NUMBER | 7

Builder Insight

TECHNICAL BULLETIN

Energy Performance Requirements for the Building Enclosure:

Compliance Paths for Multi-Unit Residential Buildings

Overview

Building codes continue to drive improvements in the energy performance of buildings. Amendments to the 2012 BC Building Code (BCBC) took effect on December 20, 2013. These changes require the energy performance of Part 3 buildings to comply with either the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 90.1-2010, or the 2011 National Energy Code of Canada for Buildings (NECB).

The energy performance of Part 9 buildings is comprehensively addressed in subsection 9.36 of the BCBC. It allows the NECB to be used as an optional compliance path for any Part 9 building. The NECB is the only compliance path for Part 9 buildings with more than 30% non-residential occupancies or with any medium hazard industrial (F2) occupancy. The energy performance requirements of subsection 9.36 are outlined in the *Illustrated Guide to Energy Efficiency Requirements for Houses in British Columbia* published by the HPO.

As of January 21, 2014, the 2014 City of Vancouver Building Bylaw (VBBL) requires the energy performance of multi-unit residential buildings (MURBs) to be designed to either ASHRAE 90.1-2010 or 2011 NECB.

This bulletin describes the energy performance requirements for the building enclosure (envelope) in accordance with these standards for new multi-unit residential buildings. A separate bulletin focuses on how these code changes affect fenestration energy performance (Builder Insight No. 9, *Fenestration Energy Performance*).

BC HOUSING

Builder Insight is a series of bulletins and companion videos designed to provide practical information on new technologies, research results, good building practices and emerging technical issues in residential construction to Licensed Residential Builders and others in the industry.

This bulletin was produced by the Technical Research & Education branch of BC Housing in collaboration with an industry steering committee. RDH Building Science Inc. prepared this bulletin.

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The code updates that specified these standards aim to improve the energy performance of buildings.

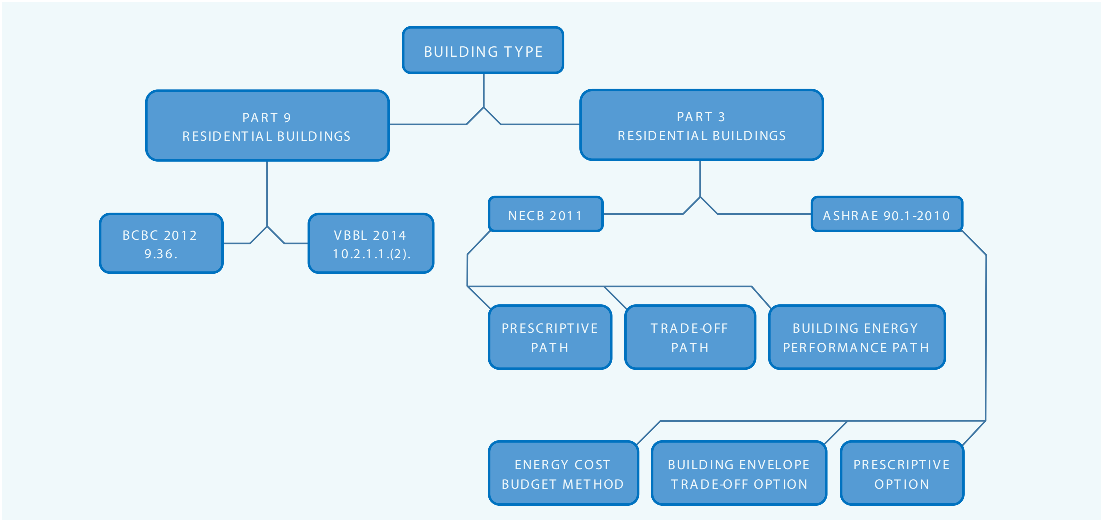


Figure 1: Code requirements for building enclosure energy performance.

