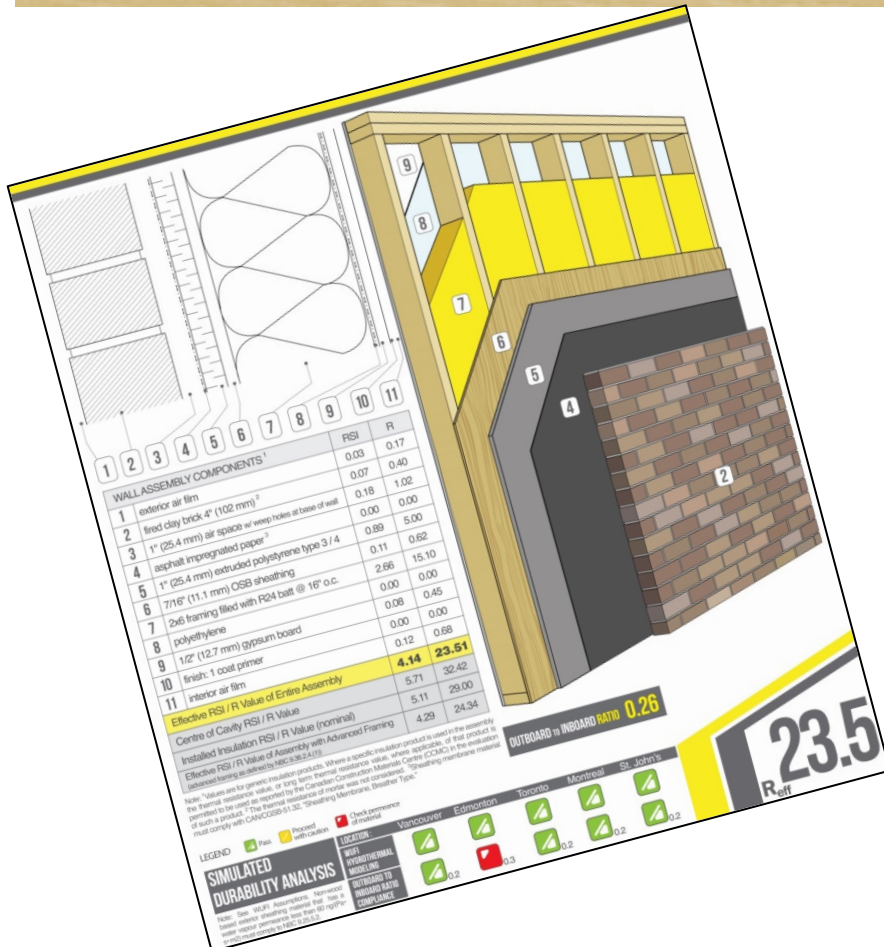


# Meeting New Energy Code Requirements with Wood Frame Construction

## WALL THERMAL DESIGN CALCULATOR



British Columbia  
Building Envelope Council  
March 20, 2014

Peter Moonen  
Sustainability Coordinator



Presentation Courtesy of  
**Robert Jonkman, P.Eng.**

# Canadian Wood Council

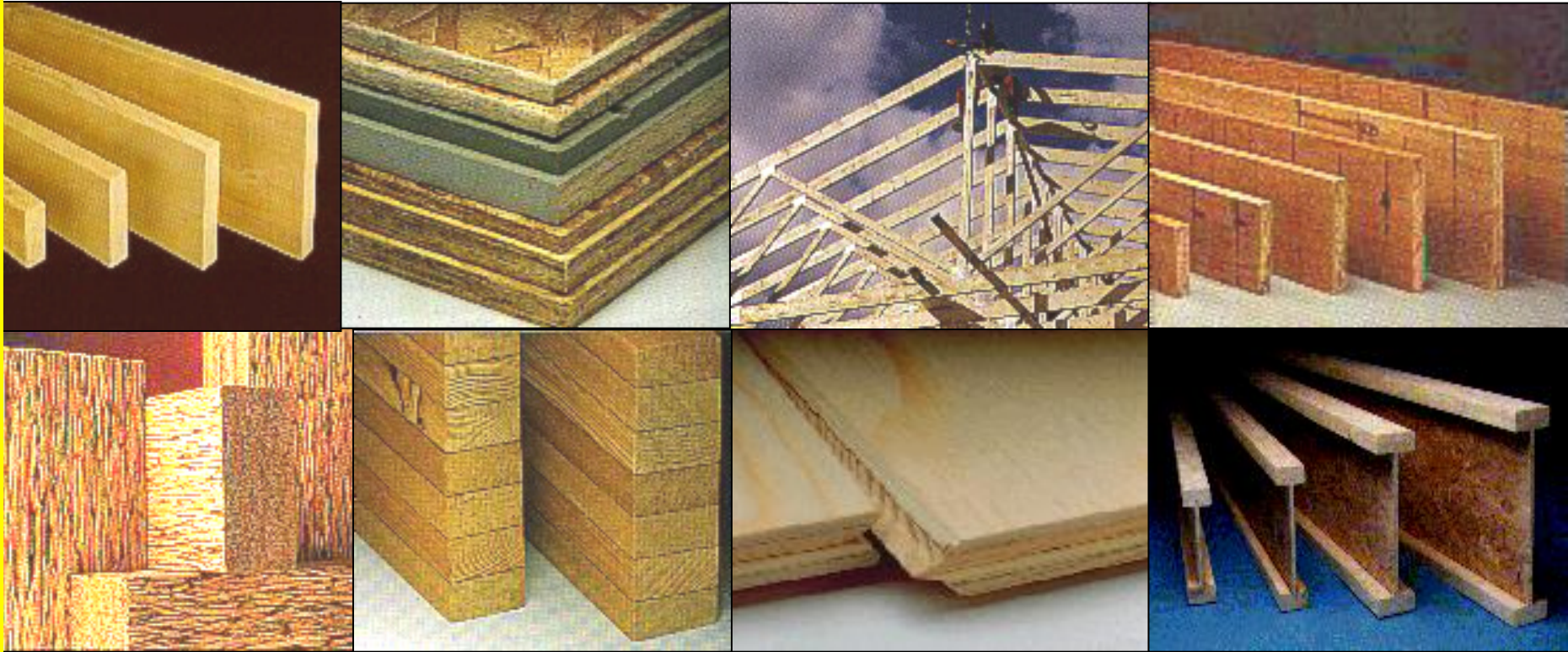
Increase Market Access- *Through the application of technical expertise to specific market access challenges and opportunities, increase access and capability of the design and regulatory sectors to better understand how wood can be used in construction.*





