Notes to Part 10 Energy and Water Efficiency

A-10.2.1.1.(4) Building or Independent Parts Thereof. The intention of sentence (4), for the purposes of Part 10, is to recognize that multiple independent structures atop a parkade, for example, can and should have their respective energy and emissions performances evaluated independently, both during design as well as operationally throughout their respective lifespans. The intention is to prevent the performance assessment of one independent structure from effecting the performance assessment of any other, thus eliminating the ability to trade-off energy and/or emissions performance(s) between independent structures.

A-10.2.1.2.(1)(a) Passive House. If designing to Passive House standard, then contact the Office of the CBO for potential recognition as being compliant with Article 10.2.1.2., where buildings and major occupancies designed and constructed to conform to the certification criteria for the Passive House Standard, may, at the discretion of the CBO, be deemed to comply with Article 10.2.1.2. provided the design's energy model is

a) version 9 or newer of the Passive House Planning Package, and

b) prepared by a Certified Passive House Designer, or Certified Passive House Consultant.

A-10.2.1.5.(1)(a)(ii) Subsidiary Structures with Conditioned Space. The intention of this wording is to allow separate ancillary structures such as garages or workshops, with conditioned space(s), to be constructed to the same requirements of a residential *building* with not more than 2 principal *dwelling units* rather than another standard such as ASHRAE 90.1, NECB, or ZEPB (10.2.2.5.) requirements that may be triggered based on use. Conditioned space is considered to be the alteration of interior space temperature, through the provision of heating or cooling. Rev. 12692

A-10.2.2.5.(4) Passive House (PER). Exceedances of the published Primary Energy Renewable (PER) criterion of the Passive House Standard may be accepted as complying with this Sentence where written approval has been provided by the Passive House Institute, or where additional energy efficiency measures have been included to the satisfaction of the Chief Building Official.

A-10.2.2.6. Calculating the Effective Thermal Resistance of Building Envelope Assemblies. The general theory of heat transfer is based on the concept of the thermal transmittance through an element over a given surface area under the temperature difference across the element.

To calculate effective thermal resistance, contributions from all portions of an assembly including heat flow through studs and insulation, must be taken into account because the same insulation product (nominal insulation value) can produce different effective thermal resistance values in different framing configurations. The resulting effective thermal resistance of an assembly also depends on the thermal properties and thickness of the building materials used and their respective location.

The following paragraphs provide the calculations to determine the effective thermal resistance values for certain assemblies and the thermal characteristics of common building materials.

Calculating the Effective Thermal Resistance of an Assembly with Continuous Insulation: Isothermal-Planes Method

To calculate the effective thermal resistance of a building envelope assembly containing only continuous materials – for example, a fully insulated floor slab – simply add up the RSI values for each material. This procedure is described as the "isothermal-planes method" in the "ASHRAE Handbook – Fundamentals."

Calculating the Effective Thermal Resistance of a Wood-frame Assembly: Isothermal-Planes and Parallel-Path Flow Methods

To calculate the effective thermal resistance of a building envelope assembly containing wood framing, RSI_{eff}, add up the results of the following calculations:

A. calculate the effective thermal resistance of all layers with continuous materials using the isothermal-planes method, and

B. calculate the effective thermal resistance of the framing portion, $RSI_{parallel}$, using the following equation, which is taken from the parallel-path flow method described in the "ASHRAE Handbook – Fundamentals":

$$RSI_{parallel} = \frac{100}{\frac{\text{\% area of framing}}{RSI_F} + \frac{\text{\% area of cavity}}{RSI_C}}$$

where

RSI_F = thermal resistance of the framing member,
RSI_C = thermal resistance of the cavity (usually filled with insulation),
% area of framing = value between 0 and 100, and
% area of cavity = value between 0 and 100.