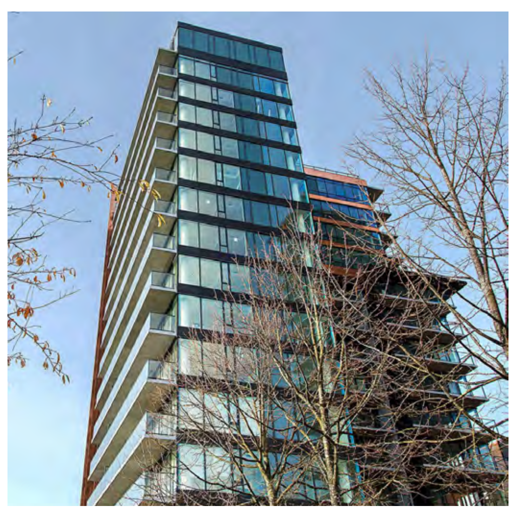
Energy Performance Standards for MURBs

ASHRAE 90.1 and the 2011 NECB give building designers a range of approaches, options and design tools to address the energy performance of buildings. Compliance with the energy performance requirements is the responsibility of design professionals who decide what energy performance standard to use, and which of the compliance paths in the standard to follow. These decisions are communicated to builders through design drawings and construction specifications.

The code updates that specified these standards aim to improve the energy performance of buildings. While all building systems are affected, builders will note a greater emphasis on controlling air leakage, the use of more energy efficient fenestration, and reducing heat loss through the building enclosure. The focus on effective R-values continues to challenge designers to address thermal bridges in construction details.

Scope and Application

ASHRAE 90.1-2010 defines its scope as applying to new buildings over three storeys tall and to additions and alterations of existing buildings. Single family homes and multi-family buildings three storeys or less are outside the scope of this standard. The NECB defines its scope as applying to the design and construction of new Part 3 buildings and to additions to existing buildings. However, the application of these documents to particular building types is defined by building codes, BCBC or VBBL.



ASHRAE 90.1-2010 Building Enclosure Requirements

Building Envelope Compliance Paths

Section 5 of ASHRAE 90.1 addresses building envelope requirements and describes two building envelope compliance paths: the Prescriptive Path and the Building Envelope Trade-off (BET) option. Buildings can also be designed according to the Energy Cost Budget (ECB) method in Section 11, which makes use of whole building energy modeling as an alternative to the prescriptive provisions of the standard. However, all three compliance paths must comply with the mandatory provisions in Section 5.4.

Mandatory Provisions

The mandatory provisions address three key areas: insulation, fenestration and air leakage. Insulation must be continuous and installed without compromising its intended performance. The fenestration energy properties, U-factor and Solar Heat Gain Coefficient (SHGC), must be determined using the precise methods of the National Fenestration Rating Council (NFRC) when generic values in Appendix A of the standard are not used.

Air leakage is addressed in several ways: by use of vestibules, by specifying maximum fenestration air leakage rates, and through the design and installation of a continuous air barrier over all surfaces of the building envelope. The air barrier components of each building envelope assembly must be clearly identified or otherwise noted on the construction documents.

Prescriptive Path

The thermal resistance of building enclosure components must meet minimum requirements set out in a series of tables by assembly and construction type for different climate zones (ASHRAE 90.1 Tables 5.5-4 to 5.5-8). The tables provide two alternate columns for prescriptive compliance: either a maximum assembly U-value or a minimum insulation R-value.

The maximum assembly U-value requirements consider the effects of thermal bridging through framing members, as well as the insulating contribution of sheathing materials and air films. While thermal bridging through wood framing (15% to 20% degradation) is not as significant as through steel (40% to over 60% degradation), it must be accounted for in calculations to determine the effective assembly U-value. Tables that provide typical enclosure assembly U-values are included in Normative Appendix A of ASHRAE 90.1.

The minimum insulation R-value requirements only consider the nominal insulation R-value, but can also include requirements for continuous insulation. Continuous insulation (c.i.) must be continuous across all structural members; it cannot be interrupted or thermally bridged except by fasteners and service openings. Achieving a layer of continuous insulation can be challenging due to structural penetrations, cladding attachments and other thermal bridges, and is often what triggers the use of the maximum assembly U-value columns.

For fenestration components, maximum U-values and maximum Solar Heat Gain Coefficients (SHGCs) now vary by the framing material and type of fenestration. For buildings following the prescriptive compliance path, the vertical fenestration area must not exceed 40% of the gross wall area, and the skylight area must not exceed 5% of the gross roof area.

Typically the prescriptive path can be followed unless:

- The maximum assembly U-value or minimum insulation R-value cannot be met, or
- There is a desire to increase fenestration area beyond the maximum allowable.

In these instances, either the BET path or the ECB method (Section 11) must be utilized.

Building Envelope Trade-off Option

This compliance path allows for the trade-off of the thermal performance of one enclosure assembly with another. Examples include providing more insulation within the roof to offset less insulation in the walls, or providing better windows to make up for walls that do not comply with the prescriptive requirements.