# *Canadian Wood Council*

Represents Over 1200 Manufacturers



# Wood WORKS! Mission

- Educate
- Influence
- Provide Technical Expertise
- Ensure sustainable cost-effective wood systems considered





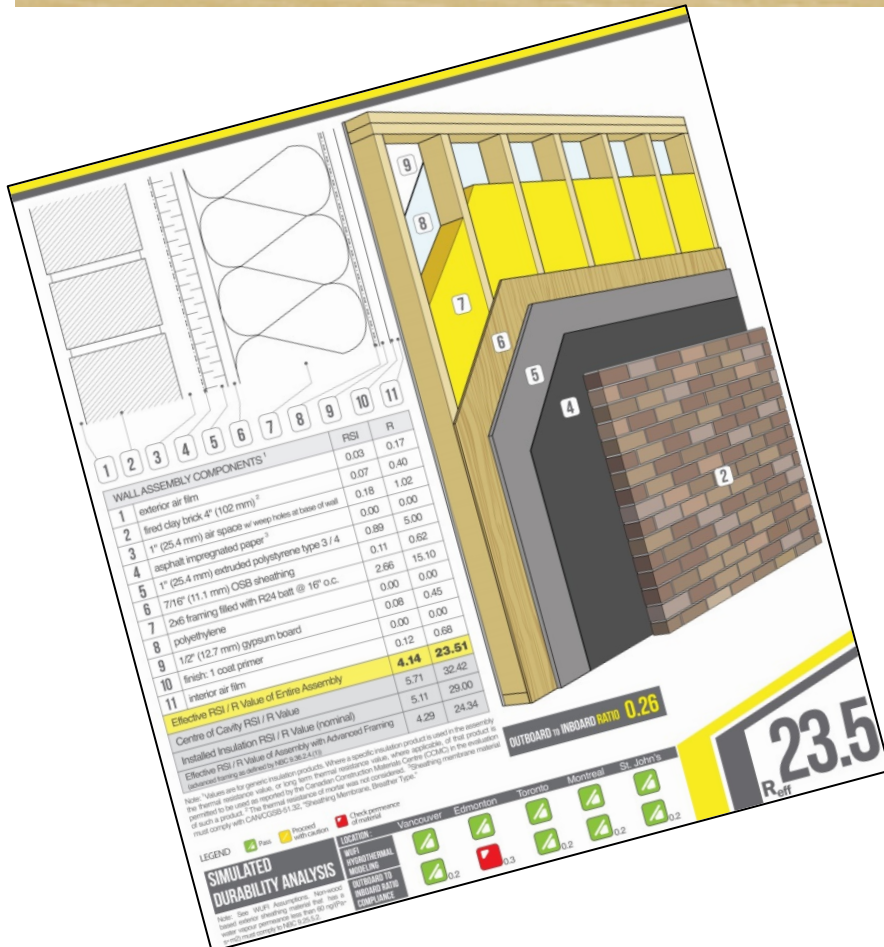
# Education / Advocacy

- Ongoing Technical support
- Engineering and Architecture Educators and Students
- Existing Practitioners
- Construction Trades
- Building officials, Inspectors and Regulatory agencies
- Contractors
- Developers / Owners
- Codes and Standards transferability



# Meeting New Energy Code Requirements with Wood Frame Construction

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Robert Jonkman, P.Eng.



# Highly insulated walls...


- Have increased potential for **condensation** on sheathing
  - Reduced heat loss from living space
  - Lower sheathing temperature
  - When there is a large amount of air leakage from living space
- Reduced **drying capacity**
  - With a larger amount of insulation
  - Particularly when low-permeance materials used

**Properly designed walls mitigate these concerns.  
The Guide and the Calculator will help design wood walls properly.**



# WALL THERMAL DESIGN CALCULATOR

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## Wall Thermal Design

Code Requirements

Energy and Thermal Performance

Durability

Builder Notes

How to use Catalogue

Search WTD Catalogue

WTD Catalogue

CWC makes a number of Resources available to the wood professionals as well as wood enthusiasts.

For almost half a century, the Canadian Wood Council (CWC) has been the trusted source of reference for the global audience of architects, engineers, builders, designers, and home owners who believe in the benefits of wood as a natural and renewable building material.