Calculating the Effective Thermal Resistance of a Steel-frame Assembly

The parallel-path flow method described above for wood-frame assemblies involves simple one-dimensional heat flow calculations based on two assumptions:

- that the heat flow through the thermal bridge (the stud) is parallel to the heat flow through the insulation, and
- that the temperature at each plane is constant.

Tests performed on steel-frame walls have shown that neither of these assumptions properly represents the highly two-dimensional heat flow that actually occurs. The difference between what is assumed and what actually occurs is even more significant in steel-frame assemblies. Designers should consider the potential discrepancies in such assemblies and include them as part of their evaluation and energy models.

Calculating Gross Wall Area

Where the structure of the lowest floor and rim joist assembly is above the finished ground level or where the above-grade portion of foundation walls separates conditioned space from unconditioned space, they should be included in the calculation of gross wall area. Figure A-10.2.2.6.-A shows the intended measurements for the most common type of housing construction.

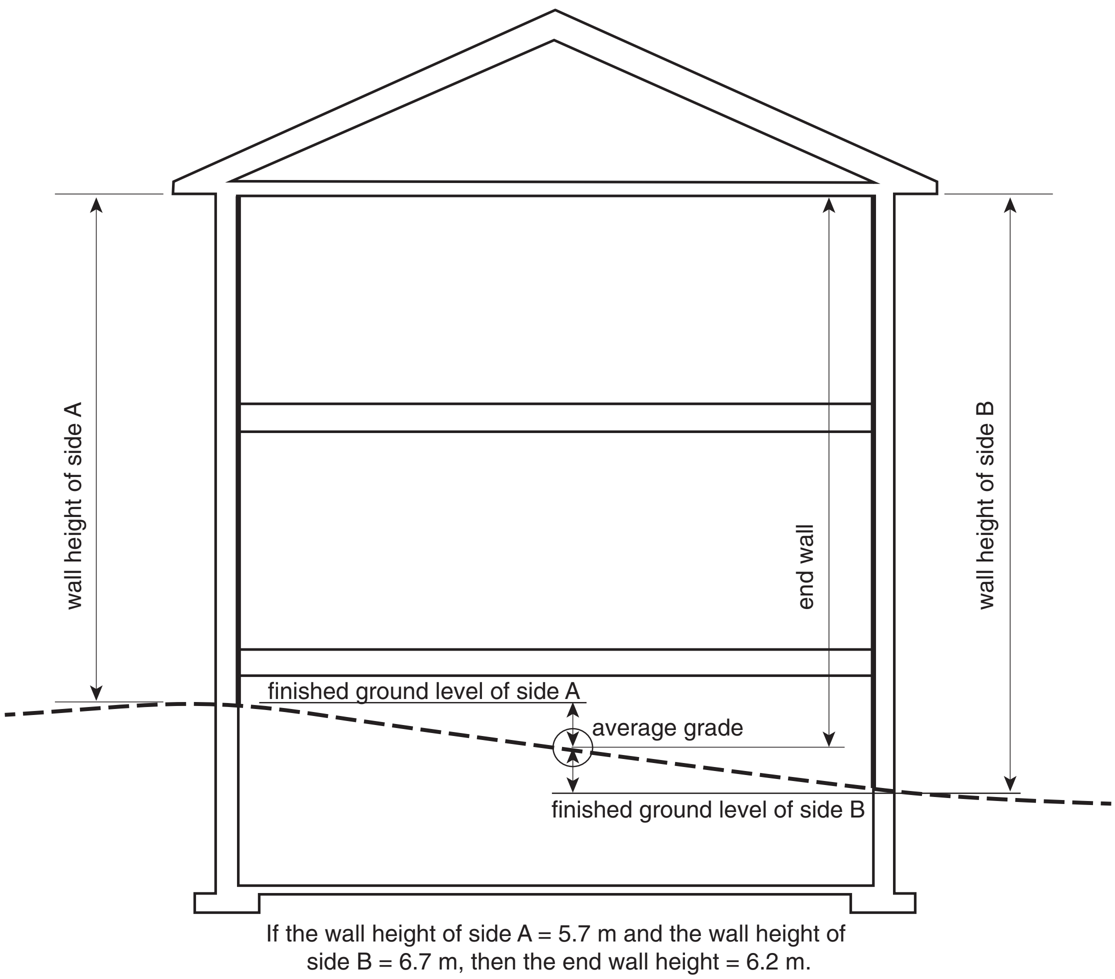

Figure A-10.2.2.6.-A
Example of interior wall height to be used in the calculation of gross wall area