The free COMcheck program from the US Department of Energy includes climate data for 12 locations in British Columbia.

Building envelope trade-off compliance is typically demonstrated using the COMcheck program. This program is available free of charge from the US Department of Energy, and includes climate data for 12 locations in British Columbia. COMcheck compares the building enclosure design inputs to a baseline minimally-compliant case. The software performs area weighted calculations of U-value multiplied by component area (UxA) and takes into consideration the effects of thermal mass, orientation, and the daylighting benefits of fenestration.

Energy Cost Budget Method

The Energy Cost Budget (ECB) method in Section 11 is an alternative to the prescriptive requirements in the other sections of the standard. It uses whole building energy modeling to determine whether the proposed building's annual energy cost is no greater than that of a baseline building as defined in Section 11. For example, a more efficient mechanical system can compensate for a building envelope that does not meet the prescriptive requirements. When this method is used to demonstrate compliance, the mandatory provisions in Sections 5 through 10 of the standard still apply.

ASHRAE 90.1 Table 11.3.1 provides detailed guidance on the procedures and requirements for modeling the baseline and proposed cases. Unless specific guidance is provided for a particular system or feature, it needs to be modeled identically in both the proposed and baseline building.

The energy cost budget path compares energy costs, not energy use. Given that the ECB method is based on relative cost savings, and that at current utility rates electricity costs twice as much as gas, designers may be encouraged to focus more attention on electricity savings than on overall energy savings.

Appendix G – Performance Rating Method

The Performance Rating Method (PRM) in Appendix G of ASHRAE 90.1 is not a compliance path of the standard. However, it is widely used to determine whether buildings qualify for LEED energy credits. The City of Vancouver is used to demonstrate compliance with conditions that apply to buildings on rezoned land. Like the ECB method, the PRM uses whole building energy modeling. It is important to understand that a PRM energy model will not be identical to an energy model used to demonstrate code compliance under the ECB because of differences in the modeling requirements.

NECB Building Enclosure Requirements

Compliance Paths

Part 3 of the NECB deals with the building envelope, and includes general requirements as well as prescriptive and trade-off compliance paths. Part 8, the Building Energy Performance (BEP) path, provides an alternative compliance path for the entire building that allows for the use of a detailed energy model to compare the energy use of a proposed building to a reference building in place of the prescriptive or trade-off provisions.

General Provisions

The general provisions in Section 3.1 apply to all compliance paths and address issues that closely parallel the Mandatory Provisions of ASHRAE 90.1: the control of heat and air through enclosure assemblies. When the performance path is followed, any increase in air leakage or reduction in insulation effectiveness over prescriptive requirements must be accounted for in the energy model.

Prescriptive Path

The maximum overall U-values of all enclosure assemblies must meet the requirements set out in a series of tables for different climate zones (NECB Tables 3.2.2.2, 3.2.2.3, 3.2.2.4, and 3.2.3.1).

The prescriptive U-value requirements in NECB do not differ by occupancy or construction type as in ASHRAE 90.1. The prescriptive requirements also address the protection and continuity of insulation.

The prescriptive path specifies the maximum allowable total vertical fenestration and door area to gross wall area ratio (FDWR), which is 40% for all locations up to 4000 HDD, and is progressively reduced with increasing HDD to a minimum of 20%. In addition, the total skylight area must not be greater than 5% of the gross roof area. Buildings that exceed these limits must follow either the trade-off path or performance path.

The prescriptive path also includes requirements to improve airtightness. The building envelope must be designed and constructed with a continuous air barrier. Fenestration and doors must meet specified air leakage rates when tested in accordance with the specified standards.

Trade-off Path

The building envelope trade-off path in Part 3 includes a simplified as well as a detailed option that differ in the extent of the trade-offs permitted. These options allow the thermal performance of one enclosure assembly to be offset by that of another.

The simplified trade-off path applies to above-ground assemblies only, and allows assembly U-value trade-offs to take place between vertical assemblies such as walls and windows, or between horizontal assemblies such as roofs, decks and skylights. It does not permit the allowable areas of fenestration and doors to be increased beyond the maximum prescriptive requirements. Compliance is demonstrated by comparing the area weighted U-values for the assemblies in the proposed case and the reference case. If the sum of the U-values multiplied by each corresponding area (UxA analysis) of the proposed case is less than or equal to that of the reference case, the building envelope complies. This is a simpler approach than the one used in the ASHRAE 90.1 Building Envelope Trade-off option and thus does not require a tool like COMcheck to verify compliance.