CWC makes a number of Resources available to the wood professionals as well as wood enthusiasts. From Electronic Tools to Tips for home renovators and home buyers we work hard in providing you with the best tools and reference information.

FaLang translation system by Faboba



# WALL THERMAL DESIGN CALCULATOR

## Purpose of wall thermal design calculator

To provide designers with climate-zone appropriate insulated wall assembly solutions:

- easily comparable with prescriptive energy efficiency requirements (NECB, NBC, Provincial)
- with a climate specific durability assessment

## Canadian Code Requirements for Minimum Thermal Resistance of Above Grade Wall Assemblies

|                   |   | Celsius Heating Degree Days for Climate Zones and Typical Locations |   |  |   |  |                           |
|-------------------|---|---|---|--|---|--|---------------------------|
| Code/Jurisdiction |   | Zone 4<br>< 3000  | Zone 5<br>3000 - 3999                                 | Zone 6<br>4000 - 4999  | Zone 7A<br>5000 - 5999  | Zone 7B<br>6000 - 6999                   | Zone 8<br>≥ 7000          |
|                   |   | Vancouver<br>Victoria   | Kamloops<br>Kelowna<br>Windsor<br>Hamilton<br>Toronto | Cranbrook<br>Prince Rupert<br>Lethbridge<br>Brampton<br>Ottawa<br>Montreal<br>Fredericton<br>Moncton<br>Saint John<br>Halifax<br>Charlottetown<br>St. John's | Calgary<br>Edmonton<br>Regina<br>Saskatoon<br>Winnipeg<br>Chicoutimi<br>Quebec City<br>Edmundston | Fort McMurray<br>Cold Lake<br>Whitehorse | Yellowknife<br>Nunavut    |
| Effective R-Value | 2012<br>National Building Code<br>9.36 (No HRV)   | <b>15.8</b><br>(RSI 2.78)   | <b>17.5</b><br>(RSI 3.08)                             | <b>17.5</b><br>(RSI 3.08)  | <b>17.5</b><br>(RSI 3.08)   | <b>21.9</b><br>(RSI 3.86)                | <b>21.9</b><br>(RSI 3.86) |
|                   | 2012<br>National Building Code<br>9.36 (with HRV) | <b>15.8</b><br>(RSI 2.78)   | <b>16.9</b><br>(RSI 2.98)                             | <b>16.9</b><br>(RSI 2.98)  | <b>16.9</b><br>(RSI 2.98)   | <b>17.5</b><br>(RSI 3.08)                | <b>17.5</b><br>(RSI 3.08) |
|                   | 2011<br>National Energy Code<br>for Buildings     | <b>18</b><br>(RSI 3.17)   | <b>20</b><br>(RSI 3.52)                               | <b>23</b><br>(RSI 4.05)  | <b>27</b><br>(RSI 4.76)   | <b>27</b><br>(RSI 4.76)                  | <b>31</b><br>(RSI 5.46)   |



## Canadian Code Requirements for Minimum Thermal Resistance of Above Grade Wall Assemblies

Celsius Heating Degree Days for Climate Zones and Typical Locations

|  |  | Zone 4<br>< 3000                  | Zone 5<br>3000 - 3999             | Zone 6<br>4000 - 4999             | Zone 7A<br>5000 - 5999            | Zone 7B<br>6000 - 6999            | Zone 8<br>≥ 7000                  |
|--|--|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| Installed R-Value (Nominal)  | 2012<br>British Columbia<br>Building Code Part 10                              | <b>20</b><br>(RSI 3.52)           | <b>20</b><br>(RSI 3.52)           | <b>22</b><br>(RSI 3.87)           | <b>22</b><br>(RSI 3.87)           | <b>22</b><br>(RSI 3.87)           | <b>22</b><br>(RSI 3.87)           |
|  | 2012<br>Ontario Building Code<br>SB-12, AFUE ≥ 90%                             | <b>22 - 27</b><br>(RSI 3.88-4.76) | <b>22 - 27</b><br>(RSI 3.88-4.76) | <b>22 - 27</b><br>(RSI 3.88-4.76) | <b>24 - 29</b><br>(RSI 4.23-5.11) | <b>24 - 29</b><br>(RSI 4.23-5.11) | <b>24 - 29</b><br>(RSI 4.23-5.11) |
|  | 2012<br>Ontario Building Code<br>SB-12, Electric Space Heating                 | <b>29</b><br>(RSI 5.11)           | <b>29</b><br>(RSI 5.11)           | <b>29</b><br>(RSI 5.11)           | <b>29</b><br>(RSI 5.11)           | <b>29</b><br>(RSI 5.11)           | <b>29</b><br>(RSI 5.11)           |
| Centre of Cavity R-Value   | January 2013<br>Quebec Construction<br>Code (<600 m <sup>2</sup> surface area) | <b>24.5</b><br>(RSI 4.31)         | <b>24.5</b><br>(RSI 4.31)         | <b>24.5</b><br>(RSI 4.31)         | <b>24.5</b><br>(RSI 4.31)         | <b>29</b><br>(RSI 5.12)           | <b>29</b><br>(RSI 5.12)           |
| <p><b>Note: Quebec Construction Code Requirements</b></p> <ul style="list-style-type: none"> <li>A continuous layer of insulating material with a minimum of R4 (RSI 0.70) is required to cover the thermal bridging components on either the outside, inside, or a combination of both if the wood framing members are spaced less than 24" (600mm) o.c.</li> <li>A continuous layer of insulating material with a minimum of R3 (RSI 0.53) is required to cover the thermal bridging components on either the outside, inside, or a combination of both if the wood framing members are spaced equal to or more than 24" (600mm) o.c.</li> </ul> |  |                                   |                                   |                                   |                                   |                                   |                                   |

