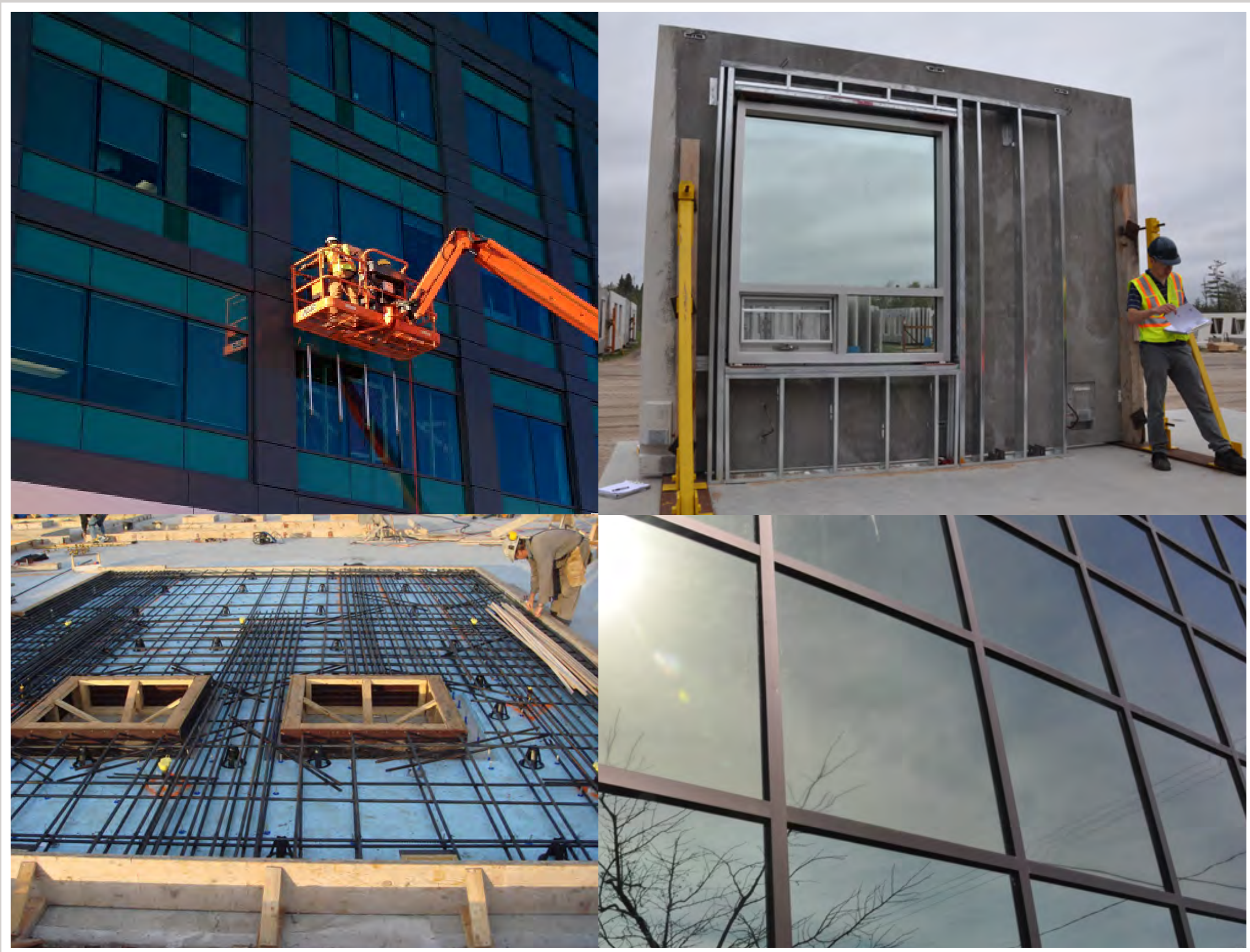

GUIDE TO BETTER BUILDING ENVELOPES FOR LARGE BUILDINGS — 2016

Newfoundland Labrador

This Guide was developed in partnership with:

ThermalWise
BUILDING ENERGY SAVINGS

DISCLAIMER:

This Guide is intended to provide general information on building envelope design and construction best practices. This Guide is not a replacement for knowledge of construction techniques, building science and relevant building codes and it is not intended to provide construction or design advice. We cannot guarantee that all information is current or accurate. Users should verify the information before acting on it. References in this Guide to other sources of information are presented as a convenience to users. The Government of Newfoundland and Labrador, does not accept any responsibility for the content, accuracy, reliability, or currency of information contained in this Guide or in sources of information referenced by it. Information in this Guide is provided solely for the user’s information and it is provided without warranty, guarantee, or responsibility of any kind, either express or implied. The Government of Newfoundland and Labrador and its employees will not be liable for any loss or damages of any nature, either direct or indirect, arising from use of the information provided in this Guide.

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Source: John Hearn Architect Inc.

PREFACE

PURPOSE OF THIS GUIDE

This Guide is intended to provide an overview of some best practices for the design and construction of more energy efficient building envelopes. This Guide is focused on *larger* buildings. Generally, this means buildings with a footprint over 600 m^2 (6,458 ft^2) that are primarily institutional, commercial or industrial in use. Readers who work in the multi-unit-residential sector may also find some of the Guide's content useful. The Guide also primarily applies to new construction projects.

Readers who are interested in learning more about energy efficient house and small building best practices and code requirements are encouraged to look at the province's *Guide to Building Energy Efficient Homes and Small Buildings*.

The building envelope has a significant impact on the energy consumption of a building. While there are other factors that influence a building's energy consumption (heating/cooling systems, ventilation systems, lighting, etc.), the building envelope is the one component that is often most difficult to upgrade or change after construction. Because of this, it's important to build a high performing building envelope from the start.

In addition to providing an overview of some large building envelope design and construction best practices, this Guide provides background information on Leadership in Energy and Environmental Design (LEED), ASHRAE 90.1 and the National Energy Code for Building (NECB). The Guide cannot replace any of these resources, nor is it intended to. Instead, it is designed to serve as an introduction to how these rating systems, standards and codes are influencing building envelopes.

The Guide is divided into three main parts:

- Section 1 provides an overview of what the building envelope is and of how the design and construction industry is moving towards higher performing building envelopes. This section outlines the relationship between building envelopes and rating systems, standards and codes such as LEED, ASHRAE 90.1 and NECB.

- Section 2 of the Guide provides an overview of some best practices in high performance building envelope design and construction. These include: designing for higher *effective* assembly insulation values, minimizing thermal bridging; optimizing glazing, and specifying and verifying building envelope performance.

- Section 3 of the Guide provides additional information on each of these best practices and provides some resources that will help designers and contractors implement them. This includes highlighting tools that are available to designers and contractors that can be used to implement building envelope best practices.

Source: John Hearn Architect Inc.

SECTION 1

INTRODUCTION

INTRODUCTION

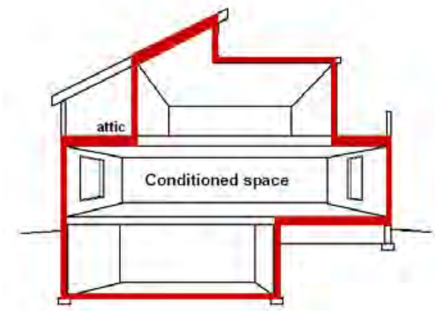
THE BUILDING ENVELOPE

Before digging in, let's start with a brief overview of what the "building envelope" is. In the simplest terms, the building envelope (or "building enclosure") is what separates a building's interior, conditioned space from the exterior, unconditioned space. Building elements commonly associated with envelopes or enclosures include:

- Floors,
- Ceilings/Roofs,
- Walls,
- Windows, and
- Doors.

Building envelopes have a number of *functions*. A few of the major ones are:

- Energy conservation,
- Water/vapour control,
- Air control,
- Sound control,
- Fire safety, and
- Security.



Source: *Keeping the Heat In*, Natural Resources Canada

Often building envelopes include elements like studs, beams, etc., which means they're also providing a structural function.

Each of these functions can have a performance level associated with it. For example, by adding more insulation to a wall we would assume that we're increasing the building's ability to conserve energy and therefore increasing the building's energy conservation functional performance.

This concept of functional performance becomes important when we want to design and construct better building envelopes because it's the means by which we can measure our success. Specifying and verifying higher functional performance is how we'll know that we have a better building envelope!

INFLUENCES ON BUILDING ENVELOPE DESIGN AND CONSTRUCTION

Building envelope design and construction decisions are largely influenced by the building owners' requirements (often referred to as owners' project requirements or OPRs), cost and the architects' design suggestions. In addition to these influences, building envelope design and construction is affected by:

- Building location and climate;
- Building function;
- Building codes; and,
- The availability of materials and onsite resources.

Consider for example a quick-service restaurant being designed for Western Labrador. We would likely assume that adding more insulation would be important due to the building's colder climate and increased need for heating.

We might also want to consider the *constructability* of the eventual building due to the fact that the location may mean fewer materials and resources are available on- or near-site. We would also assume that the projected life cycle of this building would be less than that of a multi-storey office building.

These assumptions would lead us to believe that the building envelope for this building will likely be different from those for other building types located in more densely populated and relatively temperate climates.

Building codes are perhaps the most important influencer of building envelope design and construction. In Newfoundland and Labrador, the most widely used code is the National Building Code of Canada (NBC). The NBC addresses the design and construction of new buildings and the substantial renovation of existing buildings, and is "objective-based." What does this mean? It means that all the requirements in the Code are linked to one or more of the following objectives:

- Safety
- Health
- Accessibility
- Fire and Structural Protection of Buildings
- Energy Efficiency (as of December 2012 for Part 9 buildings)

While the National Building Code governs many of the basic requirements for buildings, there are a number of other rating systems, codes and standards that are influencing the design and construction of building envelopes across Canada and also here in the province. There are three main ones that relate to energy efficiency and greener design and construction:

1. Leadership in Energy and Environmental Design (LEED);
2. ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings; and,
3. The National Energy Code for Buildings (NECB).

