Ontario Association of Architects

Practice Tip – PT.36.2
Version 3.2
December 10, 2018

OBC SB-10 Energy Efficiency Requirements – Prescriptive Compliance

Summary

"This is our time." When Ed Mazria spoke those words to the RAIC,[1] all understood the challenge before them, all were energized by his call to service, all felt their enthusiasm for our profession rekindled. Buildings account for 40% of Canada's energy consumption. The need and opportunity for architects to make a critical difference is clear. For designers to rise to this challenge they must be fluent with building energy conservation codes.

Ontario continues to promote some of the most progressive regulations in North America for improvements in energy conservation in buildings and reductions of Green House Gas (GHG) emissions. With each iteration of the Building Code (OBC), the requirements related to energy performance have increased. These regulations are captured in OBC Part 12[2] and Supplementary Standard SB-10[3]. These requirements cover:

- New buildings and additions to existing buildings within the scope of OBC Part 3.
- Non-residential building within the scope of Part 9.

The energy efficiency of existing buildings is covered in Parts 10 & 11.

Architects will naturally focus on the building envelope provisions of SB-10 but they should be conversant with the impact of mechanical and electrical requirements on their design as well.

Beginning January 01, 2018 designers have 6 compliance paths[4] for Part 3 buildings:

• ASHRAE 90.1-2013[5] (90.1-2013) + OBC SB-10 Division 3, Chapter 2	Prescriptive, Trade-Off & Performance options
• 2015 National Energy Code for Buildings (NECB 2015) + OBC SB-10 Division 3, Chapter 3	Prescriptive, Trade-Off & Performance options
• ASHRAE 189.1-2014[6] (189.1-2014)	Prescriptive & Performance options
• ASHRAE 90.1-2010 (90.1-2010) + OBC SB-10 Division 2 Chapter 2 + 13%	Performance option
• National Energy Code for Buildings (NECB 2011) + OBC SB-10 Division 2, Chapter 3 + 13%	Performance option
• ASHRAE 90.1-2010 + 5% + 13%	Performance option

[1] RAIC Fellows Convocation Ceremony, Vancouver, BC, 2011

[2] Resource Conservation and Environmental Integrity

[3] OBC SB-10 Energy Efficiency Supplement

[4] The Ministry of Municipal Affairs SB-10 Energy Efficiency Checklists for Part 3 Buildings from May 2017 list only the 3 prescriptive paths. The foreword to SB-10 from July 2017 however lists 6 paths to compliance available to designers after December 31, 2017.

[5] ANSI/ASHRAE/IES Standard 90.1-2013 -- Energy Standard for Buildings Except Low-Rise Residential Buildings

[6] Standard for the Design of High-Performance Green Buildings

For non-residential buildings within the scope of Part 9, Division 5 offers a prescriptive path similar to Division 3 Chapter 2.

GHG emissions in the form of Carbon Dioxide Equivalents (CO_{2e}) are regulated by SB-10. Buildings which comply with the prescriptive requirements of SB-10 will meet these requirements.

This Practice Tip focuses on the prescriptive paths and trade off options for Part 3 Buildings and for Part 9 Non-residential buildings.

SB-10 Organization

Like other OBC Supplementary Standards, SB-10 is organized in Divisions and Chapters:

Division 1 General.

Division 2 Energy Efficiency Design Before January 01, 2017

- Chapter 1 General
- Chapter 2 Additional Requirements to ANSI/ASHRAE/IES Standard 90.1 2010
- Chapter 3 Additional Requirements to the 2011 NECB.

Division 3 Energy Efficiency Design After December 31, 2016

- Chapter 1 General
- Chapter 2 Additional Requirements to ANSI/ASHRAE/IES Standard 90.1 2013
- Chapter 3 Additional Requirements to NECB 2015.

Division 4 Buildings of Non-Residential Occupancy within the Scope of Part 9 (before January 01, 2017).

Division 5 Buildings of Non-Residential Occupancy within the Scope of Part 9 (after December 31, 2016).