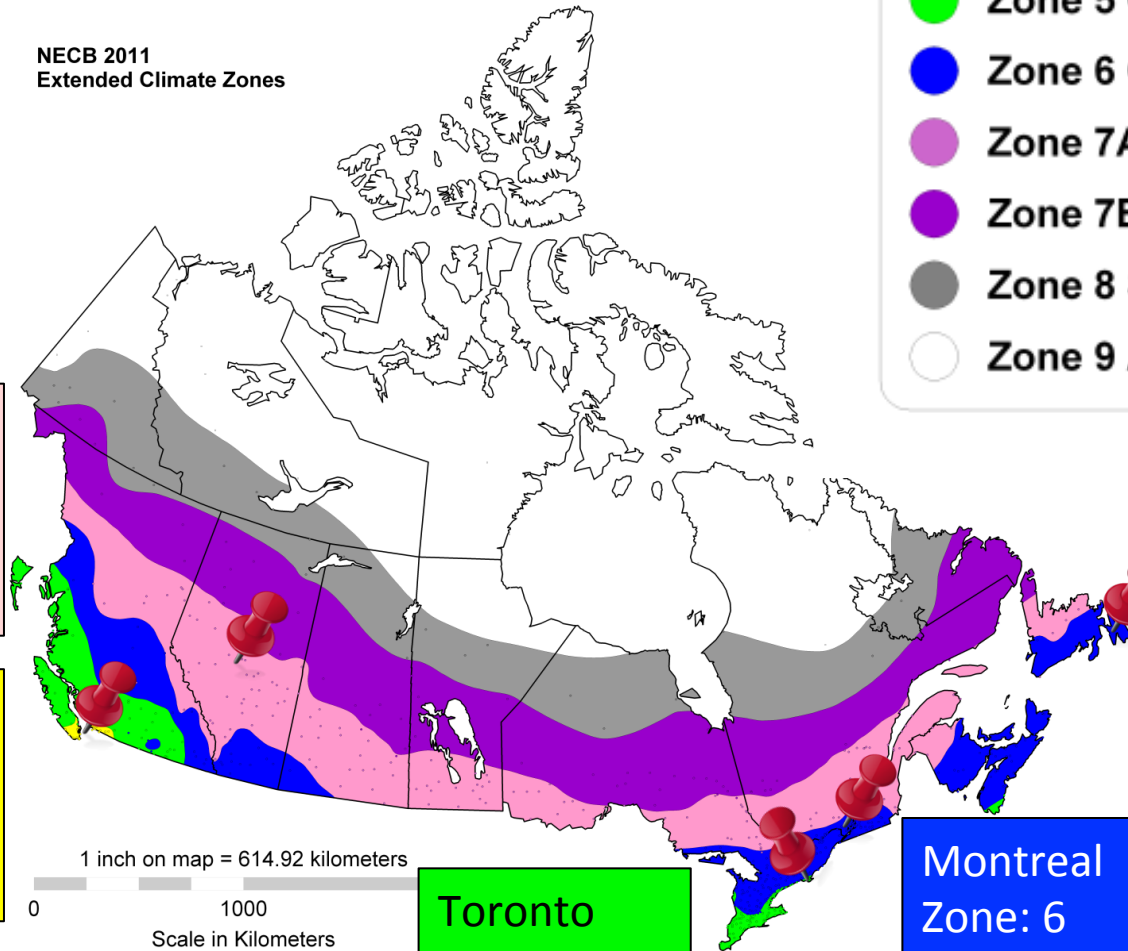
# Climate zones (HDD 18 °C) and modelled cities

NECB 2011  
Extended Climate Zones

- Zone 4 Mixed < 3000
- Zone 5 Cool < 4000
- Zone 6 Cold < 5000
- Zone 7A Very Cold < 6000
- Zone 7B Very Cold < 7000
- Zone 8 Subarctic < 8000
- Zone 9 Arctic  $\geq$  8000

Edmonton  
Zone: 7A  
HDD: 5120  
MI: 0.48

Vancouver:  
Zone: 4  
HDD: 2950  
MI: 1.69



St John's  
Zone: 6  
HDD: 4800  
MI: 1.41

Montreal  
Zone: 6  
HDD: 4500  
MI: 0.93

Toronto  
Zone: 5  
HDD: 3800  
MI: 0.87

wall assembly section detail

wall assembly components and their thermal resistance values

wall assembly isometric illustration

calculation summary of wall assembly's thermal resistance (effective, centre of cavity, nominal, advanced framing)

outboard to inboard ratio for this wall

simulated durability analysis (WUFI hydrothermal analysis and outboard to inboard ratio code compliance for different 5 climate zones)

effective R-value of wall assembly

summary of wall assembly durability performance

The software interface displays a wall assembly analysis. On the left, there are two diagrams: a cross-section detail and an isometric illustration. The cross-section detail shows 11 numbered components. Below it is a table:

| WALL ASSEMBLY COMPONENTS* | R <sub>si</sub> | R <sub>i</sub> |
|---------------------------|-----------------|----------------|
| 1                         |                 |                |
| 2                         |                 |                |
| 3                         |                 |                |
| 4                         |                 |                |
| 5                         |                 |                |
| 6                         |                 |                |
| 7                         |                 |                |
| 8                         |                 |                |
| 9                         |                 |                |
| 10                        |                 |                |
| 11                        |                 |                |