Let's take a look at each of these and how they relate to building envelope design and construction.

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED)

Leadership in Energy and Environmental Design (LEED) is a widely known family of green building rating systems. In Canada, LEED is managed by the non-governmental, not-for-profit Canada Green Building Council. There are a number of LEED rating systems, including ones for neighbourhood developments, new construction, existing buildings, homes and commercial interiors.

LEED is an optional rating system that deals with comprehensive green building practices. These include:

- Energy efficiency;
- Sustainable site practices;
- Efficient use of water;
- Environmentally preferable material usage and waste management;
- Better indoor environmental quality; and,
- Innovation and better design practices.

The Province of Newfoundland and Labrador's "Build Better Buildings Policy" requires that a project receiving provincial funding pursue LEED Silver certification. What does this mean for building envelope design and construction?

The LEED rating system for new construction requires that projects meet a certain minimum energy efficiency target. However, projects are given flexibility in how they meet this requirement. To demonstrate compliance every project must complete an energy model to demonstrate that the proposed building will meet the energy efficiency target. This energy model takes into account improvements in the building envelope, mechanical systems (heating, cooling and ventilation), hot water, lighting, fans and motors. Some projects decide to put more emphasis on mechanical system efficiencies, some decide to put more emphasis on building envelope improvements and many decide to do both!

ASHRAE STANDARD 90.1

ASHRAE Standard 90.1 is an optional energy standard that applies to most building types other than low-rise residential buildings. ASHRAE stands for the American Society of Heating, Refrigeration, and Air Conditioning Engineers. This organization, with a large international membership base, develops a number of standards, including ones for the design and construction of energy efficient buildings. ASHRAE standards are used widely throughout the world. ASHRAE Standard 90.1 is frequently referenced in North America when more energy efficient construction is being specified. In Canada, ASHRAE 90.1 is used widely in Ontario and British Columbia. The Standard addresses building envelope, mechanical systems, hot water systems, lighting, controls and fans/motors.

ASHRAE 90.1 allows users to demonstrate compliance using either a prescriptive or performance pathway. The basic difference between these two pathways to code compliance is:

- The Prescriptive Pathway uses a checklist approach to make sure minimum requirements are met (including minimum building envelope insulation requirements); and,
- The Performance Pathway uses a computer model to show that the building is meeting minimum energy efficiency requirements.

ASHRAE 90.1 is updated every 3 years, with each update becoming more ambitious in terms of energy savings. Jurisdictions outside of Newfoundland and Labrador who are implementing ASHRAE 90.1 as a required energy code often reference either ASHRAE 90.1 2010 or ASHRAE 90.1 2013.

THE NATIONAL ENERGY CODE FOR BUILDINGS (NECB)

The National Energy Code of Canada for Buildings (NECB) is a model energy code for larger buildings in Canada. While not a requirement in Newfoundland and Labrador, it has been adopted as a requirement in some other provinces. The most recent version of NECB is NECB 2015, however most jurisdictions that require compliance are using NECB 2011.

Similar to ASHRAE 90.1, NECB allows users to demonstrate compliance using either prescriptive or performance pathways. NECB's prescriptive compliance requirements for building envelope insulation are relatively significant, requiring more insulation than is currently common practice for commercial, industrial and institutional buildings. Most larger projects in areas where NECB has been adopted choose to use the energy modelling/performance compliance pathway, as it allows for more flexibility.

PRESCRIPTIVE COMPLIANCE EXPLAINED

In some ways, prescriptive compliance is the most straightforward method for complying with either ASHRAE 90.1 or NECB. Think of it like a checklist. Energy efficiency requirements are listed by building component (walls, attics, windows, mechanical systems, etc.) and all a project needs to do is make sure that it meets the requirements for each one.

PERFORMANCE COMPLIANCE EXPLAINED

The performance compliance pathway is all about showing that the proposed building will be as energy efficient as, or more energy efficient than, a computer model of a similar building built to the prescriptive requirements of either ASHRAE 90.1 or NECB. This option allows projects the most flexibility but can be more complicated due to the need to produce an energy model.

As we mentioned earlier, building envelope design and construction decisions often depend on where a project is located. Given that it can be much colder in northern parts of the province, it only makes sense that you'd want more insulation in Western Labrador than you'd want in St. John's.

The NECB lists building envelope insulation requirements by "climate zones." For the purposes of the Code, a climate zone is an area that shares roughly the same heating requirements. These heating requirements are expressed as "heating degree days," basically a measure of how much heating you need to use to stay comfortable.

The map on the next page shows Newfoundland and Labrador's four climate zones. If your climate zone isn't obvious from the map, you can also refer to the list of municipalities in Appendix A.

We'll return to climate zones in the next section of the Guide, when we explore some of the NECB prescriptive requirements.

WHAT EXACTLY ARE HEATING DEGREE DAYS?

Heating degree days reflect the demand for energy needed to heat a building. They measure how much (the degree part) and for how long (the day part) the outside temperature stays below a certain level. The Code uses 18°C as the base temperature. Heating degree days are calculated by using historic climate data. As an example, for April 1st a town may have 7 degrees as the highest and -1.9 degrees as the lowest temperature, which gives an average of 2.6 degrees, which is subtracted from the base temperature of 18°C to give the heating degree day reading of 15.4. This is repeated for each day of the year and added together. The higher the number of heating degree days, the more heating you'll need to do.

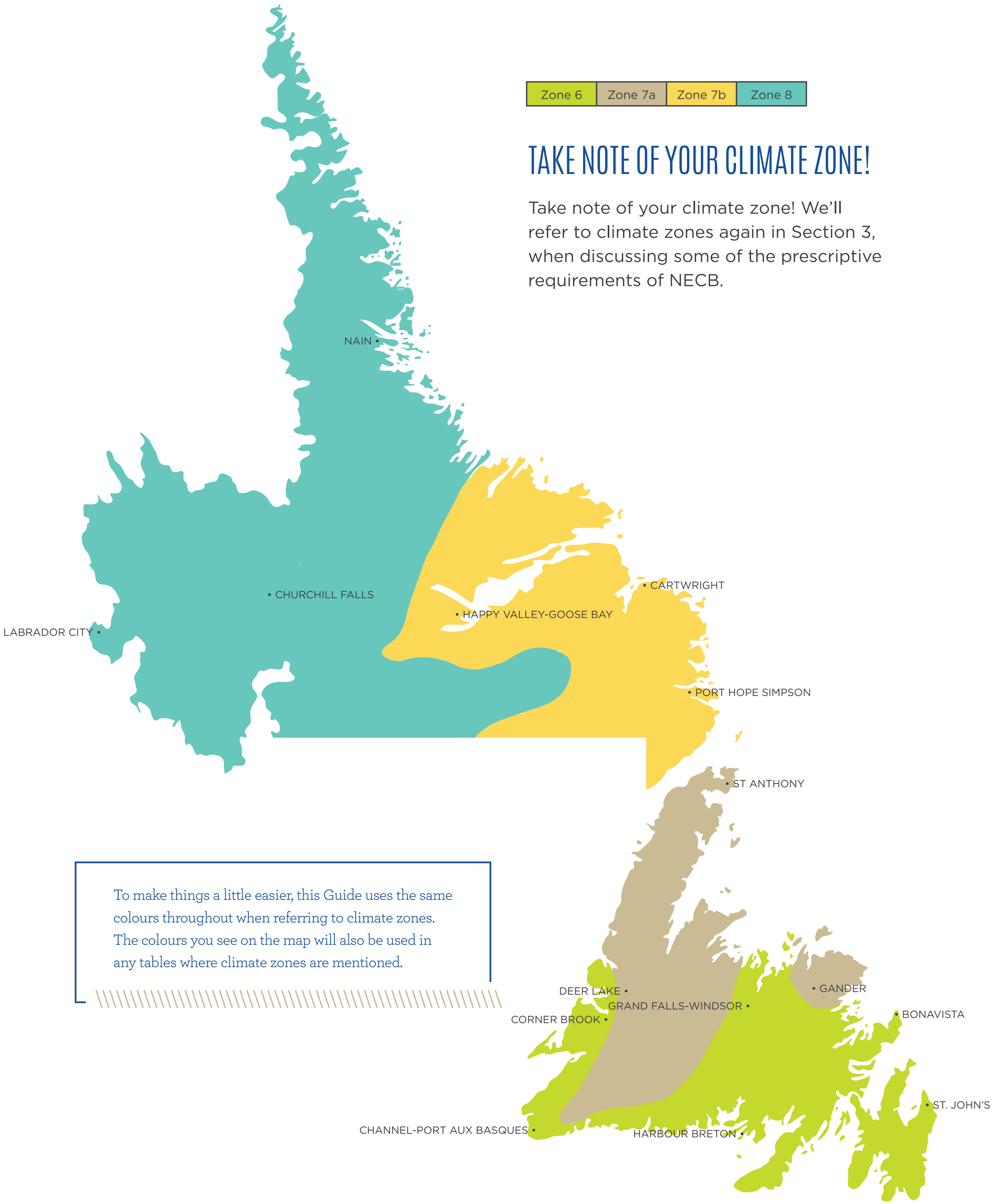
- Zone 6 includes places that have between 4,000 and 4,999 heating degree days
- Zone 7a includes places that have between 5,000 and 5,999 heating degree days
- Zone 7b includes places that have between 6,000 and 6,999 heating degree days
- Zone 8 includes places that have 7,000 or more heating degree days

PUSHING THE ENVELOPE

Though LEED, ASHRAE 90.1 and NECB don't explicitly require that buildings have better insulated building envelopes, they do require that buildings on the whole be more energy efficient. One of the key strategies for projects to accomplish this is to include higher performing building envelopes. In practice, this means that LEED, ASHRAE 90.1 and NECB projects will most likely have building envelopes that have higher insulation values, higher performing glazing, and generally higher specified overall performance. The next section of this Guide looks at some of the best practices that will help accomplish this.

TAKE NOTE OF YOUR CLIMATE ZONE!

Take note of your climate zone! We'll refer to climate zones again in Section 3, when discussing some of the prescriptive requirements of NECB.