A more efficient mechanical system can compensate for a building envelope that does not meet the prescriptive requirements.

The detailed trade-off path permits not only the U-values, but also the overall area of fenestration and doors, to vary from the maximum prescriptive requirements. Whole building energy modeling is used to determine the energy consumption of the proposed and reference buildings in this trade-off path without varying the mechanical and electrical systems between the two models.

The detailed trade-off path also allows buildings to "trade down" envelope performance when fenestration and door ratios are lower than the maximum allowable. Consider the example of a building in Victoria whose design parameters call for a FDWR of only 25%. Because the building's FDWR is less than the 40% prescriptive maximum FDWR for Victoria, the building is permitted to use a lower wall R-value or some other trade-off under the Building Envelope Trade-off Path. This is not permitted under ASHRAE 90.1-2010.

Performance Path

The building envelope performance path in Section 3.4 requires the use of Part 8, which evaluates all systems covered under the NECB and is an alternative to the prescriptive requirements. It therefore allows trade-offs between systems, as long as the proposed building's annual energy consumption remains below that of a reference building that meets minimum requirements. For example, a more efficient mechanical system can compensate for a building envelope that does not meet the prescriptive requirements.

Unlike the ASHRAE 90.1 Energy Cost Budget method, the performance path compares the energy consumption of the proposed and reference buildings, and not the difference in the cost of energy between them.

Performance path compliance must be demonstrated using whole building energy modeling. Section 8.4 provides detailed guidance on the procedures and requirements for modeling the reference and proposed cases, and energy modellers should review these rules. CAN-QUEST,[1] a Canadian adaptation of eQUEST, is one modeling option that can be used to demonstrate performance path compliance with the NECB.

[1] For more information about CAN-QUEST or to obtain a free copy of the tool, email info.services@nrcan-rncan.gc.ca

BC Climate Zones for NECB and ASHRAE 90.1

Both ASHRAE 90.1-2010 and the 2011 NECB define energy performance requirements with respect to the climate zone the building is in. The BCBC states that the authority having jurisdiction (AHJ) can establish climatic values for use in defining climate zones, and building designers must consult the AHJ before making any assumptions about what climate zone a building is in.

The BC Building Code requires climate data acceptable to the authority having jurisdiction to be used with ASHRAE 90.1-2010 climate zone threshold criteria.

NECB climate zones are based on Heating Degree-Day thresholds (HDD) below 18°C. ASHRAE 90.1 climate zones are defined not only by HDD, but also zone subtypes (A, B and C) based on Cooling Degree-Days above 10°C, Monthly Mean Temperature, and Monthly Precipitation values.

The BC Building Code requires climate data acceptable to the authority having jurisdiction to be used with ASHRAE 90.1-2010 climate zone threshold criteria.[1] If the AHJ chooses not to establish climatic values for buildings designed to ASHRAE 90.1, the building designer must use climatic values from Table C-2 of the BC Building Code or data obtained by contacting the Atmospheric Environment Service of Environment Canada.

Figure 2 presents the NECB and ASHRAE 90.1 climate zone maps for municipalities in British Columbia. ASHRAE 90.1-2010 climate zones parallel those of the 2011 NECB when SI values and Canadian climate data are used except that NECB divides zone 7 into two (7A and 7B).

Vancouver is listed in ASHRAE 90.1-2010 as being in climate zone 5 and the 2014 VBBL confirms that zone 5 is to be used for buildings designed to that standard, even though its HDD would place it in climate zone 4.

[1] For detailed information consult Information Bulletin B14-01 from the BC Building and Safety Standards Branch, titled Determining ASHRAE 90.1-2010 Climate Zones.

Comparing ASHRAE 90.1-2010 and 2011 NECB

Tables 1 and 2 summarize the prescriptive minimum thermal resistance requirements of ASHRAE 90.1 and the 2011 NECB. There are many other differences between the two energy design approaches that cannot be easily summarized. Depending on the building type, it may be more advantageous to build under one standard than under the other.