Below the table, there are summary values for thermal resistance:

- Effective R<sub>si</sub> / R<sub>i</sub> Value of Entire Assembly
- Centre of Cavity R<sub>si</sub> / R<sub>i</sub> Value
- Included Insulation R<sub>si</sub> / R<sub>i</sub> Value (nominal)
- Effective R<sub>si</sub> / R<sub>i</sub> Value of Assembly with Advanced Framing (per ASHRAE 90.1-2010 Table 6.2-1)

On the right, an isometric illustration shows the wall assembly with components numbered 1 through 11. A yellow bar indicates the effective R-value: **RETARDER / BRND R<sub>si</sub> 0.32**. Below the diagrams is a 'SIMULATED DURABILITY ANALYSIS' section with a legend and a table of results for five climate zones.

Legend:  Pass  Proceed with caution  Check permeance of material

| CLIMATE ZONE | Pass                                | Proceed with caution     | Check permeance of material |
|--------------|-------------------------------------|--------------------------|-----------------------------|
| 1            | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>    |
| 2            | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>    |
| 3            | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>    |
| 4            | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>    |
| 5            | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>    |

Summary of results:

- R<sub>si</sub> 21.8**
- Summary
- Energy & Thermal Performance
- Exterior Moisture / Wetting
- Air Leakage Transported Moisture from Inside



## building science notes

(thermal, moisture, air leakage, vapour diffusion)



recommendations to improve the durability of the wall assembly

## builder notes

(constructability, affordability, design implications)



external sources for additional information related the wall assembly

## Energy & Thermal Performance

[Redacted]

### Exterior Moisture / Wetting

[Redacted]

### Air Leakage Transported Moisture from Inside

[Redacted]

### Water Vapour Diffusion from Outside

[Redacted]

### Water Vapour Diffusion from Inside

[Redacted]

## How to Improve Durability

[Redacted]

## Ease of Construction

[Redacted]

### Affordability: Cost Implications

[Redacted]

### Esthetics: Architectural Design

[Redacted]

## Additional Sources of Information

[Redacted]



# WALL THERMAL DESIGN CALCULATOR

## Project team

|                |  |
|----------------|--|
| Robert Jonkman | Canadian Wood Council                    |
| Andy Oding     | Building Knowledge Canada                |
| Gord Cooke     | Building Knowledge Canada                |
| Chris Timusk   | Timusk Consulting / George Brown College |
| Candice Luck   | buildABILITY Corporation                 |
| Robert Fiorino | buildABILITY Corporation                 |
| Michael Lio    | buildABILITY Corporation                 |

# WALL THERMAL DESIGN CALCULATOR

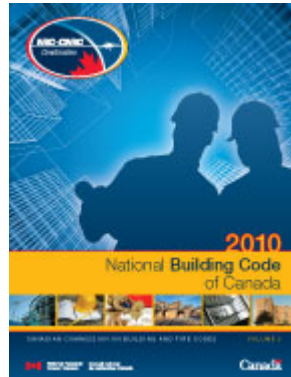
## Steering committee

|                      |   |
|----------------------|---|
| BJ Yeh               | APA – The Engineered Wood Association             |
| Bob Wilson           | R.S. Wilson Building Inspection & Consulting Inc. |
| Christopher McLellan | Natural Resources Canada                          |
| David Birmingham     | APA – The Engineered Wood Association             |
| Dave Henderson       | Brookfield Homes                                  |
| Gary Sharp           | Canadian Home Builder's Association               |
| Gillian Haley        | ERA Architects Inc.                               |
| John Hockman         | JLHockman Consulting Inc.                         |
| Jieying Wang         | FPIinnovations                                    |
| Paul Smith           | Mattamy Homes Limited                             |
| Richard Kadulski     | Solplan Review                                    |
| Todd Rogers          | City of St. Catharines                            |
| Salvatore Ciarlo     | Owens Corning Canada                              |
| Silvio Plescia       | Canada Mortgage and Housing Corporation           |

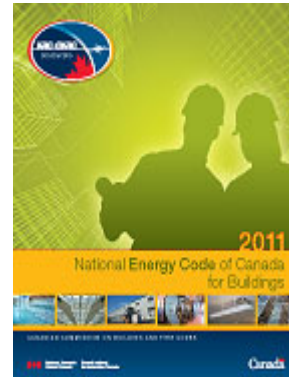


# Effective thermal insulation:

To be adopted  
in these  
provinces 2015



To be adopted  
in these  
provinces 2014



## Plan for Adoption of Energy Codes

“ Both the **NECB** and energy efficiency requirements for houses and small buildings in the **NBC** are proposed to be adopted as published to support consistent application of these codes across Canada.

