0	4.8	5.1	5.5	5.6	5.7	5.9	6.2
	40	3.2	4.1	4.7	5.1	5.5	5.6	5.7	6.0	6.3	2.9	3.9	4.6	4.8	5.2	5.3	5.4	5.6	6.0	2.6	3.6	4.3	4.6	5.0	5.1	5.2	5.4	5.7
Medium obstructed exterior context (≥ 20° to < 40° AEOA)																												
Thermal - Low-E - Clear glazing	80	3.1	3.5	3.8	3.8	4.0	4.1	4.2	4.3	4.6	2.8	3.3	3.5	3.5	3.6	3.7	4.0	4.2	4.6	2.5	3.0	3.2	3.2	3.4	3.6	3.8	4.2	4.6
	70	3.0	3.4	3.7	3.8	3.9	4.0	4.1	4.2	4.4	2.7	3.2	3.5	3.5	3.6	3.6	3.7	4.0	4.2	2.4	2.9	3.1	3.1	3.4	3.5	3.6	4.0	4.4
	60	3.0	3.4	3.6	3.7	3.8	3.9	4.0	4.1	4.3	2.6	3.0	3.2	3.3	3.4	3.5	3.5	3.6	4.0	2.4	2.8	3.0	3.0	3.1	3.2	3.4	3.6	4.0
	50	2.8	3.2	3.5	3.6	3.7	3.7	3.8	3.9	4.2	2.5	3.0	3.2	3.2	3.4	3.4	3.4	3.5	3.7	2.2	2.6	2.9	2.9	3.0	3.0	3.1	3.2	3.6
	40	2.6	3.1	3.3	3.5	3.6	3.6	3.7	3.8	4.0	2.3	2.8	3.1	3.2	3.3	3.3	3.3	3.4	3.6	2.1	2.5	2.8	2.8	2.8	2.8	2.8	2.9	3.2
Highly obstructed exterior context (≥ 40° to ≤ 60° AEOA)																												
Thermal - Low-E - Clear glazing	80	1.6	1.7	1.8	1.8	1.8	2.0	2.1	2.4	2.8	1.4	1.5	1.5	1.5	1.5	1.7	1.8	2.2	2.7	1.0	1.1	1.2	1.3	1.4	1.6	1.8	2.2	2.6
	70	1.6	1.7	1.8	1.8	1.8	1.9	2.0	2.2	2.4	1.4	1.5	1.5	1.5	1.5	1.6	1.7	2.0	2.4	NS*	1.1	1.2	1.2	1.2	1.4	1.6	2.0	2.4
	60	1.6	1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.2	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.6	2.0	NS*	1.0	1.1	1.1	1.1	1.2	1.3	1.6	2.0
	50	1.5	1.6	1.7	1.7	1.8	1.8	1.8	1.9	2.0	1.2	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.8	NS*	1.0	1.0	1.0	1.0	1.1	1.2	1.4	1.7
	40	1.5	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.2	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.5	NS*	NS*	NS*	NS*	NS*	NS*	1.0	1.0	1.2

Notes:

- (1) Refer to the limitations on the use of this table 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](#).
- (3) While the *VLT* percentage generally improves moving from Thermal, through Low-E to Clear glazing and from triple, through double to single glazing, there is no clear boundary between glazing types versus *VLT* as there are overlaps.
- (4) NS* - No Solution. Verification Method G7/VM1 or an alternative means may be used to demonstrate compliance.

Part 3. Awareness of the outside environment

3.1 Area of transparent glazing

3.1.1 Demonstrating compliance

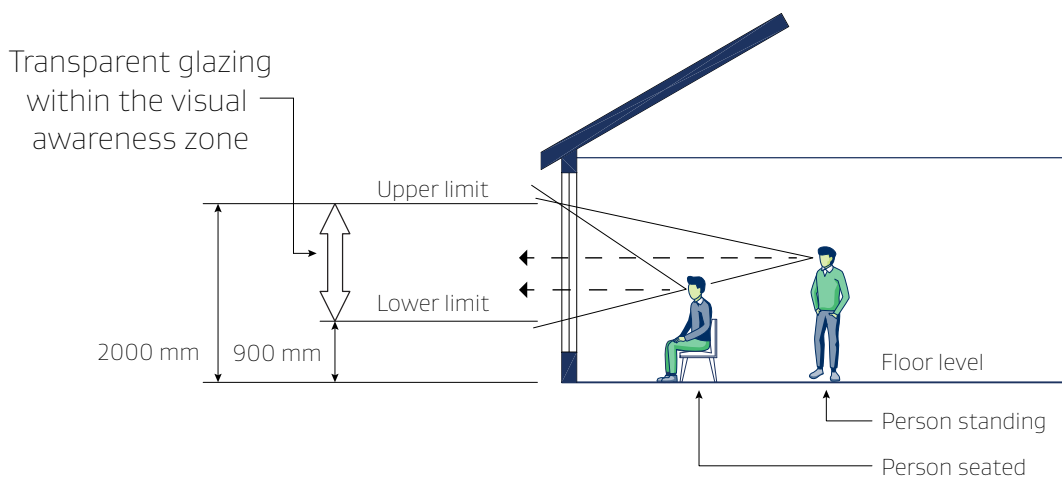
3.1.1.1 For *habitable spaces* of **housing**, old people's homes, and *early childhood centres*, openings to the outside shall have an area of transparent glazing suitable to give awareness of the outside. This is demonstrated through the use of a calculation method described in Subsection 3.1.2.

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 transparent glazing. The transparent 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



References and Definitions

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	<i>Adequate</i> 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)	<p>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—</p> <p>a) by the day or part of a day; but</p> <p>b) not for any continuous period of more than seven days.</p> <p>ECC does not include home based early childhood services.</p>
External wall	Any vertical exterior face of a <i>building</i> consisting of <i>primary</i> and/or <i>secondary elements</i> 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 <i>external wall</i> containing the 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.

BUILDING PERFORMANCE

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