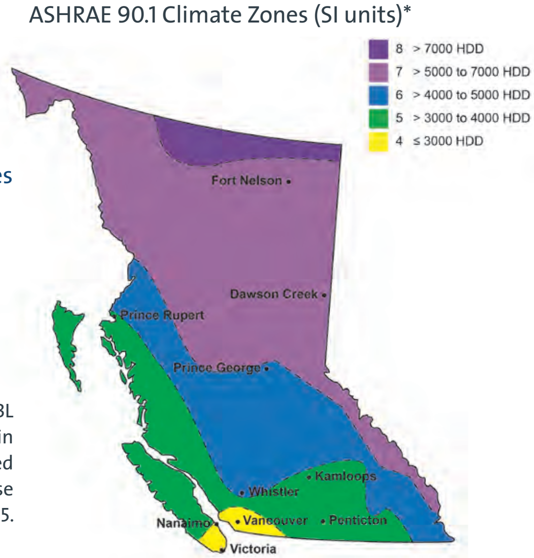
A study comparing the energy savings for buildings designed to the 2011 NECB compared to ASHRAE 90.1-2010 showed a modest 5% reduction in energy use for a high-rise MURB in Vancouver designed to NECB over one designed to ASHRAE 90.1.[1] The MURB archetype had a FDWR of 40%.

For high-rise MURBs, the cost of compliance is generally higher under NECB than under ASHRAE 90.1 due to more stringent requirements for the building envelope and mechanical systems, with one important exception. For MURBs whose window-wall ratio exceeds the maximum prescriptive ratio of 40% that is common to both design standards, compliance must be demonstrated on the basis of energy savings (NECB Performance Path) or energy cost savings (ASHRAE 90.1 Energy Cost Budget method). It is often easier for high-rise MURBs with electric baseboard heating to comply under the NECB, because of the differences in mechanical system requirements for the baseline or reference building used for the whole building energy models.

Ventilation and Energy Performance

Whether following the ASHRAE 90.1 or NECB compliance paths, ventilation rates must comply with Part 6 of the BCBC. Information Bulletin number B13-05 published by the Building and Safety Standards Branch specifies that although the choice of ventilation standards will have energy implications, ventilation is a health and safety issue rather than an energy issue. As such, all Part 3 buildings are required to use the ventilation standard referenced in Part 6 of the BCBC. Code users are advised to adjust the ventilation settings of modelling programs for the ASHRAE 90.1 (2010) standard, which are based on a different ventilation regime.

ASHRAE 90.1 Climate Zones (SI units)*



2011 NECB Climate Zones (SI units)

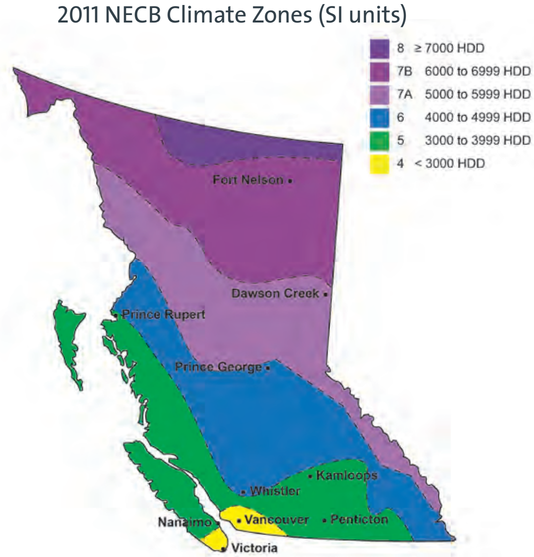


Figure 2: ASHRAE 90.1 Climate Zones Based on BCBC Data Compared to NECB Climate Zones

* The 2014 VBBL requires buildings in Vancouver designed to ASHRAE 90.1 to use climate zone 5.

[1] ASHRAE 90.1 2010 and NECB 2011 Cross Canada Comparison, report prepared for Natural Resources Canada, Caneta Research Inc., 2012.

Table 1 - Minimum Thermal Resistance for Part 3 Residential Buildings (Excerpt from Table 5.5-4 to 5.5-8 from ASHRAE 90.1-2010)