Reduced Effective Thermal Resistance Near the Eaves of Sloped Roofs.

Minimum thermal resistance values for attic-type roofs are significantly higher than those for walls. The exemption in Note (1) of T-10.2.2.6. recognizes that the effective thermal resistance of a ceiling below an attic near its perimeter will be affected by roof slope, truss design and required ventilation of the attic space. It is assumed that the thickness of the insulation will be increased as the roof slope increases until there is enough space to allow for the installation of the full thickness of insulation required.

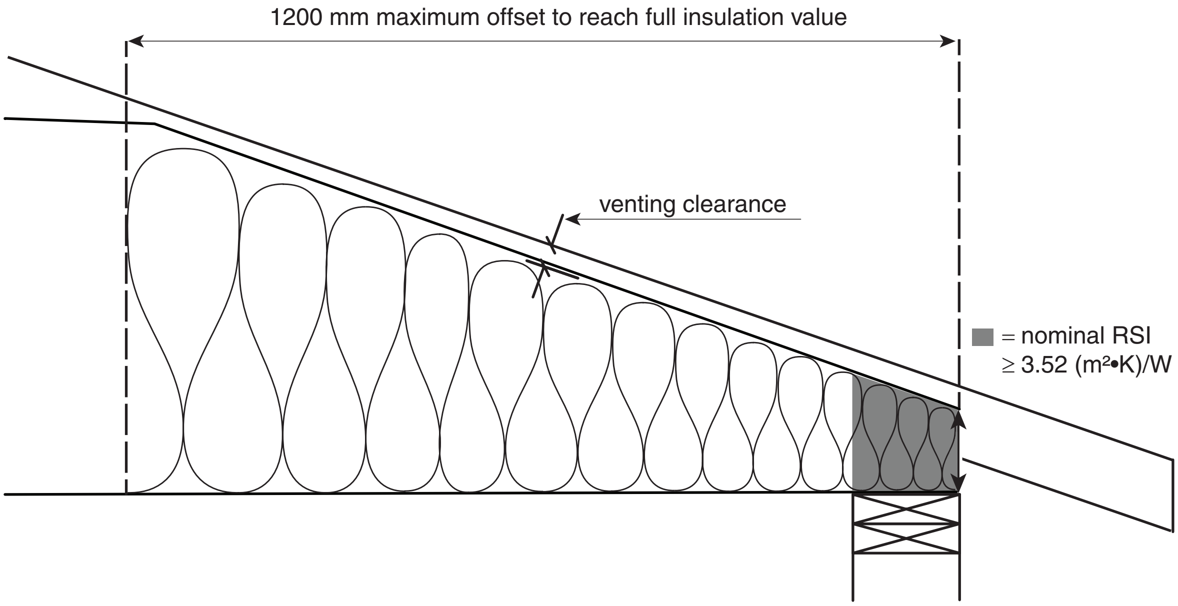

Figure A-10.2.2.6.-B
Area of ceiling assemblies in attics permitted to have reduced thermal resistance

A-10.2.2.7.(3) Building Envelope Windows, Skylights, Doors and Other Glazed Products. There are three compliance paths ('A' to 'C') available for fenestration products to comply with the energy performance requirements in Article 10.2.2.7. General guidelines are provided first, followed by the details of each compliance path.