To make things a little easier, this Guide uses the same colours throughout when referring to climate zones. The colours you see on the map will also be used in any tables where climate zones are mentioned.

SECTION 2

BUILDING ENVELOPE BEST PRACTICES

BUILDING ENVELOPE BEST PRACTICES

BEYOND CODES, RATING SYSTEMS AND STANDARDS

Now that we understand how optional energy standards, codes and green rating systems can positively affect building envelope design and construction, let's take a look at some of some of the best practices that support this. The following four best practices will be explored in this section:

1. Achieving higher effective insulation values;
2. Reducing thermal bridging;
3. Choosing more appropriate glazing ratios and improving glazing performance; and,
4. Specifying and verifying functional performance.

Let's look at each one of these best practices in a little more detail.

ACHIEVING HIGHER EFFECTIVE INSULATION VALUES

One of the key strategies to improving building envelope performance is increasing insulation levels. It's important to understand, however, that an insulation's ability to insulate is significantly affected by where and how it's installed. This fact becomes more clear once the difference between nominal and effective insulation values is understood.

EFFECTIVE VS. NOMINAL INSULATION

When you buy insulation and install it in a building, chances are, the wall, ceiling or floor won't have the same insulation value as the insulation you've just installed.

Why not? Well, walls, ceilings and floors have other materials in them that have different insulating properties. If you were building a wall out of just R-19 fibreglass batts (that is, without a stud frame in the wall), then you would have an R-19 wall. In this case the *effective* R-value of the wall would be the same as the *nominal* R-value of the insulation. But walls are more than just insulation.

Consider a wood stud wall where there is both insulation and wood framing:

- Everywhere there's a stud, the R-value of the wall is approximately R-5.5 because the R-value for wood is about R-1 per inch. Everywhere there's insulation, the R-value of the wall is approximately R-19 because that's what the insulation's nominal R-value is.
- If the wall has a stud every 16 inches, as most conventional wood frame walls do, then only 77% of the wall is made up of areas with insulation. The rest of the wall is wood framing. Because of this, the R-value of the whole wall is going to be less than the R-19 nominal rating for the insulation. This total performance R-value of the wall is referred to as the effective R-value. In the case of this wall, the effective R-value is R-15.96.

Steel stud walls perform even worse from an overall effective insulation perspective. Substituting the wood studs in the wall above for steel studs would result in an overall effective R-value closer to R-10. This is because steel studs do a better job conducting heat. And thermal conductance is something that we don't want to happen in a building assembly!

One of the biggest changes in many codes is that there are now effective insulation requirements for building components. Effective insulation values describe how "effective" an area is at resisting heat transfer. Insulation is usually rated by its "R-value" or RSI. This is a reflection of its insulating property. The higher the R-value, the better the insulation is. The better the insulation is, the slower heat moves through it. When you buy insulation you'll see an R-value or RSI on the package. This R-value or RSI is a rating for the insulation that's in the package. It's often referred to as the insulation's "nominal" insulation value.

In the next section of the Guide you'll find an overview of some techniques and tools that can be used to help you improve and determine the effective insulation values of building assemblies.

REDUCING THERMAL BRIDGING

Now that we understand the difference between *effective* and *nominal* insulation values, let's take a look at one of the key strategies to increase the *effective* insulation value of assemblies – *minimizing thermal bridging*.

Thermal bridging occurs when there is a "pathway of less resistance" for heat to move through a building assembly. One common example of thermal bridges would be studs in an exterior wall without continuous insulation. The diagram to the right shows how the studs, with lower thermal resistance values (or higher thermal conductance values), transfer heat through the wall. This isn't something we want happening!

One common strategy for dealing with thermal bridging is to add continuous insulation. The diagram to the right also shows how this can be effective.

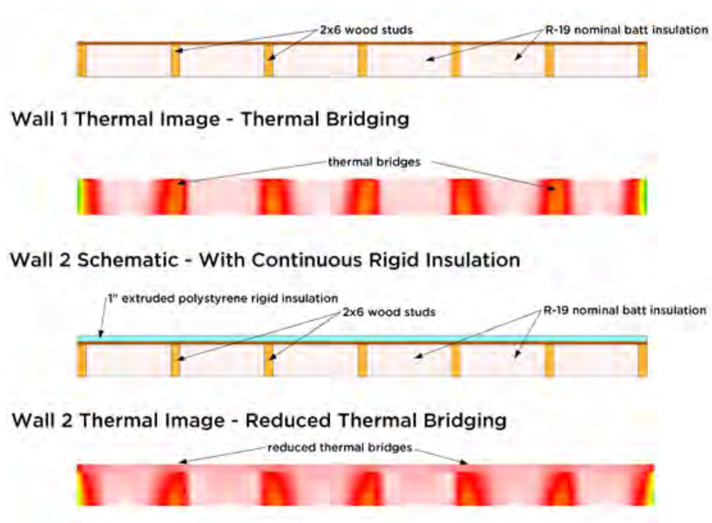
A NOTE ON UNITS

Generally speaking, when we're comparing the insulating value of building products or building assemblies we're usually looking at either the thermal resistance or the thermal conductivity.

If we're looking at thermal resistance, a higher thermal resistance would be better. The measures commonly referred to here are R-value (imperial – IP) and RSI (metric – SI). To convert from RSI to R-value multiply by 5.678. To convert from R-value to R-value divide by 5.678. For both R-value and RSI, higher numbers are better from a thermal performance point of view.

If we're looking at thermal conductivity, a lower thermal conductivity would be better. The measures commonly referred to here are U-values or U-factors. U-values/U-factors are the inverse of thermal resistance values. To convert from R-value or RSI to U-values simply invert the number (1/R-value or 1/RSI equals the U-value). When doing this you'll want to watch your units to make sure you're consistently dealing with IP or SI units or converting appropriately.

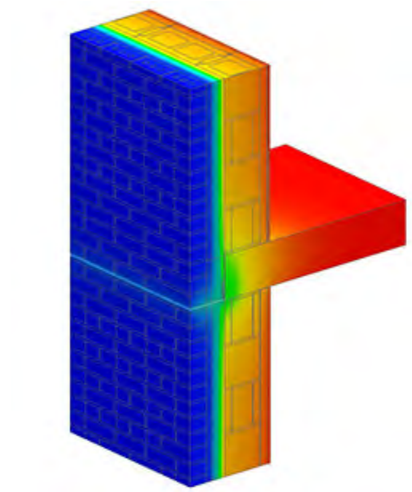
You'll notice that both ASHRAE 90.1 and NECB list building envelope requirements primarily by thermal conductivities (U-values). ASHRAE 90.1 does it using the IP units (1/R-value) and NECB does it using the SI units (1/RSI).



Thermal bridging doesn't just occur through steel and wood studs, however. There are a number of other areas where you can have thermal bridging in the building envelope. Some of these include:

- Window/wall transitions,
- Balcony/slab edges,
- Parapet/ceiling connections,
- Service penetrations, and,
- Exterior cladding attachments.

Some resources that can be used to help designers and contractors minimize thermal bridging are referred to in the next section of the Guide.

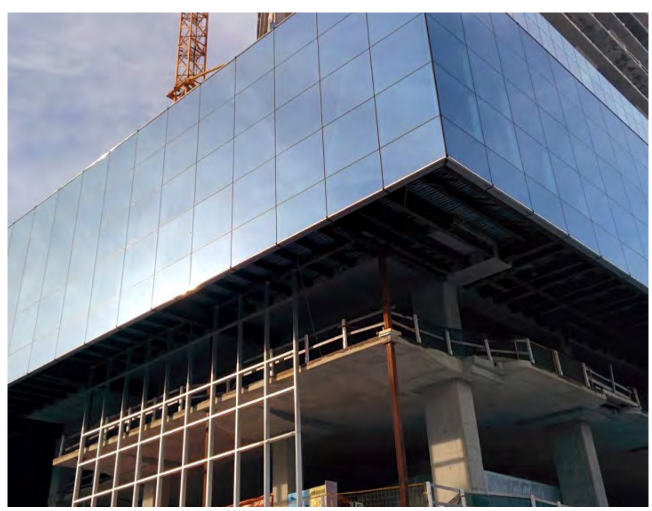


Source: *Building Envelope Thermal Bridging Guide*, Morrison Hershfield/BC Hydro

> The easiest way to ensure a better effective R-value for walls is to install continuous insulation. This approach will minimize thermal bridging that takes place through the structural elements in the wall (studs, beams, etc.).

APPROPRIATE GLAZING RATIOS AND IMPROVED GLAZING PERFORMANCE

More and more buildings have larger areas of windows, doors or curtain walls. While the increased amount of glazing area can be advantageous from a daylighting perspective, these areas are usually the "weakest link" in the building envelope from a thermal performance point of view. While walls can have typical effective R-values from R-12 to R-27, windows, curtain walls and doors usually have effective R-values between R-2 and R-6.



Increasing the relative area of windows and doors to wall area can have a significant effect on the overall thermal performance a building envelope. This ratio between areas is often referred to as the window-to-wall ratio. Increasing this ratio will often result in lower overall envelope performance.

Consider the example in this column below where there is a wall that has an effective R-value of 22.71. The windows being installed in this hypothetical project have an R-value of 2.58. This is approximately the expected performance of a typical double-glazed commercial window. The vertical axis of the graph shows the overall effective R-value of the assembly, factoring in the windows. The horizontal axis of the graph shows the window-to-wall ratio, increasing from 0% windows at the left to 90% windows at the right. The highlighted yellow area shows the typical glazing ratios for buildings, though many buildings are now being built with even more than 50% window-to-wall ratios.