Procedures for Prescriptive and Simple Trade Off Compliance

The procedures are straight-forward. Based on location and use, select the values for building components from tables in SB-10 or the chosen standard. Envelope calculations are limited to area and percentage. Tradeoffs require balancing area weighted averages[7].

For Part 3 buildings:

- Determine if your building is exempt from the requirements of SB-10[8]. Existing buildings, open air buildings, camps, seasonal buildings and some industrial buildings are exempt from some requirements.
- SB-10 assumes a high level of air tightness in accordance with OBC Division B Part 5. While always important, the selection of appropriate materials, attention to detail and careful review during construction are critical to meeting Ontario's energy conservation targets.

[7] Area weighted averages trade off: the sum of the products of the component areas (Ai) by their respective U-values (Ui) of the proposed building (p) is less than the sum of the products of the component areas by the respective U-values of the reference building (r) or $\sum \boldsymbol{nUipAip} \leq \sum \boldsymbol{nUirAipr}$. COMCheck and CANQuest both offer useful forms for doing these calculations. In simple trade off you can trade within vertical components - windows and opaque walls or horizontal components - roofs and skylights but you cannot offset windows and walls with roofs. The areas of windows and opaque walls in the reference building must equal the areas in the proposed building. If you have 30% windows in your design you need to compare it with 30% windows in the reference building.

[8] Refer to OBC SB-10 Division 1, Sentence 1.1.1.1.(2) and Division 3, Chapter 1, Article 1.2.1.1. for exemption details.

- Determine the area of windows, doors and skylights and their percentage of the exterior walls and roofs respectively. This will determine which compliance paths are available to you.[9][10] Window area is typically limited to 40% in all prescriptive based solutions.[11]
- Determine the area of structural penetrations such as balconies, suspended and roof top equipment supports. These thermal bridges are limited to 2% of the exterior building envelope area, walls, roofs, exposed floors, doors and fenestration. Brick ties, flashings and intermediate structural connections are permitted thermal bridges.
- Determine the number of Heating Degree Days (HDD) for your building's location from OBC Volume 2 SB-1[12]. Select the appropriate tables from SB-10 Division 3 Chapters 2 or 3, Division 5 or ASHRAE 189.1[13] and record the required U, R, F and C-values[14] for the envelope components.

Chapter 2 - ASHRAE 90.1 2013 + SB-10 Division 3, Chapter 2

Since its first publication in 1975[15], ASHRAE 90.1 has been the most widely used energy conservation standard in North America. Ontario began referencing the standard in the 90's. In 2011 the province introduced SB-10. Based on 90.1, this supplement raised the performance of Ontario buildings to among the highest in North America.

To use this compliance option:

- Review ASHRAE 90.1-2013. General information to help you understand the 90.1 standard is in Chapters 1-4. Chapter 5, Building Envelope, contains the requirements for envelope compliance including the mandatory provisions. Aside from mechanical and electrical changes it is largely this chapter that SB-10 Division 3, Chapter 2 modified to suit Ontario's requirements. Appendix A has useful tables for converting assembly insulation thermal resistance RSI (R) values to assembly thermal transmittance U-values. Section 5.6 and Appendix C describe the method for trading between building elements[16].
- SB-10 and 90.1 limit the amount of glazing to 40% of the vertical envelope area[17]. The amount of glazing may be increased by using higher performance glazing provided the product of the Area and U value in the design building is less that that of the code compliant building. ASHRAE requires the use of energy modelling software to determine the trade-off values. One such program is COMCheck. It is free, intuitive and it includes the Ontario Energy Code OBC SB-10.

[9] Division 3 Chapter 2 (ASHRAE) prescriptive paths limit the area of windows and doors to 40% of the vertical envelope area (FDWR) and the area of skylights to 3% of all roofs (SRR).

[10] Division 3 Chapter 3 (NECB 2015) has higher prescriptive envelope requirements and limits window area from 40% FDWR for locations with Heating Degree Days (HDD) ≤ 4000 and 20% FDWR if HDD >7000. The allowable area decreases linearly from 40% - 20%. Appendix A to NECB includes a table for interpolation between 4000 – 7000 HDD.