General Requirements for Labels On Factory-Assembled Fenestration Products Rev. 12997

The U-value (either IP or SI) labeling and verification requirements for windows, doors, and skylights in British Columbia are stipulated in the Energy Efficiency Standards Regulation of the BC Energy Efficiency Act.

Labels bear the mark of a third-party verifier and follow NFRC 100-2010 or CSA A440.2-14 standards. Each product shall bear two labels: a removable "temporary" label indicating the product U-value, and a non-removable "permanent" marking or label identifying the verification entity, the product line and the manufacturer.

The organizations that verify U-values according to these standards require these labels to be applied at the factory. They do not permit labels to be applied at the jobsite without prior authorization of the verifier.

The U-value on a label is reported to two decimal places. To determine compliance, the U-value is rounded to one decimal place; for example: a USI-value of U 1.44 would be rounded to USI 1.4 and a USI-value of USI 1.45 would be rounded to USI 1.5.

General Requirements for Simulated U-value Reports

Products may comply with the By-law under a "flexibility provision" that demonstrates compliance by means of a simulated U-value report accompanied by supporting documentation. This provision provides a path by which a designer can provide "suitable documentation" of U-values for products that cannot be labeled because they are outside the scope of existing energy performance certification programs, and for imported products that do not yet have U-values determined using NFRC 100 or CSA A440.2 methods.

An electronic copy of the report and description of the chosen compliance path should be provided to the Building Official prior to sheathing inspection. A paper copy of the report must be present on-site for the Building Official at time of sheathing inspection.

Simulation reports must include the following:

1) A cover letter on the professional's letterhead that includes:

a) the professional's identity and contact information.

b) the street address(es) of the building.

c) the U-values (reported to two decimal places) for each product type, at its standard size as identified in NFRC 100 or CSA A440.2, at the actual project size, or at an average size product, depending on the compliance option.

d) verification by the registered professional that the information provided in the energy performance certification and accompanying documentation supports the U-value of the fenestration assembly or assemblies identified in the report.

e) the name, address and contact information of the fenestration product supplier(s).

f) the name, address and contact information of the glass supplier(s), if different from the fenestration product supplier(s).

g) the name, address and contact information of any individuals or firms that carried out energy performance simulations, if different from the registered professional.

h) a complete list of the supporting documentation attached to the letter.

i) the registered professional's seal and signature.

2) An attached documentation package that includes:

a) a list of each fenestration product type, quantity, size, area, description and U-value.

b) the sizes and configurations of the simulated products as shown by frame elevations and/or shop drawings, keyed to the list.

c) a table of the area-weighting calculations performed to determine the overall average U-value of all products using Method 1 or Method 2, of Option 2 of Compliance Path C, when applicable.

d) a description of each framing system used, including manufacturer name, series, and model numbers, as well as frame material and any internal reinforcing used.

e) a complete description of the glazing, including overall glass thickness, number of panes, pane thicknesses, gap widths, low-E coating manufacturer and type, low-E coating emissivity, and surfaces to which coatings are applied, type of gap fill with percentages of inert gas, complete description of spacer by make, series, and model, and its constituent materials, and insulating glass edge sealant materials.

f) NFRC or CSA A440.2 certified test data for each system, or isotherms for each unique framing member used in each system covered by the letter, (heads, sills, jambs, mullions) as well as all reinforcing metal in mullions and perimeter frames.

Compliance Path 'A' (Prescriptive U-value compliance)

Compliance is demonstrated by means of verifier labels, affixed to factory-assembled fenestration products at the manufacturing location in which each individual fenestration product has a compliant U-value. Compliance is achieved if each product meets the USI-value requirements required by Article 10.2.2.7., at its standard size as identified in NFRC 100 or CSA A440.2. Rev. 12997

When one or more products exceed the applicable USI-value in Table 10.2.2.7.(1), compliance Paths B or C may be employed.