*[http://www.municipalaffairs.alberta.ca/CP\\_Energy\\_Codes\\_Information.cfm](http://www.municipalaffairs.alberta.ca/CP_Energy_Codes_Information.cfm)*

**NOTICE is hereby given** that amendments to the Nova Scotia Building Code Regulations (the Building Code) made pursuant to the Building Code Act, Chapter 46, R.S.N.S. 1989 are intended to be prescribed by me, Frank Corbett, Minister of Nova Scotia Labour and Advanced Education, to come into effect throughout the Province of Nova Scotia on December 31, 2013.

These amendments adopt the

- 1st Revisions and Errata to the National Building Code of Canada 2010 and the National Plumbing Code of Canada 2010 effective on December 31, 2013.

- National Energy Code for Buildings 2011 with the 1st Revisions and Errata.

Amendments and the

**National Energy Code for Buildings... December 31, 2013**

**Houses and Small Buildings... December 31, 2014...**



No. B13 - 05  
May 22, 2013

## New Energy Requirements

---

### Large Residential, Industrial, Commercial and Institutional Buildings (Part 3) – **December 20, 2013**

- *2011 National Energy Code for Buildings (NECB) or*
- *ASHRAE 90.1(2010)*

### Housing and Small Buildings (Part 9) - **December 19, 2014**

- Effective December 19, 2014, BC has adopted [*NBC 9.36, amended Dec 2012*].

# Quebec Energy requirements

Aug 30 2012

## 11.2.2.1. Thermal Resistance of Building Components:

Walls have a **Total thermal resistance** (*RSIT*) of either:

- 4.31 (R24.5) for <6000 HDD or
- 5.11 (R29.0) for  $\geq 6000$  HDD

## 11.2.3.1. Thermal Bridges in Walls:

**Wood framing must be covered in insulating material**

having a *thermal resistance* of either:

- RSI 0.53 (R3) where studs are  $\geq 600$  mm
- RSI 0.70 (R4) where studs are < 600 mm

# City of Vancouver – Jan 2014

- attic – R-40
- roof joist assembly – R-28
- exterior wall – R-22



## Green Homes Buyer's Guide

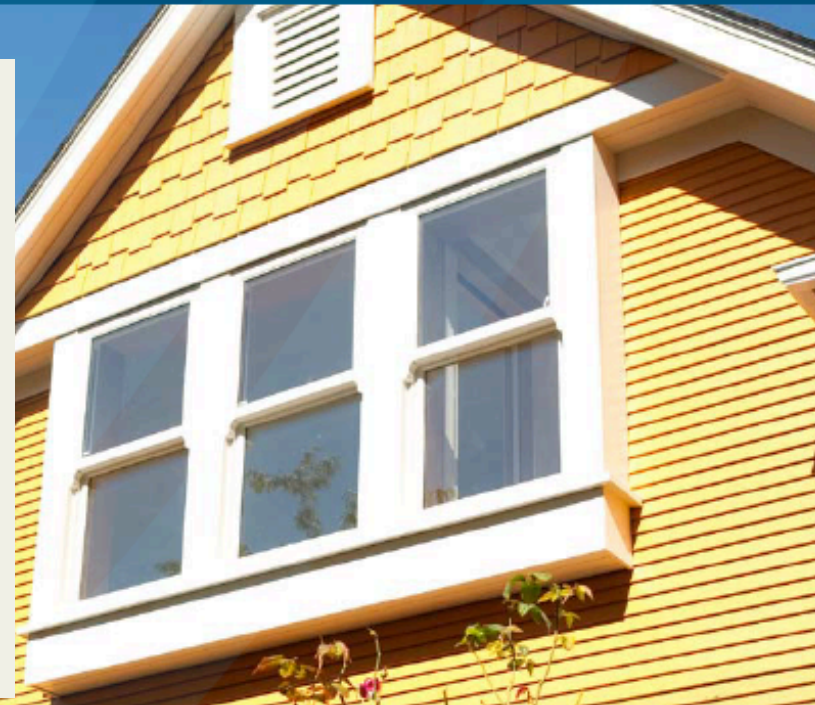
*green home renovation*

*healthy homes for a healthy environment*

## Energy Efficiency

Home energy use in The United States is responsible for 20 per cent of CO<sub>2</sub> emissions nationwide.<sup>4</sup> Choosing, or creating, a more energy-efficient home will reduce fuel use, greenhouse gas emissions and your utility bills. An R-2000 home will use at least 30 per cent less energy than a conventional new home built at current building codes. An energy-efficient home will have:

- A well-insulated, airtight, envelope. The City of Vancouver Green Homes Program specifies the following insulation requirements for residential construction:
  - attic – R-40
  - roof joist assembly – R-28
  - exterior wall – R-22
  - full height of basement wall – R-22
  - under slab – R-12
  - framed suspended floor – R-28
  - concrete slab suspended floor – R-12
  - windows – max U-2
  - radiant heating suspended floor – R-12





**Table 10.2.1.1.A**  
**Minimum Thermal Resistance of Insulation RSI, m<sup>2</sup>°C/W for Buildings of Residential Occupancy less than 5 Storeys in Building Height**  
Forming part of [Sentence 10.2.1.1.\(2\)](#)

| <i>Building Assembly</i> | <b>Value Required</b> |
|--------------------------|-----------------------|
|--------------------------|-----------------------|

**Houses: R<sub>eff</sub> 22**

**Other than houses: R<sub>eff</sub> 20**

|   |            |
|---|------------|
| Frame Walls other than one and two family dwellings (including frame crawl space walls)             | 3.5        |
| Frame Walls for one and two family dwellings (including frame crawl space walls) – Effective rating | 23<br>3.85 |