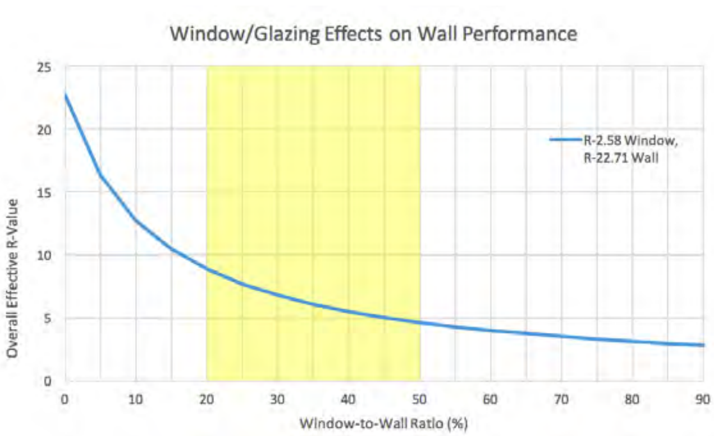
As you can see from the graph, increasing the window area relative to the wall area has a significant effect on overall thermal performance! If we were to have 20% of our wall area be windows in this scenario, the overall effective thermal performance of the wall assembly would be approximately R-9. Quite the reduction from our R-22.71 wall!

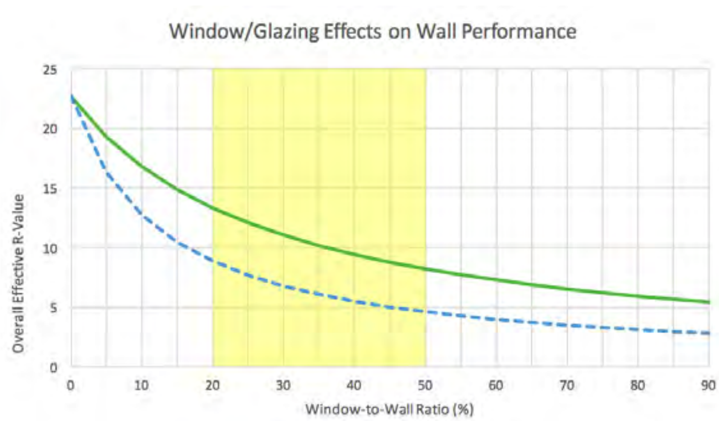
20% might be a typical window-to-wall ratio for a single-family home. Office buildings and institutional buildings are typically between 30% and 40% or more. If we increased our window area in this scenario to 40% of the wall area, the overall effective thermal performance of the envelope would fall further to R-5.5.

The best practice for dealing with reduced envelope performance as a consequence of increased glazing area is obviously to decrease the relative amount of glazing area. This isn't always possible or desirable, however. Choosing higher performance windows, doors or curtain walls is another good strategy to employ.

The green line in the graph below shows the same wall as the example above except this time the window performance has been increased from R-2.58 to R-5 (or an SI U-value of 1.13). The dotted blue line shows the original scenario. With the improvement to the window, the wall now has an effective R-value of 9.5 at a 40% glazing ratio. This represents almost a doubling in the performance of the overall wall assembly!

Of course choosing higher performance glazing can be expensive. Ultimately designers and building owners will need to weigh the pros and cons of increased glazing performance. But if you're designing a building with a lot of glass it's certainly an option worth considering. In addition to improving the thermal performance of the building envelope, higher performance windows and curtain walls will likely mean that there is improved occupant comfort.





SPECIFYING AND VERIFYING FUNCTIONAL PERFORMANCE

As we mentioned earlier, building envelopes have various responsibilities or functions. The main ones we typically think of are thermal control, air control and moisture control. For each of these functions it is possible to specify levels of performance. These are known as *functional performance* levels.

Earlier we mentioned the best practice of increasing *effective* insulation values by minimizing thermal bridging and adding continuous insulation. This is a best practice that relates directly to the thermal functional performance of a building envelope assembly.

Consider for example if you were an owner or designer, you might specify a particular overall effective R-value or U-value. This specification would be a functional performance specification. As project owner or designer you would likely go one step further to verify that this functional performance has been achieved onsite in the actual construction. For thermal resistance or thermal conductance, the easiest way to do this would likely be a visual inspection to ensure the insulation products, installation procedures and installation quality meet the requirements of the construction specification. This would be verifying functional performance.

This process of specifying performance and then verifying it onsite is another best practice that can help ensure better, high performing building envelopes. Specified and verified performance can be especially important when dealing with air and moisture control. The design features and construction techniques that serve this function are often covered up during construction and they can be costly to fix after occupancy.

For this reason, more and more owners are asking for functional performance specifications and verifications of window/curtain wall installations and air barrier installations. Below are a few photos of some types of testing that can be completed onsite to verify the functional performance.

It is important that any functional performance specifications and verifications follow standardized procedures and guidelines to ensure that results are consistent and repeatable. Working with experienced professionals who are familiar with functional performance verification and testing is one of the best ways to ensure this happens.

This image shows a functional performance test of a museum space's enclosed exhibit area. The client was interested in determining whether the contractor's air barrier installation met the specification in the construction documents.

This image shows a window being tested for air leakage. The building owner was interested in learning whether the windows delivered and installed onsite met the expected performance ratings.

This image shows a window installation being tested for water infiltration. The building owner wanted to verify that the window and the installation met the expected performance specification.

This image shows a window mockup being tested away from the construction site. Mockup testing can be a good way to verify functional performance and detailing before any related work is completed onsite.

SECTION 3

HIGHER PERFORMANCE BUILDING ENVELOPES IN PRACTICE

HIGHER PERFORMANCE BUILDING ENVELOPES IN PRACTICE

This section of the Guide will return to the best practices listed in the previous section but will provide more detail on resources that are available to designers and contractors to implement better building envelopes.

MINIMIZING THERMAL BRIDGING AND INCREASING EFFECTIVE INSULATION VALUES

Minimizing thermal bridging and increasing assemblies' effective insulation values are some of the most important strategies for achieving a higher thermal performance with your building envelope. Determining the effects of thermal bridges and calculating the effective insulation values of assemblies can be difficult, however. Thankfully, there are a number of tools that designers and contractors can use to help them with this.

NECB 2011 PRESCRIPTIVE REQUIREMENTS

Before looking at these tools, let's take a quick look at what NECB 2011 is asking for from projects using the prescriptive compliance pathway. Remember, compliance with NECB is not currently a requirement in Newfoundland and Labrador, but it is in some other provinces.

Below are two tables that provide an overview of the NECB 2011 prescriptive building envelope requirements. The first table is as it appears in the Code, with values expressed as maximum overall thermal transmittance or conductance values (U-values). The second table has been converted to express the same requirements using minimum assembly effective R-values.

	Maximum Overall Thermal Transmittance (SI U-Value)			
	Zone 6	Zone 7a	Zone 7b	Zone 8
Walls	0.247	0.210	0.210	0.183
Roofs	0.183	0.162	0.162	0.142
Floors	0.183	0.162	0.162	0.142

	Minimum Assembly Effective Thermal Resistance (R-Value)			
	Zone 6	Zone 7a	Zone 7b	Zone 8
Walls	22.99	27.04	27.04	31.03
Roofs	31.03	35.05	35.05	39.99
Floors	31.03	35.05	35.05	39.99

As you can see from these tables, the prescriptive envelope insulation requirements of NECB are relatively significant. The lower allowed assembly thermal transmittance values (or higher required assembly thermal resistance values) means that many designers and contractors would need to significantly modify their "typical" walls if building to the NECB prescriptive requirements.

While codes such as NECB can be a challenge, there are strategies and best practices that can make compliance easier. For example, many projects that are located in areas where NECB is a requirement tend to use the performance compliance route. Using this pathway allows projects to balance envelope thermal performance with improved performance in other areas of the building, such as heating/cooling systems, ventilation systems and lighting systems. Performance compliance can often be a more cost-effective way to comply with NECB because building to all of the prescriptive requirements isn't necessary as long as the project as a whole meets the NECB energy performance targets.

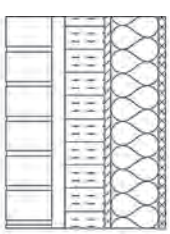
Building in colder climate zones can also be challenging. The prescriptive requirements are especially substantial and may not be cost-effective if energy is relatively cheap. In other jurisdictions where NECB is required, projects often look first to the cost-effectiveness of performance compliance.

Below are four examples of higher performance wall assemblies. These assemblies would exceed the NECB prescriptive requirements for Zone 6 and meet the requirements for Zones 7a and 7b.

STRIVING FOR ENERGY EFFICIENCY: THE BOWRING PARK POOL HOUSE

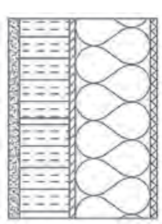
For the City of St. John's, incorporating energy efficiency and environmental responsibility into project design is a key objective. To this end, the City's Bowring Park Pool House was constructed with a view to minimizing energy consumption and includes a number of environmentally responsible design features, including passive solar heating, natural ventilation, building and indoor air quality systems and a well-insulated building envelope.

The pool house's walls are built using insulated concrete forms (ICFs), which is a generic building product that includes a layer of continuous foam insulation on both sides of a steel-reinforced concrete infill core. This type of wall construction has high effective insulation values as it eliminates the thermal bridging that occurs in a typical steel frame wall construction.



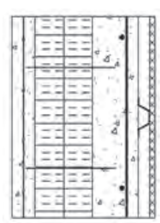
41mm x 92mm 20 ga. steel studs, 406mm on centre, 90mm clay brick, 76mm (3") polyiso + RSI-2.47 mineral wool cavity insulation

U-Value (SI) - 0.205
RSI - 4.87
R-Value - 27.70



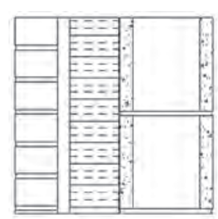
41mm x 152mm 20 ga. steel studs, 610mm on centre, stucco, 102mm (4") polyiso with horizontal Z-girts + RSI-3.96 mineral wool cavity insulation

U-Value (SI) - 0.207
RSI - 4.90
R-Value - 27.83



precast concrete, 127mm (5") extruded polystyrene

U-Value (SI) - 0.209
RSI - 4.78
R-Value - 27.17



190mm concrete masonry unit, 90mm clay brick, 102mm (4") polyiso

U-Value (SI) - 0.208
RSI - 4.81
R-Value - 27.30

ACHIEVING HIGHER PERFORMANCE BUILDING ASSEMBLIES

Luckily there are a couple of simple best practices that will most always lead to better building envelopes in all climate zones. These are:

- Increasing continuous insulation; and,
- Thermally separating cladding and thermally broken cladding attachments.