	BCBC – ASHRAE 90.1-2010 Building Enclosure Insulation Requirements | R-value (RSI) | ft^2·°F·h/Btu (m^2·°K/W)									
	Zone 4		Zone 5		Zone 6		Zone 7		Zone 8	
	Minimum Assembly	**Minimum Insulation**	**Minimum Assembly**	**Minimum Insulation**	**Minimum Assembly**	**Minimum Insulation**	**Minimum Assembly**	**Minimum Insulation**	**Minimum Assembly**	**Minimum Insulation**
Roofs										
Above Deck	R-20.8 (3.67)	R-20.0 c.i. (3.52)	R-20.8 (3.67)	R-20.0 c.i. (3.52)	R-20.8 (3.67)	R-20.0 c.i. (3.52)	R-20.8 (3.67)	R-20.0 c.i. (3.52)	R-20.8 (3.67)	R-20.0 c.i. (3.52)
Attic	R-37.0 (6.52)	R-38.0 (6.69)	R-37.0 (6.52)	R-38.0 (6.69)	R-37.0 (6.52)	R-38.0 (6.69)	R-37.0 (6.52)	R-38.0 (6.69)	R-47.6 (8.29)	R-49.0 (8.63)
Above Grade Walls										
Mass	R-11.1 (1.95)	R-11.4 c.i. (2.0)	R-12.5 (2.20)	R-13.3 c.i. (2.34)	R-14.1 (2.48)	R-15.2 c.i. (2.67)	R-14.1 (2.48)	R-15.2 c.i. (2.67)	R-19.2 (3.39)	R-25.0 c.i. (4.40)
Wood Frame	R-15.6 (2.75)	R-13+3.8 c.i. (2.29+0.67)	R-19.6 (3.45)	R-13+7.5 c.i. (2.29+1.32)	R-19.6 (3.45)	R-13+7.5 c.i. (2.29+1.32)	R-19.6 (3.45)	R-13+7.5 c.i. (2.29+1.32)	R-27.8 (4.89)	R-13+15.6 c.i. (2.29+2.75)
Steel Frame	R-15.6 (2.75)	R-13+7.5 c.i. (2.29+1.32)	R-15.6 (2.75)	R-13+7.5 c.i. (2.29+1.32)	R-15.6 (2.75)	R-13+7.5 c.i. (2.29+1.32)	R-23.8 (4.19)	R-13+15.6 c.i. (2.29+2.75)	R-27.0 (4.76)	R-13+18.8 c.i. (2.29+3.31)
Below Grade Walls	-	R-7.5 c.i. (1.32)	-	R-7.5 c.i. (1.32)	-	R-7.5 c.i. (1.32)	-	R-10.0 c.i. (1.76)	-	R-12.5 (2.20)
Floors										
Mass	R-13.5 (2.37)	R-10.4 c.i. (1.83)	R 15.6 (2.75)	R-12.5 c.i. (2.20)	R-17.5 (3.09)	R14.6 c.i. (2.57)	R-19.6 (3.45)	R-16.7 c.i. (2.94)	R-19.6 (3.45)	R-16.7 c.i. (2.94)
Wood Frame	R-30.3 (5.34)	R-30 (5.28)	R-30.3 (5.34)	R-30 (5.28)	R-30.3 (5.34)	R-30 (5.28)	R-30.3 (5.34)	R-30 (5.28)	R-30.3 (5.34)	R-30 (5.28)
	Perimeter Insulation F-factors Btu/h·ft·°F (W/m·°K) - ASHRAE Table A6.3									
Slab-on Grade										
Unheated	F-0.54 (0.93)	R-10 for 24″ (1.76)	F-0.54 (0.93)	R-10 for 24″ (1.76)	F-0.52 (0.90)	R-15 for 24″ (2.64)	F-0.52 (0.90)	R-15 for 24″ (2.64)	F-0.51 (0.88)	R-20 for 24″ (2.64)
Heated	F-0.86 (1.49)	R-15 for 24″ (2.64)	F-0.86 (1.49)	R-15 for 24″ (2.64)	F-0.688 (1.19)	R-20 for 48″ (3.52)	F-0.688 (1.19)	R-20 for 48″ (3.52)	F-0.688 (1.19)	R-20 for 48″ (3.52)
	Window and Door Assembly Maximum U-value Btu/h·ft^2·°F (W/m^2·°K)									
Opaque Doors										
Swinging	U-0.70 (4.0)		U-050 (2.84)		U-050 (2.84)		U-050 (2.84)		U-050 (2.84)	
Non-Swinging	U-0.50 (2.84)		U-050 (2.84)		U-050 (2.84)		U-050 (2.84)		U-050 (2.84)	
Windows										
Non-Metal	U-0.40 (2.27)		U-0.35 (1.99)		U-0.35 (1.99)		U-0.35 (1.99)		U-0.35 (1.99)	
Metal CW/ Storefront	U-0.50 (2.84)		U-0.45 (2.56)		U-0.45 (2.56)		U-0.40 (2.27)		U-0.40 (2.27)	
All Other	U-0.55 (3.12)		U-0.55 (3.12)		U-0.55 (3.12)		U-0.45 (2.56)		U-0.45 (2.56)	
	General Window Notes:	- 40% maximum window area - Additional requirements for skylights, entry doors, and SHGC are provided in ASHRAE 90.1-2010								

c.i. – denotes continuous insulation

Table 2- Minimum Thermal Resistance for Part 3 Residential Buildings (Excerpt from Table 3.2.2.2 to 3.2.3.1 from NECB 2011)