Compliance Path 'B' (Labeled / Tested U-value area-weighted average compliance)

Compliance Path 'B' is intended for projects in which all products have U-values simulated at NFRC standard sizes.

Compliance path B requires area-weighting calculations but does not require actual size or project-specific simulation. When one or more products within Table 10.2.2.7.(1) exceed the applicable USI-value, compliance may be demonstrated by calculating the overall average USI-value by means of a tabulated USI x A reporting format. In such a table, the USI-values for the standard size of each product are to be multiplied by the area of the product to determine the average area weighted USI-value of all the products.

Under this option, standard size U-values from test and simulation reports from accredited laboratories may be used for unlabeled products. The U-value report with area-weighting calculations shall be submitted under the seal of a registered professional and may be subject to independent review at the discretion of city staff.

$$Overall\ U\ value = \frac{\Sigma U_1 A_1 + \cdots U_n A_n}{Total\ Area}$$

The area-weighting report shall include documentation of verified U-values by means of label reproductions or attached laboratory simulation reports. In the case of NFRC certified products, CPD numbers may be used in place of label reproductions.

Compliance Path 'C' (Simulated U-value compliance)

Compliance path 'C' is intended for projects that use products that cannot demonstrate compliance at standard size by means of labels or accredited laboratory test/simulation reports. Such products include:

- site-assembled windows, doors, Rev. 12997
- imported windows and doors not previously tested in Canada,
- curtainwalls and sloped glazing assemblies, and
- factory-assembled curtainwalls and window wall assemblies. Rev. 12997

Under this compliance path qualified professionals perform simulations for each Individual Product simulated in accordance with NFRC 100 procedures at the size and configuration defined in NFRC 100 Table 4-3, including the normative table footnotes. Individual Products are defined in NFRC 100 and may be grouped according to NFRC 100 Grouping Rules. Products that require metal reinforcing at project sizes shall be simulated with metal reinforcing. U-values may be reported using one of the following options:

Option 1 - All products conform to Table 10.2.2.7.(1) at standard sizes.

If all products are found to have USI-values that conform to Table 10.2.2.7.(1) at sizes in NFRC 100 Table 4-3, the standard size USI-values may be reported to demonstrate compliance with Article 10.2.2.7.

Option 2 - One or more products do not conform to Table 10.2.2.7.(1) at standard sizes.

Area-weighting the USI-values of products within a U-value group at actual project sizes may be employed to demonstrate compliance for that U-value group.

To comply with Option 2, area-weighted average USI-values may be computed using one of two methods:

Method 1 USI x A table of all products within a U-value group, tabulating frame size, frame area and USI-value for each individual product to compute an overall area-weighted average for all products within the U-value group.

Method 2 USI x A table of USI-values for each individual product at its average project frame size.

$$Overall\ U\ value = \frac{\Sigma U_{avg(1)} A_{System\ 1} + \cdots U_{avg\ (n)} A_{System\ n}}{Total\ Area}$$

Average project frame sizes shall be determined as follows:

1) Average frame sizes shall be determined for each individual product.

2) For fixed windows, the average frame size shall be based on averaging the width and height of all fixed daylight opening sizes for the fixed product type.

3) For curtain wall framing at single storey height, the average frame size shall be based on averaging the width and height of all fixed daylight opening sizes for the Window Wall product type.

4) For single panel operable windows and swinging doors, the average frame size shall be the average of all single panel operable product frame sizes of the same operator type.

5) For multiple panel side hinged products (swinging doors, folding doors), the average frame size shall be based on averaging the width and height of all panel sizes for the Swinging Door with Frame product type.

6) For sliding doors, the average frame size and number of panels will depend on the number of sliding door tracks. (The fixed lite of a sliding door shall be considered a panel.)

a) For two-track sliding doors, a two-panel door configuration shall be simulated having a frame size shall be based on two average size panels.

b) For three-track sliding doors, a three-track, three-panel door configuration shall be simulated having a frame size based on three average size panels.

c) For four-track sliding doors, a four-track, four-panel door configuration shall be simulated having a frame size based on four average size panels. (Etc.)

d) Simulations shall include two jambs, head and sill simulations with the glass in each panel position, and one interlock for each panel-panel joint of the configuration.