If all other things are equal and a project team has to choose between adding a certain amount of extra insulation to a wall cavity or adding the same amount of extra insulation to the exterior of the structure, the choice should be clear. Adding or increasing the amount of exterior insulation is a most always a wise decision. This is because exterior insulation is usually more continuous than cavity insulation. Continuous insulation will improve the *effective* insulation level of a wall more than the same *nominal* amount being added to a wall cavity. Of course, you'll want to verify with your design professional the feasibility and durability considerations of this strategy.

Thermally separated cladding and thermally broken cladding attachments are increasingly becoming popular as ways to improve the thermal performance of wall assemblies. Commonly, exterior insulation and cladding is attached to buildings using 'z' furring strips (also known as z-girts). While z-girts are good because they allow building designers and contractors to add continuous exterior insulation to the building, they also conduct heat, which is not ideal. There are a number of strategies that can be used to minimize the heat transfer effects of z-girts. They include:

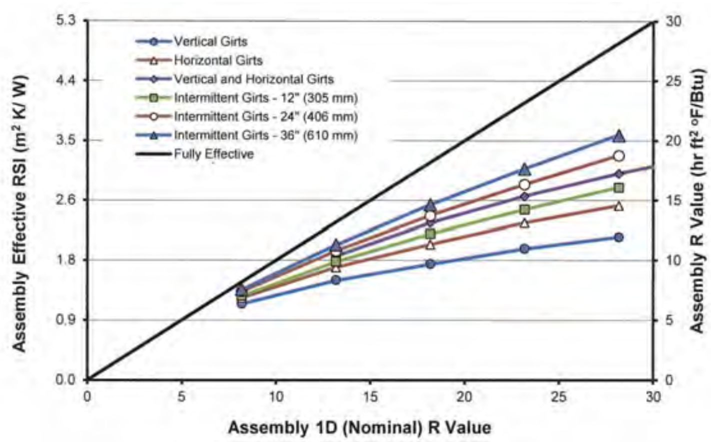
- Using horizontal z-girts instead of vertical z-girts;
- Using a combination of horizontal and vertical girts instead of one layer of girts; and/or,
- Using thermally broken cladding attachment systems.

Using horizontal girts instead of vertical girts will minimize heat transfer. This is due to the fact that horizontal girts are only attached to the steel stud structure where they cross it. On the other hand, vertical girts run parallel with the steel stud structure and therefore transfer more heat across the building envelope. If structurally possible, using a combination of horizontal and vertical girts will further minimize heat transfer because it further minimizes thermal conductance associated with the girts.

Thermally broken cladding attachment systems are another strategy that further decreases thermal conductance and improves wall assembly performance. Many of these systems are proprietary and are therefore more expensive than using just z-girts. These systems usually result in higher performing walls, however.

The following page has a few examples of some of these proprietary cladding attachment systems.

Below is a graph showing the comparative performance of the various strategies.

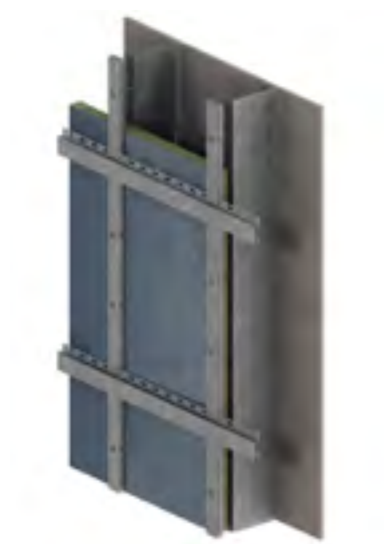


Source: Morrison Hershfield Solutions: "Thermal Bridging in Exterior Insulated Steel Stud Assemblies"

While these examples demonstrate a few strategies that apply across the board for most building and wall types, there are a number of other techniques and best practices that are more specific to wall type and building type. Luckily there are some tools available to help designers and contractors with more specific situations. Let's take a look at a few!

The “TcLip” from Engineered Assemblies.
Source: Engineered Assemblies

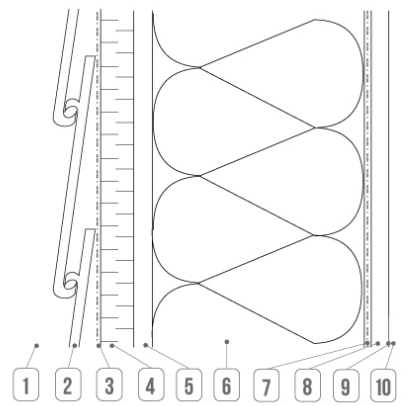
The “Cascadia Clip” from Cascadia Windows.
Source: Cascadia Windows

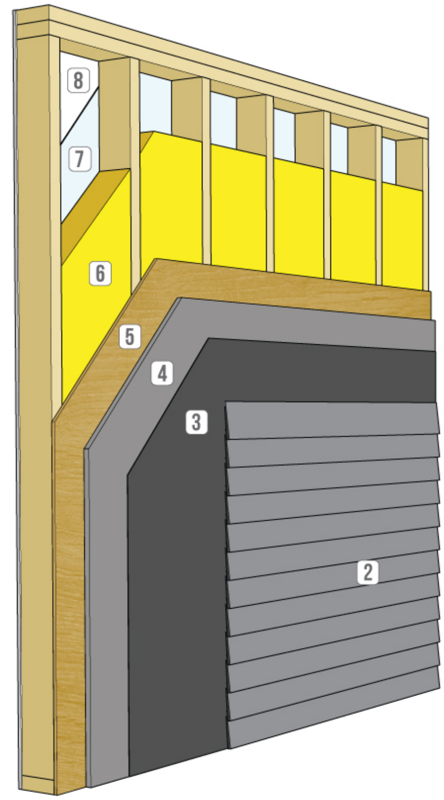


The Knight CI™ and Knight MFI™ systems from Knight Wall Systems
Source: Knight Wall Systems

CANADIAN WOOD COUNCIL THERMAL WALL DESIGN CALCULATOR

While most commercial, institutional and industrial buildings' walls are made from steel or concrete, some larger buildings may still include wood-framed walls, such as some multi-unit residential buildings. One excellent tool for evaluating the overall effective thermal performance of wood-framed walls is the Canadian Wood Council's *Thermal Wall Design Calculator*. This free online tool can be used to determine the effective thermal conductance and thermal resistance of various wood framed wall assemblies. Additionally, the calculator provides information on the hygrothermal properties of the wall assemblies and provides some indication of suitability for various climates in Canada. Below is part of a sample output from the calculator.





WALL ASSEMBLY COMPONENTS[1]		RSI	R
1	exterior air film	0.03	0.17
2	vinyl siding (no air space)	0.11	0.62
3	asphalt impregnated paper[2]	0.00	0.00
4	2" (50.8mm) extruded polystyrene type 3/4	1.78	10.10
5	1/2" (12.7mm) Plywood sheathing	0.11	0.62
6	2x6 framing filled with R19 batt @ 16" o.c.	2.36	13.40
7	polyethylene	0.00	0.00
8	1/2" (12.7mm) gypsum board	0.08	0.45
9	finish: 1 coat latex primer and latex paint	0.00	0.00
10	interior air film	0.12	0.68
Effective RSI / R Value of Entire Assembly		**4.59**	**26.04**
Centre of Cavity RSI / R Value		5.58	31.64
Installed Insulation RSI / R Value(nominal)		5.13	29.10
Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC9.36.2.4.(1))		4.68	26.55

Note: [1]Values are for generic insulation products. Where a specific insulation product is used in the assembly, the thermal resistance value, or long term thermal resistance value, where applicable, of that product is permitted to be used as reported by the Canadian Construction Materials Centre (CCMC) in the evaluation of such a product. [2]Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane Breather Type."

Source: Canadian Wood Council *Thermal Wall Design Calculator*

ASHRAE 90.1 TABLES

Designers and contractors who are working with steel frame or mass walls may find the tables included with ASHRAE Standard 90.1 to be of help. ASHRAE Standard 90.1 includes tables to calculate the assembly U-factors (thermal transmittance) for a wide variety of wall types. Because there are a lot of tables, you'll want to make sure that you're using the right tables for the wall type you're building. One other thing you'll want to watch for is that you've got your units right. The ASHRAE tables are all in IP units. Remember that U-value/U-factor can be either IP or SI. Since the tables will give you an IP U-factor, you'll want to make sure that you convert that to an SI U-factor before comparing it to the NECB requirements. Take a look at the "Note on Units" feature in this Guide for further information.

Below is an example of a table for calculating the assembly thermal transmittance for steel-frame walls.