	BCBC – NECB 2011 Building Enclosure Insulation Requirements | R-value (RSI) | ft²·°F·h/Btu (m²·°K/W)					
	Zone 4	Zone 5	Zone 6	Zone 7	Zone 7B	Zone 8
Roofs						
Above Grade	R-25.0 (4.41)	R-31.0 (5.46)	R-31.0 (5.46)	R-35.0 (6.17)	R-35.0 (6.17)	R-40.0 (7.04)
Below Grade <1.2m	R-10.0 (1.76)	R-15.0 (2.64)	R-37.0 (6.52)	R-38.0 (6.69)	R-37.0 (6.52)	R-38.0 (6.69)
Walls						
Above Grade	R-18.0 (3.17)	R-20.4 (3.6)	R-23.0 (4.05)	R-27.0 (4.76)	R-27.0 (4.76)	R-31.0 (5.46)
Below Grade	R-10.0 (1.76)	R-15.0 (2.64)	R-20.0 (3.52)	R-20.0 (3.52)	R-20.0 (3.52)	R-27.0 (4.76)
Floors						
Above Grade	R-25.0 (4.41)	R-31.0 (5.46)	R-31.0 (5.46)	R-35.0 (6.17)	R-35.0 (6.17)	R-40.0 (7.04)
Below Grade <0.6m	R-7.5 for 48" (0.757)	R-7.5 for 48" (0.757)	R-7.5 for 48" (0.757)	R-7.5 for 48" (0.757)	R-7.5 for 48" (0.757)	R-15.0 full area (2.64)
Heated Below Grade	R-7.5 full area (0.757)	R-7.5 full area (0.757)	R-7.5 full area (0.757)	R-7.5 full area (0.757)	R-7.5 full area (0.757)	R-15.0 full area (2.64)
Doors	U-0.42 (2.4)	U-0.39 (2.2)	U-0.39 (2.2)	U-0.39 (2.2)	U-0.39 (2.2)	U-0.28 (1.6)
Windows	U-0.42 (2.4)	U-0.39 (2.2)	U-0.39 (2.2)	U-0.39 (2.2)	U-0.39 (2.2)	U-0.28 (1.6)
	Additional requirements for skylights, access hatches, and other door types are provided in NECB 2011					

Fenestration Energy Performance

Fenestration energy performance is determined by simulation or physical testing. While ASHRAE 90.1 references NFRC standards only, the NECB also allows CSA A440.2 to be used. CSA A440.2 follows NFRC simulation methods for U-value and SHGC, but does not require U-values be verified by physical testing as NFRC does.

It is significant that both ASHRAE 90.1 and NECB stipulate that U-value and SHGC are to be reported only with respect to the sizes in the respective standards and only to the edges of the fenestration frames. Fenestration U-values do not include thermal bridging related to installation method or accessories. The intent of limiting fenestration U-values, SHGC and visible transmittance (VT) to the sizes and configurations in NFRC 100 and CSA A440.2 is to allow the energy performance characteristics of fenestration products to be verifiable by testing and certification, and to allow products to be compared under identical conditions.

Air Leakage

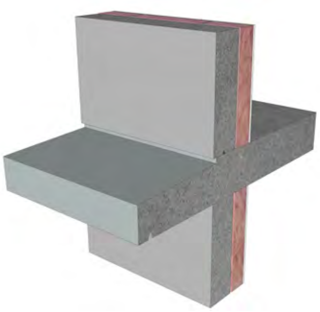
The unintentional flow of air between the interior and exterior environment through the building enclosure is known as air leakage. Air leakage can be a significant portion of the heat loss in a building.

It is difficult to quantify air leakage through the building enclosure of larger multi-unit residential buildings. Therefore, ASHRAE 90.1-2010 and 2011 NECB provide only qualitative requirements for air barrier continuity of the building enclosure, except for windows and doors where prescriptive performance values are provided.