## SB-12

Table 2.1.1.2.A  
ZONE 1 - Compliance Packages for Space Heating Equipment with AFUE  $\geq 90\%$   
Forming Part of Sentence 2.1.1.2.(1)

| Component  | Compliance Package |               |               |               |               |               |               |               |               |               |                  |                  |                  |
|--|--------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|------------------|------------------|------------------|
|  | A                  | B             | C             | D             | E             | F             | G             | H             | I             | J             | K <sup>(3)</sup> | L <sup>(4)</sup> | M <sup>(5)</sup> |
| Ceiling with Attic Space<br>Minimum RSI (R)-Value <sup>(1)</sup>                                   | 8.81<br>(R50)      | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50) | 8.81<br>(R50)    | 8.81<br>(R50)    | 8.81<br>(R50)    |
| Ceiling Without Attic Space<br>Minimum RSI (R)-Value <sup>(1)</sup>                                | 5.46<br>(R31)      | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31)    | 5.46<br>(R31)    | 5.46<br>(R31)    |
| Exposed Floor<br>Minimum RSI (R)-Value <sup>(1)</sup>  | 5.46<br>(R31)      | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31) | 5.46<br>(R31)    | 5.46<br>(R31)    | 5.46<br>(R31)    |
| Walls Above Grade<br>Minimum RSI (R)-Value <sup>(1)</sup>  | 4.23<br>(R24)      | 4.75<br>(R27) | 4.75<br>(R27) | 4.23<br>(R24) | 4.23<br>(R24) | 4.23<br>(R24) | 4.23<br>(R24) | 4.23<br>(R24) | 3.87<br>(R22) | 3.87<br>(R22) | 3.87<br>(R22)    | 4.23<br>(R24)    | 4.23<br>(R24)    |
| Basement Walls<br>Minimum RSI (R)-Value <sup>(1)</sup>   | 3.52<br>(R20)      | 3.52<br>(R20) | 3.52<br>(R20) | 3.52<br>(R20) | 3.52<br>(R20) | 2.11<br>(R12) | 2.11<br>(R12) | 2.11<br>(R12) | 3.52<br>(R20) | 2.11<br>(R12) | 3.87<br>(R22)    | 3.87<br>(R22)    | 3.52<br>(R20)    |
| Below Grade Slab<br>Entire surface > 600 mm<br>below grade<br>Minimum RSI (R)-Value <sup>(1)</sup> | 0.88<br>(R5)       | -             | -             | -             | -             | -             | -             | -             | -             | -             | -                | -                | -                |
| Edge of Below Grade Slab<br>> 600 mm Below Grade   | 1.76               | 1.76          | 1.76          | 1.76          | 1.76          | 1.76          | 1.76          | 1.76          | 1.76          | 1.76          | 1.76             | 1.76             | 1.76             |

24  
Nominal insulation values

# Nominal vs Effective R-values

## Nominal R-value:

Installed R-value of the insulation components only, as labelled on the product.

Example: R19/20 batts  
**R19 batt (wood studs)**  
**R20 batt (metal studs)**




## Effective R-value:

R-value including the contribution of framing members (spacing and material type)



# Effective R-values are based on framing material and framing spacing

|   | $R_{\text{eff}}$ | Framing material | Stud spacing    | Nominal Insulation (cavity + cont. exterior)  |
|---|------------------|------------------|-----------------|---|
|   |                  |                  |                 |  |
| 1 | <b>16.6</b>      | 2x6 wood studs   | 16" std framing | $R19 + 0 = R19$   |
| 2 | <b>17.9</b>      | 2x6 wood studs   | 24" adv framing | $R19 + 0 = R19$   |
| 3 | <b>10.4</b>      | 2x6 metal studs  | 16" std framing | $R20 + 0 = R20$   |
|   |                  |                  |                 |   |
|   |                  |                  |                 |   |
|   |                  |                  |                 |   |

Based on the examples in NBC A-9.36.2.4, using brick and airspace for all assemblies with Gypsum sheathing outside and inside .



## Phase 1 Scope

### 156 unique assemblies

- Brick and Vinyl Cladding
- High performance 2x4, 2x6, 2x8
- Batt and Spray Foam
- Wood and Insulated Sheathings (EPS, XPS, Polyiso, mineral wool)
- Cross Laminated Timber Sample
- Advanced framing

# WALL THERMAL DESIGN CALCULATOR

## STEP 1

SELECT YOUR KNOWN WALL COMPONENTS

[www.cwc.ca/wtd](http://www.cwc.ca/wtd)

[Skip to View results](#)

[Skip to Durability](#)

# WALL THERMAL DESIGN CALCULATOR

Reff: From:

To: **Reff until**

Rnominal: From:

To:

Strapping (inches):

Framing (inches):

Spacing (inches):

Cavity Fill:

Sheathing (inches):

Strapping (inches):


Cladding:

- 15
- 15.8
- 16
- 16.9
- 17
- 17.5
- 18
- 19
- 20
- 21
- 21.9
- 22
- 23
- 24
- 24.5
- 25
- 26
- 27
- 28
- 29
- 30
- 31
- 32
- 33<sup>29</sup>
- 34

# WALL THERMAL DESIGN CALCULATOR

Reff: From: Reff from

To: Reff until

 Rnominal: From: 24

To: 29

Strapping (inches):

--- Select Strapping (inches) ---

Framing (inches):

--- Select Framing (inches) ---

Spacing (inches):

16 o.c.