7) For individual unit (single lite) skylights, the average frame size shall be the average of all frame sizes of the same product type.

8) For skylights with more than one lite, the average frame size shall be based on averaging the width and height of all daylight opening sizes for the Sloped Glazing product type at the solarium-sunroom configuration in NFRC 100 Table 4-3 Note 3.

A-10.2.2.8 Vestibules. The intention of the vestibule requirements within 10.2.2.8. are to recognize that vestibules are breeches within a building's envelope and are the last line of defense against the interaction between a building's interior conditioned space and the ambient conditions. The vestibule design requirements are intended to minimize the transference of air and associated energy properties through the opening of these breeches, with or without the assistance of pressure differentials from internal sources such as stack effect or elevator operation, or external pressures such as wind load. Vestibules are therefore to be enclosed spaces without direct access by stairwells and elevators.

Specified distances between interior and exterior vestibule doors support typical daily operation. These specified minimum separation distances are to be deemed the vestibule's maximum separation distances as well, however, under circumstances deemed problematic by the CBO, these maximum distances may be extended by 1 foot increments until the design issue is resolved. For example, a 7 foot minimum spacing may not be possible due to interference from a structural column, in which case an application may be requested for an 8 foot separation. No request for a 9 foot separation will be considered without review of the 7 foot and 8 foot separation scenarios.

A-10.2.2.10 Exterior Lighting in Residential Buildings.

10.2.2.10.(1)(b) Master Switch. The objective is to require a master switch that will permit non-essential lighting to be turned off when an occupant leaves the premises. As this was only intended to consider residential portions of a building, it is considered acceptable to consider each portion of the building structure located above the parkade slab constructed to Article 3.2.1.2. on an individual basis given that the cost-effectiveness of such energy saving features would not be as significant for smaller structures with proportionally larger exterior wall and roof surface areas relative to their volume.

10.2.2.10.(2) Exterior Lighting. A growing body of evidence exists that identifies that excessive amounts of nighttime lighting (frequently referred to as light pollution) may be potentially harmful to the environment and to human wellbeing. Poorly controlled night time lighting in urbanized areas has been widely documented to have significant effects on the environment, such as increased skyglow, and physiological and behavioral changes to individual organisms. Research suggests that excessive nighttime lighting may be detrimental to human health.

Consequently, Sentences 10.2.2.10.(2) attempts to limit the quantity and quality of exterior lighting of buildings to reduce the impact and consequences of external lighting. Interior lighting emitted through glazed openings is also a concern, but this is largely dependent upon human activity, and it is not presently considered as part of these requirements. Nonetheless, it can be seen that conceptually this would also have similar effect as exterior lighting, so an effort should be made to minimize the potential for lighting trespass where possible.

The key components of Sentence 10.2.2.10.(2) requirements are the requirements for appropriate lighting fixtures that eliminate the upwards emission of light, and cast more of the illumination produced across the intended surfaces. Horizontal emission of lighting across the property line is more challenging due to the varying heights of a given building, but measures should be taken to reduce the potential and extent of lighting trespass to the limits specified. Additionally, the reflectance of adjacent surfaces that may be illuminated must also be considered as these also contribute to the total lighting emitted into adjacent properties. The orientation, reflectance, and illumination of the adjacent surfaces should be evaluated to limit backscatter or unintended reflectance.

To increase the likelihood of meeting the requirements, designers opt to

- Choose light fixtures that minimize backlight, uplight, and glare (BUG). Light fixtures with a BUG rating of UO are optimal.
- Choose luminaires with the lowest possible intensity for the task needed
- Consider warmer tones of 2500-3000K to reduce impact. A practical maximum temperature is 4000K.