TABLE A3.3 Assembly U-Factors for Steel-Frame Walls

Framing Type and Spacing Width (Actual Depth)	Cavity Insulation R-Value: Rated (Effective Installed [see Table A9.2B])	Overall U-Factor for Entire Base Wall Assembly	Overall U-Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing), Rated R-Value of Continuous Insulation																			
			R-1.00	R-2.00	R-3.00	R-4.00	R-5.00	R-6.00	R-7.00	R-8.00	R-9.00	R-10.00	R-11.00	R-12.00	R-13.00	R-14.00	R-15.00	R-20.00	R-25.00	R-30.00	R-35.00	R-40.00
Steel Framing at 16 in. on center																						
	None (0.0)	**0.352**	0.260	0.207	0.171	0.146	0.128	0.113	0.102	0.092	0.084	0.078	0.072	0.067	0.063	0.059	0.056	0.044	0.036	0.030	0.026	0.023
3.5 in. depth	R-11 (5.5)	**0.132**	0.117	0.105	0.095	0.087	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.051	0.049	0.046	0.044	0.036	0.031	0.027	0.024	0.021
	R-13 (6.0)	**0.124**	0.111	0.100	0.091	0.083	0.077	0.071	0.066	0.062	0.059	0.055	0.052	0.050	0.048	0.045	0.043	0.036	0.030	0.026	0.023	0.021
	R-15 (6.4)	**0.118**	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057	0.054	0.051	0.049	0.047	0.045	0.043	0.035	0.030	0.026	0.023	0.021
6.0 in. depth	R-19 (7.1)	**0.109**	0.099	0.090	0.082	0.076	0.071	0.066	0.062	0.058	0.055	0.052	0.050	0.047	0.045	0.043	0.041	0.034	0.029	0.026	0.023	0.020
	R-21 (7.4)	**0.106**	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057	0.054	0.051	0.049	0.047	0.045	0.043	0.041	0.034	0.029	0.025	0.022	0.020
Steel Framing at 24 in. on center																						
	None (0.0)	**0.338**	0.253	0.202	0.168	0.144	0.126	0.112	0.100	0.091	0.084	0.077	0.072	0.067	0.063	0.059	0.056	0.044	0.036	0.030	0.026	0.023
3.5 in. depth	R-11 (6.6)	**0.116**	0.104	0.094	0.086	0.079	0.073	0.068	0.064	0.060	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.035	0.030	0.026	0.023	0.021
	R-13 (7.2)	**0.108**	0.098	0.089	0.082	0.075	0.070	0.066	0.062	0.058	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.034	0.029	0.025	0.023	0.020
	R-15 (7.8)	**0.102**	0.092	0.084	0.078	0.072	0.067	0.063	0.059	0.056	0.053	0.050	0.048	0.046	0.044	0.042	0.040	0.034	0.029	0.025	0.022	0.020
6.0 in. depth	R-19 (8.6)	**0.094**	0.086	0.079	0.073	0.068	0.064	0.060	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.041	0.039	0.033	0.028	0.025	0.022	0.020
	R-21 (9.0)	**0.090**	0.083	0.077	0.071	0.066	0.062	0.059	0.055	0.052	0.050	0.048	0.045	0.043	0.042	0.040	0.038	0.032	0.028	0.024	0.022	0.020

Source: ASHRAE Standard 90.1 - 2010

COMcheck

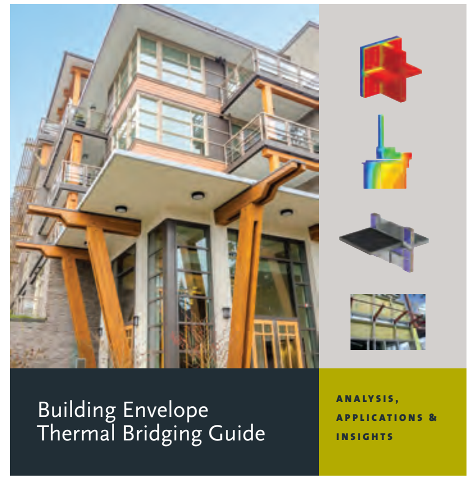
COMcheck is a series of software and web products designed and made available freely by the US Department of Energy. Intended to be user-friendly, COMcheck is a tool that can be used to determine whether buildings are in compliance with the prescriptive requirements of ASHRAE 90.1 and some other state-specific codes.

While the tool doesn't provide compliance verification for the NECB prescriptive requirements, it does include a user-friendly way of determining assembly U-factors. It includes a software- or web-based interface for using the ASHRAE 90.1 tables referenced above. The web and software version of COMcheck also allows users to save their work, so they can update calculations if assembly constructions change as designs progress. Remember, however, that the results of COMcheck are IP U-values/U-factors. You'll need to convert to SI U-values/U-factors if you want to compare the results to the NECB prescriptive requirements.

BUILDING ENVELOPE THERMAL BRIDGING GUIDE

Up to this point, the resources mentioned are for calculating the effective thermal performance of building assemblies and dealing primarily with two-dimensional heat transfer through simplified assemblies. At this time, these tools (ASHRAE 90.1 tables, COMcheck, and the CWC *Thermal Wall Design Calculator*) are all sufficient to calculate effective values for demonstrating compliance with either ASHRAE 90.1 or NECB. In the real world, however, heat transfer occurs in three dimensions and building envelopes are a bit more complicated. More advanced methods of calculation will yield more realistic results.

In recognition of this, ASHRAE developed *ASHRAE Research Project 1365*. This project's goal was to develop better tools for building designers to address thermal bridging in the building envelope. In effect, ASHRAE wanted to provide more realistic predictive models for understanding how building assemblies, including thermal bridges, perform in the real world. Morrison Hershfield was contracted to complete the work. The results of the ASHRAE Research Project were published in 2011.

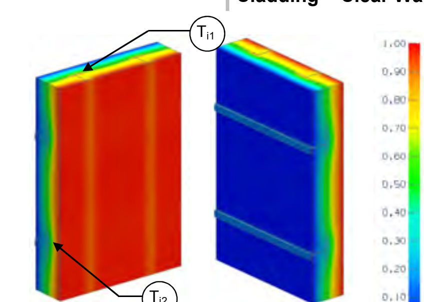


Since 2011, the results of this study have been expanded. In 2014, the *Building Envelope Thermal Bridging Guide* was developed by Morrison Hershfield with funding from BC Hydro Power Smart, the Canadian Wood Council, Fortis BC, FPInnovations and the BC Homeowner Protection Office. This free document provides building designers with more realistic overall assembly thermal resistance values that account for thermal bridging. The document includes a library of opaque building assemblies and transition details, each with their own thermal performance characteristics. A sample from the Guide is on the left.

The *Building Envelope Thermal Bridging Guide* is particularly useful if designers and contractors want to compare various ways of designing and constructing transition details. These would

Appendix B - Catalogue Thermal Data Sheets BUILDING ENVELOPE THERMAL BRIDGING GUIDE

Detail 5.1.7 **Exterior and Interior Insulated 3 5/8" x 1 5/8" Steel Stud (16" o.c) Wall Assembly with Horizontal Z-Girts (24" o.c.) Supporting Metal Cladding – Clear Wall**



View from Interior View from Exterior

Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-14.2 (2.5 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	"clear wall" U- and R-value
Surface Temperature Index[1]	T_i	0 = exterior temperature 1 = interior temperature

[1]Surface temperatures are a result of steady-state conductive heat flow with constant heat transfer coefficients. Limitations are identified in final report.

Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-Value (RSI)	R_{1D} ft²·hr·°F / Btu (m² K / W)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)
R-0 (0)	R-14.2 (2.50)	R-9.2 (1.62)	0.109 (0.62)
R-5 (0.88)	R-19.2 (3.38)	R-13.4 (2.36)	0.075 (0.42)
R-10 (1.76)	R-24.2 (4.26)	R-16.3 (2.87)	0.061 (0.35)
R-15 (2.64)	R-29.2 (5.14)	R-18.5 (3.25)	0.054 (0.31)
R-20 (3.52)	R-34.2 (6.02)	R-20.5 (3.61)	0.049 (0.28)
R-25 (4.40)	R-39.2 (6.90)	R-22.1 (3.90)	0.045 (0.26)

Temperature Indices

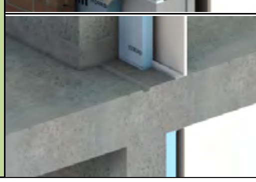
	R0	R5	R10	R15	R20	R25	
T_{i1}	0.06	0.21	0.28	0.32	0.36	0.38	Min T on sheathing, along girts between studs
T_{i2}	0.35	0.59	0.68	0.72	0.75	0.78	Max T on sheathing, along studs between girts

Source: *Building Envelope Thermal Bridging Guide*, Morrison Hershfield/BC Hydro include:

- Window/wall transitions,
- Balcony/slab edges,
- Parapet/ceiling connections, and,
- Exterior cladding attachments.

Below is an example from the document that shows the thermal performance implications of various floor and balcony slab edge details.

While the *Building Envelope Thermal Bridging Guide* goes above and beyond the current calculation requirements for ASHRAE Standard 90.1 compliance and NECB compliance, the results it contains are much more reflective of the real world performance of building envelopes. It is a great resource for designers and contractors who want to have a better understanding about the expected real-world performance of their building envelopes.

	Performance Category		Description and Examples	Linear Transmittance	
				Btu / hr ft F	W / m K
FLOOR AND BALCONY SLABS		**Efficient**	**Fully insulated with only small conductive bypasses** Examples: exterior insulated wall and floor slab.	0.12	0.2
		Improved	**Thermally broken and intermittent structural connections** Examples: structural thermal breaks, stand-off shelf angles.	0.20	0.35
		Regular	**Under-insulated and continuous structural connections** Examples: partial insulated floor (i.e. firestop), shelf angles attached directly to the floor slab.	0.29	0.5
		Poor	**Un-insulated and major conductive bypasses** Examples: un-insulated balconies and exposed floor slabs.	0.58	1.0

Source: *Building Envelope Thermal Bridging Guide*, Morrison Hershfield/BC Hydro

APPROPRIATE GLAZING RATIOS

As we mentioned earlier, reducing the glazing area in a building will most likely improve the thermal performance of the building envelope. This is because opaque walls typically have higher effective insulation values than do windows, doors or curtain walls.

Some building codes recognize this fact. Performance compliance pathways in ASHRAE 90.1 and NECB will reflect the impact of glazing ratios and glazing performance in the proposed building's modelled energy consumption. If projects choose instead to use the prescriptive pathway of some codes, glazing ratios can be limited to a maximum amount.

NECB is one code where the prescriptive pathway limits the glazing ratio. NECB refers to a maximum "allowable fenestration and door area to gross wall area ratio (FDWR)." The maximum allowable FDWR depends on the climate where the project is being built. Instead of using climate zones like the NECB does for prescriptive insulation requirements, NECB uses heating degree days (HDD) to determine the maximum allowable FDWR.