Effective R-values and Thermal bridges

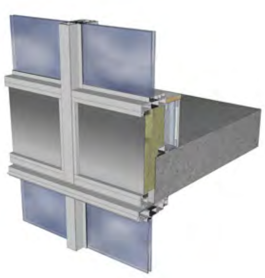
ASHRAE 90.1 and NECB require effective U- and R-values to be used for building envelope compliance. While there is general consensus on effective R-values for many assemblies, highly optimistic R-values continue to be used for some assemblies commonly found in British Columbia MURBs.

The Building Envelope Thermal Bridging Guide provides methods and data that building designers can use to determine effective overall U- and R-values for many common enclosure assemblies characterized by significant thermal bridging.



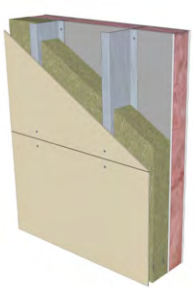
Problematic Energy Code Compliance Detail # 1: Exposed Concrete Slab Edges, Shear Walls, Concrete Eyebrows, and Balcony Projections

Exposed concrete slab edges and projections result in discontinuous insulation and large reductions in whole wall effective R-values — typically in the order of 40-60%. Where these linear thermal bridges are present, the building enclosure must be evaluated using a trade-off or energy modeling pathway where the significant reduction in effective R-value can be accounted for using linear transmittance values.



Problematic Energy Code Compliance Detail # 2: Window-wall and Curtain Wall Spandrel Sections

Buildings incorporating aluminum framed spandrel panels must follow one of the trade-off paths because the thermal performance of spandrel areas is typically in the range of R-3 to R-6 effective and cannot comply with minimum prescriptive values (typically in range or R-15.6 or higher). No amount of insulation added within the system or behind it will significantly reduce the heat lost through the vertical mullions of the window system that will remain exposed in the vision area.



Problematic Energy Code Compliance Detail #3: Cladding Attachment through Exterior Insulation

Cladding attachments through exterior insulation can be a significant source of thermal transfer that must be accounted for in effective wall R-value calculations. Avoiding continuous girts, whether vertical or horizontal, will lead to much better thermal performance. Many generic and proprietary cladding supports that achieve low levels of thermal degradation and high effective R-values are available in the BC construction market.

Examples of thermally effective cladding attachment

Z-girts flush with face of exterior insulation, mounted to wall with low conductivity stand-off clips.

Galvanized steel clips support exterior insulation and cladding.

Stainless steel masonry ties and stand-off ledger angle support for brick.

Vertical wood strapping mounted outboard of exterior insulation, attached to wall with long screws.

Key Points

- Energy performance requirements for MURBs are based on the climate zones. The BCBC allows the authority having jurisdiction (AHJ) to determine the climate data to be used, and building designers must consult the AHJ before making any assumptions about what climate zone a building is in.
- The BC Building Code requires BC climate data to be used with ASHRAE 90.1-2010 climate zone threshold criteria.
- There are three ASHRAE 90.1 compliance paths: prescriptive, building envelope trade-off, and energy cost budget (ECB).
  - The ECB path is different than the ASHRAE 90.1 Performance Rating Method (PRM) referenced by programs such as LEED. The PRM is not a BCBC compliance path, but is used to demonstrate compliance with building permit conditions for developments on rezoned land in Vancouver.
  - COMcheck can be used for the Building Envelope Trade-off Path under ASHRAE 90.1-2010.

- There are three NECB compliance paths: prescriptive, building envelope trade-off and performance.
- ASHRAE 90.1 -2010 and NECB have similar climate zone definitions and maps with some slight differences at 1000 HDD increments. Consult the authority having jurisdiction (AHJ) about the climate zone to be used as AHJs may override climate data published in building codes.
- The focus on building enclosure compliance under ASHRAE 90.1 or the NECB 2011 has a lot to do with the determination of effective R-values for assemblies and details. Several useful resources on this topic have been developed by the HPO and are referenced below.
- The 2010 version of ASHRAE 90.1 requires that the air barrier components of each assembly and detail be clearly identified or otherwise noted on the construction documents.

For More Information

1. ASHRAE 90.1-2010, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, available at www.ashrae.org.
2. *National Energy Code of Canada for Buildings 2011*, available at www.nrc-cnrc.gc.ca.
3. *Building Enclosure Design Guide – Wood-Frame Multi-Unit Residential Buildings*, Homeowner Protection Office, 2011, available at www.hpo.bc.ca.
4. *Guide for Designing Energy-Efficient Building Enclosures,* 2013, available at https://fpinnovations.ca.
5. *Building Envelope Thermal Bridging Guide*, available at www.hpo.bc.ca.

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