10.2.2.10.(3) External Illumination. Understanding that there may be periodic needs to provide external illumination, the requirements of 10.2.2.10.(3) serve to exempt lighting specifically intended to enhance security, safety and improve visibility for limited periods of time.

A-10.2.2.15. Gas Fireplaces. Interior and exterior fireplaces connected to building services are to be included as part of the building for the purposes of meeting the energy targets of Part 10 of the Building By-law. The building performance model is to incorporate such features per the requirements of the City of Vancouver Modelling Guidelines.

A-10.2.2.17. Heat Recovery in Dwelling Units. Whereas Section 9.32. addresses the effectiveness of mechanical ventilation systems in dwelling units from a health and safety perspective, Article 10.2.2.17. is concerned with their functioning from an energy efficiency perspective.

The requirements of Subsection 9.32.3. can be met using one of several types of ventilation equipment, among them heat-recovery ventilators (HRVs), which are typically the system of choice in cases where heat recovery from the exhaust component of the ventilation system is required. As such, Article 10.2.2.17. should be read in conjunction with the provisions in Subsection 9.32.3. that deal with HRVs.

Efficiency of Heat-Recovery Ventilators (HRVs)

HRVs are required to be tested in conformance with CAN/CSA-C439, "Rating the Performance of Heat/Energy-Recovery Ventilators," under different conditions to obtain a rating.

The performance of an HRV product and its compliance with Article 10.2.2.17. can be verified using the sensible heat recovery at the 0°C test station (i.e. location where the temperature is measured) published in the manufacturer's literature or in product directories, such as HVI's Certified Home Ventilating Products Directory. Any energy model output must also demonstrate an SRE (%) that meets or exceeds the requirement of this By-law.

The rating of HRVs also depends on the flow rate used during testing. Therefore, the minimum flow rate required in Section 9.32. needs to be taken into consideration when selecting an HRV product.

Servicability of Heat Recovery Ventilators

Clause 10.2.2.17.(3)(j) identifies that heat recovery ventilators and similar devices form an integral part of the building ventilation and requires inspection,maintenance, repair, and cleaning from time to time to ensure that the building air quality remains within the original design parameters. In order to perform such regular maintenance or more extensive maintenance in the event of the failure of an HRV or similar device, the mechanical components of an Heat Recovery Ventilator are to be located and installed so as to provide a worker with adequate space and access to unit to conduct maintenance on the unite or replace it. Unusually tight, distant, or convoluted access may lead to regular maintenance being skipped, or lead to other significant challenges or costs for services and replacement.

A-10.2.2.20.(3) Modelling Guidelines for Large Homes. For a building required to comply with the greenhouse gas (GHG) limit, the total annual GHG footprint shall be calculated using approved modelling software and modelling criteria provided in the "Modelling Guidelines for Large Homes." Rev. 12997

A-10.2.2.21. Building Airtightness Testing Requirements. The intent of this testing is to quantify the airtightness level of the air barrier system, not airtightness of the building at in-service operating conditions

Air Barrier Assembly Testing

Air barrier assemblies are subjected to structural loading due to mechanical systems, wind pressure and stack effect. In addition, they may be affected by physical degradation resulting from thermal and structural movement. Where local climatic data and building conditions exceed these limits, the maximum building height and sustained 1-in-50 hourly wind pressure values are permitted to be extrapolated beyond the listed ranges to apply to any building height, in any location, provided the air barrier assembly in question has been tested to the specific building site and design parameters.

Air Barrier System Approaches

For an air barrier system to be effective, all critical junctions and penetrations addressed in must be sealed using either an interior or exterior air barrier approach or a combination of both.

Where the air barrier and vapour barrier functions are provided by the same layer, it must be installed toward the warm (in winter) side of the assembly or, in the case of mass walls such as those made of cast-in place concrete, provide resistance to air leakage through much of the thickness of the assembly. Where these functions are provided by separate elements, the vapour barrier is required to be installed toward the interior of the assembly while the airtight element can be installed toward the interior or exterior depending on its vapour permeance.