GLAZING RATIO CHALLENGES

Depending on building type and design constraints, having less glazing area can often be a challenge. Consider for example quick-service restaurants. These buildings are often built to a standardized design that features a relatively large amount of glass. If a project owner wanted to build one of these buildings in a colder climate and stick with the design's typical glazing ratio they may not be able to meet the prescriptive requirements. If this were the case, and the project were required to meet NECB, it would need to use the performance compliance pathway. Another reason why the performance compliance pathway is popular in jurisdictions that require NECB compliance!

Projects that are being built in areas with less than 4,000 HDD are allowed to have a ratio of up to 0.40 or 40% windows, doors or curtain walls. Projects that are being built in areas where there are more than 7,000 HDD are allowed to have a ratio of up to 0.20 or 20%. Projects located in areas where the number of HDD are between 4,000 and 7,000 are required to use the following calculation to determine the FDWR: Max FDWR = (2,000 – 0.2 * HDD)/3,000.

Let's look at two examples here in the province: St. John's, NL (4,800 HDD) and Happy Valley-Goose Bay (6,670 HDD).

SAMPLE FDWR CALCULATIONS FOR ST. JOHN'S AND HAPPY VALLEY-GOOSE BAY

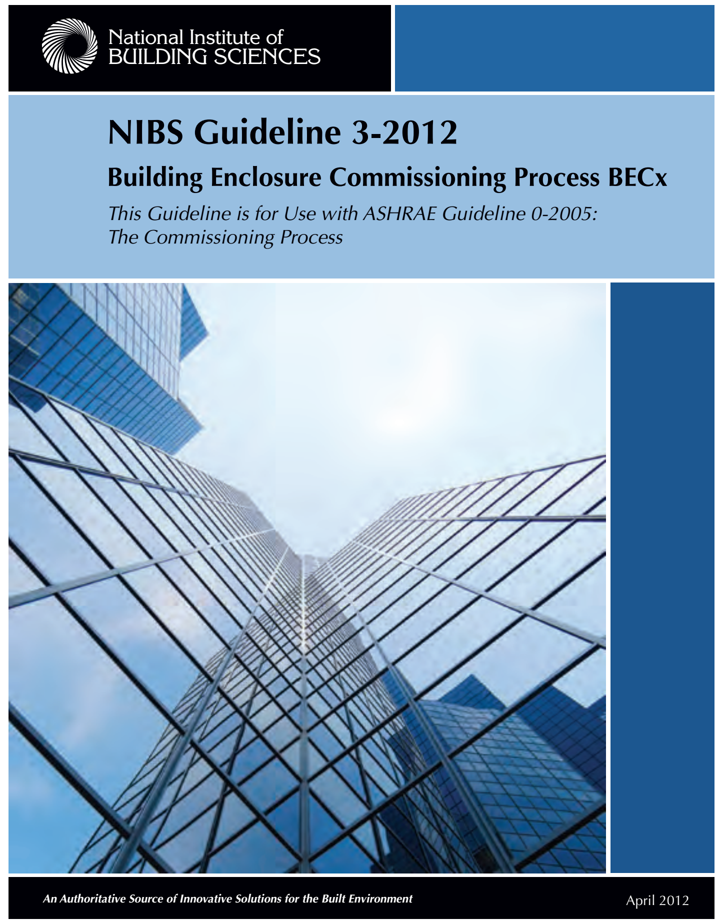
St. John's Max FDWR = (2,000 - 0.2 * 4,800)/3,000
= (2,000 - 960)/3,000
= 0.35 or 35%

Happy Valley-Goose Bay
Max FDWR = (2,000 - 0.2 * 6,670)/3,000
= (2,000 - 1,334)/3,000
=0.22 or 22%

As you can see from the calculations, since it's colder in Happy Valley-Goose Bay than it is in St. John's, it's probably a good idea to have less window, door and curtain wall area.

SPECIFYING AND VERIFYING FUNCTIONAL PERFORMANCE

Execution is important. Even the best designed building can experience significant failures due to construction flaws. One strategy to ensure better execution of design is to specify and verify functional performance. This concept has gained traction in the HVAC world, where commissioning and testing are more common. The same process can work with building envelopes!



The concept of building envelope commissioning became formalized with the publication of *NIBS Guideline 3* in 2012. Published by the National Institute of Building Science, this was the foundational document for building envelope commissioning. It provided owners and project teams with guidance on the process. Since 2012, further development of the building envelope commissioning process has been undertaken by ASTM, the voluntary standards developing organization. ASTM currently publishes and updates two documents relating to building envelope commissioning:

- ASTM E2813 – *Standard Practice for Building Enclosure Commissioning*, and
- ASTM E2947 – *Standard Guide for Building Enclosure Commissioning*.

ASTM defines building enclosure commissioning as:

> "architecture or engineering-related technical services or both, performed on behalf of the Owner that implements a quality-focused process for enhancing the delivery of a project by focusing on validating during the design phase and verifying during the construction phase that the performance of building enclosure materials, components, assemblies and systems are designed and installed to meet the Owner's Project Requirements." (ASTM E2947)

In essence, the process attempts to ensure that designs are validated through reviews prior to construction and that construction is verified through testing and visual inspection. The extent to which an owner will want to embark on comprehensive building envelope commissioning is largely a function of budget and perceived value. Full scale and comprehensive envelope commissioning is still relatively rare. Design reviews and site testing, however, are becoming more common.

While ASTM E2947 provides project teams with a general overview of the process, ASTM E2813 provides a list of the tests project teams may wish to consider to evaluate the functional performance of building envelope assemblies, components and materials. Two common field tests are air leakage testing of windows and water penetration testing of windows and curtain walls. The ASTM standards relating to these field tests are ASTM E783 and ASTM E1105 respectively.

It's important to understand that testing standards *don't* specify expected functional performance levels. The expected functional performance of building envelope products like windows, doors, or curtain walls depends on their rated characteristics.

Most building products undergo standardized laboratory testing to classify their functional performance characteristics (heat transfer, air infiltration, water penetration resistance, etc.). In situ field performance should relate in some way to these laboratory tests. It's usually up to an architect or building envelope consultant to specify an appropriate functional performance level.

A REVIEW

Now that we have a better sense of what's needed to improve building envelope performance, you'll appreciate why it's important to:

- ☐ Know your climate zone
- ☐ Know the difference between effective and nominal insulation values
- ☐ Integrate strategies to increase the effective thermal resistance of your building assembly
- ☐ Pay attention to the details when designing and building
- ☐ Choose "appropriate" glazing ratios when possible
- ☐ Choose higher performance glazing systems when possible
- ☐ Consider the thermal bridging impacts of transition details and wall assembly choices
- ☐ Understand the tools available to help you design and construct higher performing building envelopes
- ☐ Understand the value of specifying and verifying functional performance

If you're interested in learning more about any of these important strategies, we suggest browsing through the referenced resources. Links and descriptions are included in Appendix B.

APPENDICES

APPENDIX A – MUNICIPALITIES BY CLIMATE ZONE

This Appendix lists Newfoundland and Labrador's municipalities by climate zone, as referenced by the National Building Code of Canada (NBC) and the National Energy Code of Canada for Buildings (NECB).

CLIMATE ZONES Zone 6 | Zone 7a | Zone 7b | Zone 8

OFFICIAL NAME	CLIMATE ZONE
Admirals Beach	6
Anchor Point	7a
Appleton	6
Aquaforte	6
Arnold's Cove	6
Avondale	6
Badger	7a
Baie Verte	7a
Baine Harbour	6
Bauline	6
Bay Bulls	6
Bay de Verde	6
Bay L'Argent	6
Bay Roberts	6
Baytona	6
Beachside	7a
Bellburns	7a
Belleoram	6
Birchy Bay	7a
Bird Cove	7a
Bishop's Cove	6
Bishop's Falls	6
Bonavista	6
Botwood	6
Branch	6
Brent's Cove	7a
Brighton	7a
Brigus	6
Bryant's Cove	6
Buchans	7a
Burgeo	6
Burin	6
Burlington	7a
Burnt Islands	6
Campbellton	6
Cape Broyle	6
Cape St. George	6
Carbonear	6
Carmanville	7a
Cartwright	7b
Centreville-Wareham-Trinity	7a

OFFICIAL NAME	CLIMATE ZONE
Chance Cove	6
Change Islands	7a
Channel-Port aux Basques	6
Chapel Arm	6
Charlottetown (Labrador)	7b
Clarenville	6
Clarke's Beach	6
Coachman's Cove	7a
Colinet	6
Colliers	6
Come By Chance	6
Comfort Cove-Newstead	6
Conception Bay South	6
Conception Harbour	6
Conche	7a
Cook's Harbour	7a
Cormack	7a
Corner Brook	6
Cottlesville	6
Cow Head	7a
Cox's Cove	6
Crow Head	6
Cupids	6
Daniel's Harbour	7a
Deer Lake	7a
Dover	7a
Duntara	6
Eastport	6
Elliston	6
Embree	6
Englee	7a
English Harbour East	6
Fermeuse	6
Ferryland	6
Flatrock	6
Fleur de Lys	7a
Flower's Cove	7a
Fogo Island	7a
Forteau	7b
Fortune	6
Fox Cove-Mortier	6
Fox Harbour	6

CLIMATE ZONES Zone 6 | Zone 7a | Zone 7b | Zone 8

OFFICIAL NAME	CLIMATE ZONE
Frenchman's Cove	6
Gallants	6
Gambo	6
Gander	7a
Garnish	6
Gaskiers-Point La Haye	6
Gaultois	6
Gillams	6
Glenburnie-Birchy Head-Shoal Brook	6
Glenwood	6
Glovertown	6
Goose Cove East	7a
Grand Bank	6
Grand Falls-Windsor	6
Grand Le Pierre	6
Greenspond	7a
Hampden	7a
Hant's Harbour	6
Happy Adventure	6
Happy Valley-Goose Bay	7b
Harbour Breton	6
Harbour Grace	6
Harbour Main-Chapel's Cove-Lakeview	6
Hare Bay	7a
Hawke's Bay	7a
Heart's Content	6
Heart's Delight-Islington	6
Heart's Desire	6
Hermitage-Sandyville	6
Holyrood	6
Hopedale	8
Howley	7a
Hughes Brook	6
Humber Arm South	6
Indian Bay	7a
Irishtown-Summerside	6
Isle aux Morts	6
Jackson's Arm	7a
Keels	6
King's Cove	6
King's Point	7a
Kippens	6
La Scie	7a
Labrador City	8
Lamaline	6
L'Anse au Clair	7b
L'Anse au Loup	7b
Lark Harbour	6
Lawn	6