[11] Trade-off options may permit the designer to increase the FDWR above 40% by using higher performance windows and lower U-values for the walls or increasing the area of skylights by decreasing the U-value of the roof.

[12] ASHRAE climate zones 5, 6 and 7 are referenced in SB-10 Chapter 2. Climate zones 4 – 8 are referenced in NECB 2015. Division 5 zones has 2 zones: below 5000 HDD and above 5000HDD.

[13] ASHRAE 189.1increases the performance of the component values in ASHRAE 90.1-2013.

[14] Definitions of U, R, F and C are provided at the end of the Practice Tip.

[15] First published as ASHRAE 90.

[16] Software is required. CANQuest and COMcheck are straight-forward and free software suitable for the analysis. Revit has built in energy analysis tools.

[17] The area of the vertical building envelope includes the area of walls below grade around conditioned space.

- Building orientation is an important and at times restrictive consideration. 90.1 limits the amount of glazing on each of the West & East facades to 25% of the total fenestration[18] There are several exemptions to the orientation restrictions, notably shading from nearby structures and landscape, which may affect your project. Neither SB-10 nor 90.1 include caveats regarding the orientation of the main entrance. Review ASHRAE 90.1 Sub-Section 5.5.4
- Select the requirements for building envelope components from tables SB5.5-5 to SB5.5-7 appropriate to the space conditioning category - Non-residential, Residential and Semi-heated. You may use either U, C & F values for complete assemblies or RSI (R) nominal values of the insulation within an assembly with RSI_{ci} for continuous insulation.
- SB-10 permits some thermal bridging, (intermediate structural connections, structural projections (if less than 2% of the wall or roof area), brick ties, flashing) through the continuous insulation. Refer to SB-10 5.5.3.7. & 5.5.3.8.
- The maximum permissible U-values for fenestration are for the complete assembly. The thermal conductivity may be higher through the frames than through the centre of the glass (CoG). This results, especially with aluminum framing, in a higher system U-value. It is the system U-value that is used to assess the code compliance.[19] The maximum Solar Heat Gain Coefficient (SHGC) for fenestration is listed in the tables. SHGC is affected by frame profile. Consult with the manufacturer to determine the system SHGC value. Shading devices or overhangs can significantly reduce SHGC. To determine the reduction, ASHRAE 90.1 provides tables in Appendix A.
- The minimum Visible light Transmission to SHGC (VT/SHGC) ratio for fenestration is included in the tables. This requirement recognizes the value of daylighting to energy conservation.
- 90.1 permits simple weighted averaging for multiple assemblies within a single *class of construction*, within the same *space conditioning category.* For example, you may use the weighted average U-value for steel framed walls and compensate for higher U-values in curtain wall spandrels by decreasing the U-value of other steel framed walls. ASHRAE requires the use of energy modelling software to determine the trade-off values.
- Record the U, C, F or RSI-values for all opaque envelope elements and the U, SHGC and VT/SHGC ratio for fenestration. It is recommended that these values be shared with all members of the project team.

Chapter 3 - NECB 2015 + SB-10 Division 3, Chapter 3

NECB 2015 + Chapter 3 performance requirements are generally higher than ASHRAE 90.1 2013 + Division 3. NECB does not include sub-classes of construction. Walls, roofs, floors and fenestration within a zone each have the same required value. NECB does not distinguish between space conditioning categories although some reduction in the requirements for semi-heated spaces is offered by reducing the HDD18 to HDD15. NECB + Chapter 3 offers a much simpler trade-off option than 90.1.

The procedure is similar to that above:

- Select the appropriate building envelope component values for your zone from the tables in SB-10 Division 3, Chapter 3. OBC SB-10 requires reduced thermal transmittance where electric heat is used. SHGC of fenestration is included to be more in line with SB-10 Division 3, Chapter 2 requirements.
- With the prescriptive path glazing is limited to a maximum of 40% for locations with HDD18 < 4000. The allowable area decreases linearly to 20% with increased HDD18.

[18] The amount of glazing facing East & West may be increased above 25% by using area weighted averaging and the formula $A_w \times SHGC_w \leq (A_t \times {}_{SHGCc}) / 4$ Refer to 90.1 Section 5.5.4.5 for details.