A-10.2.2.22 System Requirements for Heating within Exterior Spaces. The use of the terms "licensed beverage establishment" and "licensed food establishment" are meant to clarify how the allowance of 10.2.2.22 is limited to business-licensed establishments where the primary use is the consumption of food or beverages while seated.

The intention of Article 10.2.2.22 is not to require exterior heating, rather it is meant to minimize energy use and emissions when choosing the option of providing some level of occupant heating within an exterior space. The City of Vancouver recognizes a number of options however the prioritization of these options must also take into account their viability with existing and potential site conditions. Sentence 10.2.2.22.(2) is intended to be understood as "first consider the viability of option (a), either in whole or in part, then consider the viability of option (b) in whole or in part, then consider option (c)", and so on. If the most viable solution is a mixed system then this would be encouraged, but if the best, most viable solution is a single option then proceed with that option. Designers wishing to consider a unique system, such as using waste heat, are encouraged to do so and should contact the CBO's office if any customized system design does not easily fall into the options provided.

The control items within sentence 10.2.2.22.(4) are meant to assist with the efficient operation of the heating system. It is important to note that exterior spaces are not intended to operate as if they are interior conditioned spaces. The maximum recommended temperature for exterior spaces with heating systems is 18C, and so the ambient and space temperature sensors should be set accordingly. The ambient sensor is intended to prevent the heating system from operating during warm weather while the space temperature sensors are meant to accommodate naturally occurring temperature variations across adjacent zones (direct sun vs shade), thus allowing independent zone control operation. The space temperature sensors may override the ambient sensor to prevent zones from either overheating or over cooling. The timeclock will satisfy the mandatory requirement of not operating exterior heating systems after the establishment's hours of operation. At no point should the controls system automatically activate exterior space heating.

Zoned systems are most likely to be electric radiant and so are limited to 4,800 W (240V @ 20 amp). At the maximum allowable intensity of 18 W/ft^2 this would equate to 266 ft^2 per zone, however less energy intensive systems would be allowed to cover a larger area, for example, a 15 W/ft^2 system would allow 320 ft^2 per zone.

For multi-system design scenarios, sentence 10.2.2.22.(6) is intended to clarify the options and opportunities this may provide. The total energy intensity of a combined system shall not exceed the highest allowable intensity of the system types involved. Example: where an overhead electric radiant system is allowed to operate at 18 W/ft^2, a combined system of in-slab heating with an overhead radiant system cannot be designed to exceed a combined total operation of 18 W/ft^2. This scenario allows in-slab heating at 8 W/ft^2 while limiting the overhead heating to 10 W/ft^2, or the possibility of 5 W/ft^2 and 13 W/ft^2 respectively. This concept allows one system to be used during warmer weather with the option for a secondary system as a top-up during colder weather.

A-10.3.1.1. Electric Vehicle Charging for Buildings. The Canadian Electrical Code, Part I contains the requirements of electric vehicle charging systems, the requirements of Rule 86-300(2) and (3) recognize the use of load management technologies via the manual transfer or automated control in a branch circuit that supplies the electric vehicle supply equipment load and other loads. This Rule requires that, where the electric vehicle supply equipment load and other loads are installed, only one load can be operated at any one time and the branch circuit must be based on the calculated demand in accordance with Section 8.

All references to the electrical installation including receptacle, supply equipment and rating of voltage and ampere in Article 10.3.1.1. are intended to align with the requirements of SAE AC Level 2 charging requirements, whether in applying load managed solutions or separate branch circuits for each charging point. In addition to the requirements of Article 10.3.1.1., the installation of electric vehicle charging systems and electric vehicle supply equipment must meet the requirements of the Canadian Electrical Code, Part I and the manufacturer's instructions.