OFFICIAL NAME	CLIMATE ZONE
Leading Tickles	6
Lewin's Cove	6
Lewisporte	6
Little Bay	6
Little Bay East	6
Little Bay Islands	7a
Little Burnt Bay	6
Logy Bay-Middle Cove-Outer Cove	6
Long Harbour-Mount Arlington Heights	6
Lord's Cove	6
Lourdes	6
Lumsden	7a
Lushes Bight-Beaumont-Beaumont North	7a
Main Brook	7a
Makkovik	7b
Mary's Harbour	7b
Marystown	6
Massey Drive	6
McIver's	6
Meadows	6
Middle Arm	7a
Miles Cove	7a
Millertown	7a
Milltown-Head of Bay D'Espoir	6
Ming's Bight	7a
Morrisville	6
Mount Carmel-Mitchells Brook-St. Catherine's	6
Mount Moriah	6
Mount Pearl	6
Musgrave Harbour	7a
Musgravetown	6
Nain	8
New Perlican	6
New-Wes-Valley	7a
Nippers Harbour	7a
Norman's Cove-Long Cove	6
Norris Arm	6
Norris Point	7a
North River	6
North West River	7b
Northern Arm	6
Old Perlican	6
Pacquet	7a
Paradise	6
Parker's Cove	6
Parsons Pond	7a
Pasadena	7a
Peterview	6
Petty Harbour-Maddox Cove	6

CLIMATE ZONES Zone 6 | Zone 7a | Zone 7b | Zone 8

OFFICIAL NAME	CLIMATE ZONE
Pilley's Island	7a
Pinware	7b
Placentia	6
Point au Gaul	6
Point Lance	6
Point Leamington	6
Point May	6
Point of Bay	6
Pool's Cove	6
Port Anson	7a
Port au Choix	7a
Port au Port East	6
Port au Port West-Aguathuna-Felix Cove	6
Port Blandford	6
Port Hope Simpson	7b
Port Kirwan	6
Port Rexton	6
Port Saunders	7a
Portugal Cove South	6
Portugal Cove-St. Philip's	6
Postville	7b
Pouch Cove	6
Raleigh	7a
Ramea	6
Red Bay	7b
Red Harbour	7a
Reidville	7a
Rencontre East	6
Renews-Cappahayden	6
Rigolet	7b
River of Ponds	7a
Riverhead	6
Robert's Arm	7a
Rocky Harbour	7a
Roddickton-Bide Arm	7a
Rose Blanche-Harbour Le Cou	6
Rushoon	6
Salmon Cove	6
Salvage	6
Sandringham	6
Sandy Cove	6
Seal Cove, F.B	6
Seal Cove, W.B	7a
Small Point-Adam's Cove-Blackhead-Broad Cove	6
South Brook	7a
South River	6
Southern Harbour	6

OFFICIAL NAME	CLIMATE ZONE
Spaniard's Bay	6
Springdale	7a
St. Alban's	6
St. Anthony	7a
St. Bernard's-Jacques Fontaine	6
St. Brendan's	7a
St. Bride's	6
St. George's	6
St. Jacques-Coomb's Cove	6
St. John's	6
St. Joseph's	6
St. Lawrence	6
St. Lewis	7b
St. Lunaire-Griquet	7a
St. Mary's	6
St. Paul's	7a
St. Shott's	6
St. Vincent's-St. Stephen's-Peter's River	6
Steady Brook	6
Stephenville	6
Stephenville Crossing	6
Summerford	6
Sunnyside (Trinity Bay)	6
Terra Nova	6
Terrenceville	6
Tilt Cove	7a
Torbay	6
Traytown	6
Trepassey	6
Trinity	6
Trinity Bay North	6
Triton	7a
Trout River	6
Twillingate	6
Upper Island Cove	6
Victoria	6
Wabana	6
Wabush	8
West St. Modeste	7b
Westport	7a
Whitbourne	6
Whiteway	6
Winterland	6
Winterton	6
Witless Bay	6
Woodstock	7a
Woody Point	6
York Harbour	6

APPENDIX B – FURTHER RESOURCES

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) *www.ashrae.org* **:** ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment. The Society and its members focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability within the industry.

ASTM International *www.astm.org* **:** ASTM International is a globally recognized leader in the development and delivery of voluntary consensus standards. Today, over 12,000 ASTM standards are used around the world to improve product quality, enhance health and safety, strengthen market access and trade, and build consumer confidence.

Building Envelope Design Guide *www.wbdg.org/design/envelope.php* **:** The National Institute of Building Sciences (NIBS) under guidance from the Federal Envelope Advisory Committee has developed this comprehensive guide for exterior envelope design and construction for institutional / office buildings.

Building Envelope Thermal Bridging Guide *www.bchydro.com/thermalguide* **:** This comprehensive online guide provides: a catalogue of thermal performance of common envelope assemblies and interface details; outlines information needed for thermal bridging design and whole-building energy simulations; and, evaluates cost effectiveness of improving the building envelope through different methods, building types and climates.

Building Science Corporation *www.buildingscience.com* **:** The resources available on this website combine building physics, systems design concepts, and an awareness of sustainability to promote the design and construction of buildings that aim to be more durable, healthier, more sustainable and more economical.

Canada Green Building Council (CaGBC) *www.cagbc.org* **:** The Canada Green Building Council is a not-for-profit, national organization that has been working since 2002 to advance green building and sustainable community development practices in Canada. The CaGBC is the license holder for the LEED green building rating system in Canada.

Canadian Mortgage and Housing Corporation (CMHC) *www.cmhc-schl.gc.ca* **:** CMHC's website provides information, resources, and case studies on important building research related to energy efficiency and green building. The CMHC is one of Canada's leading organizations dealing with mortgage loan insurance, mortgage-backed securities, and housing policy and programs.

Canadian Wood Council Wall Thermal Design Calculator *www.cwc.ca/resources/wall-thermal-design* **:** The purpose of this online tool and calculator is to provide designers with prescriptive wood wall assembly solutions complying with national energy efficiency requirements. This tool is meant to provide enough information that architects, designers, engineers, consultants and contractors can quickly determine suitable wall assemblies for each climate zone in Canada with confidence.

COMcheck *www.energycodes.gov/comcheck* **:** The COMcheck product group makes it easy for architects, builders, designers, and contractors to determine whether new commercial or high-rise residential buildings, additions, and alterations meet the requirements of the International Energy Conservation Code and ASHRAE Standard 90.1. COMcheck also includes a simplified method for calculating the effective thermal conductance of building assemblies.

National Institute of Building Sciences (NIBS) *www.nibs.org/* **:** The National Institute of Building Sciences is a US-based non-profit, non-governmental organization that brings together representatives of government, the professions, industry, labour and consumer interests, and regulatory agencies to focus on the identification and resolution of problems and potential problems that hamper the construction of safe, affordable structures for housing, commerce and industry throughout the United States.

National Research Council Canada (NRC) *www.nrc-cnrc.gc.ca* : As Canada's premier organization for research and development, the NRC provides access to a large database of high quality research publications. The NRC is also responsible for developing national model construction codes such as the National Building Code of Canada (NBC) and the National Energy Code of Canada for Buildings (NECB).

Office of Climate Change and Energy Efficiency *www.exec.gov.nl.ca/exec/cceeet/* **:** This department of the Government of Newfoundland and Labrador links to reports and websites outlining the Government's strategy and policy development on climate change and energy efficiency.

Turn Back the Tide *www.turnbackthetide.ca* **:** This website from the Government of Newfoundland and Labrador provides important information for homeowners, businesses and communities on how to save energy and become greener.

APPENDIX C – GLOSSARY OF TERMS

ASHRAE 90.1	Energy Standard for Buildings Except for Low-Rise Residential Buildings
Building Envelope	the parts of the building that separate the conditioned space inside from the unconditioned space outdoors
Climate Zone	an area that has roughly the same heating requirements
Effective Insulation Value	takes into account all the components of an assembly, not just the thermal resistance of the insulation in the assembly
Energy Model	computer software that uses proposed construction details, occupant behaviour, and mechanical systems to predict the energy efficiency of a building
Fenestration	refers to building envelope assemblies that transfer visible light. These include windows, clerestories, skylights, translucent wall panels, glass block assemblies, sliding glass doors, curtain walls, etc.
Heating Degree Days	reflect the demand for energy to heat a building. A measure of how much and for how long the temperature outside stays below a certain level.
National Building Code of Canada	the foundation of design and construction regulations across Canada
National Energy Code of Canada for Buildings (NECB)	model national energy code for buildings in Canada. This code is a requirement in some Canadian jurisdictions.
Nominal Insulation Value	the insulation value of individual building products
Performance Compliance Pathway	achieving energy efficiency code compliance by showing that a proposed building is as energy efficient as, or more energy efficient than, a building meeting prescriptive requirements. This is proven through energy modelling.
Prescriptive Compliance Pathway	achieving energy efficiency code compliance by meeting the listed requirements for each building component.
RSI	a measure of thermal resistance, or how effective a building material is at minimizing heat loss. The same concept as R-value but uses the metric system.

R-Value	a measure of thermal resistance, or how effective a building material is at minimizing heat loss. The same concept as RSI but uses the imperial (US) measurement system.
Thermal Break	using continuous insulation between building components with lower insulation values. The purpose is to reduce thermal bridging.
Thermal Bridge	occurs where an area of insulation is broken by material that is prone to heat loss
U-Factors/U-Values	a measure of thermal conductance, or how much heat loss occurs through a building material. Can be either metric (SI) or imperial (IP). Often used when referring to windows, doors, and skylights. Also used by NECB and ASHRAE 90.1 to denote prescriptive building envelope insulation requirements.