[19] Some manufacturers provide tables for determining the window assembly U-value based on, frame type, CoG values and window areas.

- NECB Part 3 allows simple area weighted averaging within envelope elements. Unlike 90.1 NECB offers 2 straight-forward trade off paths - simple and detailed.
- The simple trade-off permits trading within vertical elements and within horizontal elements. You cannot trade between vertical and horizontal elements. With this method the designer may increase the FDWR above 40% by using higher performance windows and lower U-values for the walls. Similarly, the area of skylights may be increased provided that the U-value of the roof is decreased. The FDWR of the reference building must conform to the zone limits in NECB.
- The detailed trade-off path permits trading between vertical and horizontal elements provided the total energy loss through the envelope of the proposed building is less than that through the reference building. You can increase the window area by decreasing the U-value of the roof. Keep in mind that large amounts of glazing will be difficult to compensate for.
- NRCan has developed convenience forms for recording NECB compliance acceptable to most municipalities. Your consultants should complete the forms for their disciplines.

ASHRAE 189.1-2014 Standard for the Design of High-Performance Green Buildings.

As the title suggests this standard covers many good design practices including much of what one expects to find in a LEED building. Solutions typically involve on-site renewable energy production. ASHRAE 189.1-2014 requires an increase of 10% in the performance values of envelope components found in 90.1-2013.

Energy efficiency requirements are found in Section 7. The procedures for prescriptive compliance with 189.1 are similar to those described for SB-10 Division 3, Chapter 2 above.

Division 5 - Buildings of Non-Residential Occupancy within the Scope of Part 9

Beginning Jan 01, 2018 designers have a single prescriptive compliance path for Non-Residential buildings within the scope of Part 9. The procedures in Division 5 are much like those in Division 3.

- Determine the number of HDD18 for your building's location from OBC Volume 2 SB-1 Climatic and Seismic Data for Locations in Ontario. Divisions 5 does not use the ASHRAE zones but uses 2 zones: Zone 1 less than 5000 HDD18 and Zone 2 5000 or more HDD18.
- Table 1.1.1.2. lists the performance requirements of envelope elements for the 2 zones.
- Record the U, C, or RSI (R) values for all opaque envelope elements and the U and SHGC for fenestration.

Carbon Dioxide Equivalents (CO2e)

CO_{2e} are a measure of the impact of energy use on the environment and global warming. They vary not only by the amount of energy used but by the source of that energy. The energy used to heat water by electricity generated from natural gas delivered over the grid produces twice the CO_2 of water heated on site by natural gas.

To determine CO_{2e} use the formula: $CO_{2e} = \sum$ energy by source in **kWh x** CO_2 emission factor in **kg/kWh** from Table 1.1.2.2.

Buildings which comply with the prescriptive requirements of SB-10 generally satisfy the OBC CO_{2e} limits and you are not required to record the $CO_{2e.}$ If you are using energy modeling, the design buildings' emissions must be less than or equal to that of the same building designed in accordance with the prescriptive requirements. Some energy modelling software will provide a prediction of the energy used by type. With this breakdown and the CO2 emission factors provided in SB-10, designers can calculate and record CO_{2e} on form 11 from MMA.

References

Definitions and Conversion Factors

1. **C-Factor (Thermal Conductance):** A measure of the heat flow through a building class of construction or a given thickness of material. Lower numbers indicate better insulating properties. C-Factor does not include the boundary air or soil films. The units for C-Factor are W/m²•K (Btu/hr•ft²•ºF).
2. ***Classes of Construction***: Doors, Fenestration, Floors, Roofs, Slab-on-Grade and Walls. Subclasses include: Doors: non-swinging, metal coiling and swinging, Fenestration: vertical and skylights, Floors: mass, steel joist and wood joist/other, Roofs: attic and other, metal building and insulation entirely above deck, Slab-on-Grade: heated and unheated, Walls: above-grade, below-grade, mass, metal building, steel-framed and wood framed/other.
3. **Conversion Factors:** Energy use is typically measured in Gigajoules (GJ) and kilowatt hours (kWh). I GJ = 278 kWh. Electricity is measured in kWh. Fuel Oil is measured in litres, 1 L = 10.20 kWh. Natural Gas is measured in cubic metres, 1 cubic metre = 10.36 kWh. Liquid propane is measured in cubic metres, 1 cubic metre = 7091.67 kWh.
4. **F-Factor:** A measure of the heat loss along the perimeter of a slab-on-grade. Lower numbers indicate better insulating properties. The units for F-Factor are W/m•K (Btu/hr•ft•ºF).
5. **HDD18**: Heating Degree Days 18 is the sum of the number of degrees the daily mean outside air temperature was below 18 C in a year. The imperial equivalent is HDD65. The conversion factor is HDD18 = 5/9•HDD65.
6. **HDD15**: Heating Degree Days 15 is the sum of the number of degrees the daily mean outside air temperature was below 15 C in a year.
7. **Parallel Path Losses:** The effect on the thermal transmittance of an assembly caused by framing members and structural penetrations in the same plane as the insulation. Parallel path losses take into account the thermal bridging caused by the framing and penetrations and can be significant. The effective RSI-value of a 92 mm steel stud wall with only mineral fibre insulation between the studs is approximately 50% of the nominal RSI of the insulation. For a 150 mm steel stud this drops to 35% of the nominal R-value of the insulation.
8. ***Space Conditioning Category****:* Non-residential conditioned space, residential conditioned space and semi-heated space.
9. **U-Factor (Thermal Transmittance):** A measure of the heat flow through a *class of construction* (e.g. a wall, roof, floor or window) including the boundary air films for a given thickness of material (e.g. insulation). Lower numbers indicate better insulating properties. The units for U-factor are W/m²•K (Btu/hr•ft²•ºF). U–factor is the inverse of R-value. Some window manufacturers provide easy to use graphs for determining the fenestration system U-value based on centre of glass U-value and the percentage of glass to rough opening. The National Fenestration Rating Council (NFRC) standard ANSI/NFRC 100-2014 sets out the procedures for determining the overall U-value of windows. Software such as “Therm” may also be used.

Codes, Standards and Guides

1. ASHRAE 90.1-2010, 2013 and 189.1-2014.
2. Model National Energy Code for Buildings 1997: (archived document) NRC Ottawa Library, 580 Booth St., TJ 163.5 B84 C214 1997
3. National Energy Code of Canada for Buildings 2015.
4. National Energy Code for Buildings 2011.
5. User Guide – National Energy Code for Buildings 2011, NRC-IRC-56134, 2014, CCBFC.
6. NFRC, ANSI/NFRC 100-2017, Procedure for Determining Fenestration Product U-factors.

7. Build Right Ontario, MMA Energy Efficiency Checklists for Part 3 Buildings and Part 9 Non-Residential Buildings. Note the Level 1 and 2 forms have minor differences notably Form 5.5.-1 which includes additional information regarding orientation. Both versions of Form 5.5-1 mention main entrance location. Neither OBC SB-10 nor 90.1 restrict main entrance location.
8. OBC Volume 1 Division B, Part 12 Resource Conservation and Environmental Integrity, MMAH.
9. OBC Volume 2 SB-10 Supplementary Standard SB-10, MMAH.

Software

1. CANQuest, Natural Resources Canada.
2. COMcheck. Pacific Northwest National Laboratory, Vers. 4. N.p., n.d. Web, US Department of Energy.
3. EE4, Natural Resources Canada.
4. Therm v 7.3.2.1, University of California, , October 2014.
5. Reference Procedure for Simulating Spandrel U-Factors, Vers 1.0, July 2017, The Fenestration Association of BC (FEN-BC).

Other References

1. All Practice Tips within the PT.36 Series.
2. Conway Architect Inc., OBC SB-10 Prescriptive Solutions Slide Presentation:
3. COMcheck, A Step by Step Guide, OAA
4. Conway Architect Inc., OBC SB-10 COMCheck ASHRAE 90.1 Trade-Off Options, Slide Presentation.