Cavity Fill:

--- Select Cavity Fill --

Sheathing (inches):

--- Select Sheathing (inches) ---

Strapping (inches):

--- Select Strapping (inches) ---

Cladding:

--- Select Cladding ---

30



# WALL THERMAL DESIGN CALCULATOR

Reff: From: 22

To: Reff until

Rnominal: From: Rnominal from

To: Rnominal until

Strapping (inches):

None

--- Select Framing (inches) ---

2X4

2X6

2X8

Cross Laminated Timber

--- Select Spacing (inches) ---

Framing (inches):

Spacing (inches):

Cavity Fill: --- Select Cavity Fill --

Sheathing (inches):

--- Select Sheathing (inches) ---

Strapping (inches):

--- Select Strapping (inches) ---

Cladding:

--- Select Cladding ---



# WALL THERMAL DESIGN CALCULATOR

Reff: From: 22

To: Reff until

Rnominal: From: Rnominal from

To: Rnominal until

Strapping (inches): None

Framing (inches): 2X6

Spacing (inches):

- Select Spacing (inches) ---
- 16 o.c.
- 19.2 o.c.
- 24 o.c.

Cavity Fill: --- Select Cavity Fill ---

Sheathing (inches): --- Select Sheathing (inches) ---

Strapping (inches): --- Select Strapping (inches) ---

Cladding: --- Select Cladding ---

# WALL THERMAL DESIGN CALCULATOR

Reff: From: 22

To: Reff until

Rnominal: From: Rnominal from

To: Rnominal until

Strapping (inches): None

Framing (inches): 2X6

Spacing (inches):

Cavity Fill:

- Select Cavity Fill ---
- R14 batt
- R19 batt
- R22 batt
- R24 batt
- R28 batt
- Low Density Foam (0.5lb)
- Medium Density Foam (2lb)

Sheathing (inches):

Strapping (inches): --- Select Strapping (inches) ---

Cladding: --- Select Cladding ---

# WALL THERMAL DESIGN CALCULATOR

Strapping (inches):

--- Select Strapping (inches) ---

Framing (inches):

2X6

Spacing (inches):

16 o.c.

Cavity Fill:

--- Select Sheathing (inches) ---

7/16 OSB

0.8 in. XPS

7/16 OSB + 1 in. Foil Faced Polyiso

7/16 OSB + 1 in. Unfaced EPS

7/16 OSB + 1 in. XPS

7/16 OSB + 2 in. XPS

7/16 OSB + 2 in. Mineral Wool

7/16 OSB + 3 in. Mineral Wool

2 layers of 3 in. mineral wool

Plywood (coming soon)

--- Select Cladding ---

Sheathing (inches):



Strapping (inches):

Cladding:



# WALL THERMAL DESIGN CALCULATOR

Reff: From: 22

To: Reff until

Rnominal: From: Rnominal from

To: Rnominal until

Strapping (inches): --- Select Strapping (inches) ---

Framing (inches): 2X6

Spacing (inches): 16 o.c.

Cavity Fill: R22 batt

Sheathing (inches): 7/16 OSB + 1 in. XPS

Strapping (inches):   
--- Select Strapping (inches) ---  
1 X4  
None



Cladding: --- Select Cladding ---

Reff: From: 22

To: Reff until

Rnominal: From: Rnominal from

To: Rnominal until

Strapping (inches): --- Select Strapping (inches) ---

Framing (inches): 2X6

Spacing (inches): 16 o.c.

Cavity Fill: R22 batt

Sheathing (inches): 7/16 OSB + 1 in. XPS

Strapping (inches): None

Cladding:

- Select Cladding ---
- Brick
- Vinyl
- EIFS (coming soon)
- Fibre Cement (coming soon)
- Stucco (coming soon)
- Wood Siding (coming soon)



und 1 result(s)

| Title | Re | ng (inghes) | Cavity Fill |
|-------|----|-------------|-------------|
|-------|----|-------------|-------------|

**Search for:**

**Search**



**Find entries that have:**  All words  Any words  Exact Phrase

**Reff:** From:

To:

**Rnominal:** From:

To:

**Strapping (inches):**

**Framing (inches):**

**Spacing (inches):**

**Cavity Fill:**

**Sheathing (inches):**

**Strapping (inches):**

**Cladding:**



# WALL THERMAL DESIGN CALCULATOR

## STEP 2

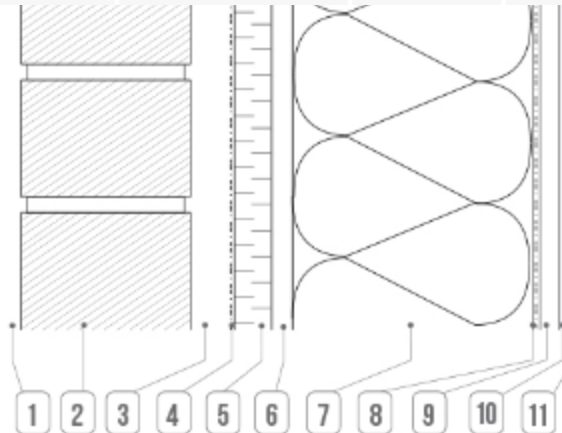
### SELECT RESULTS



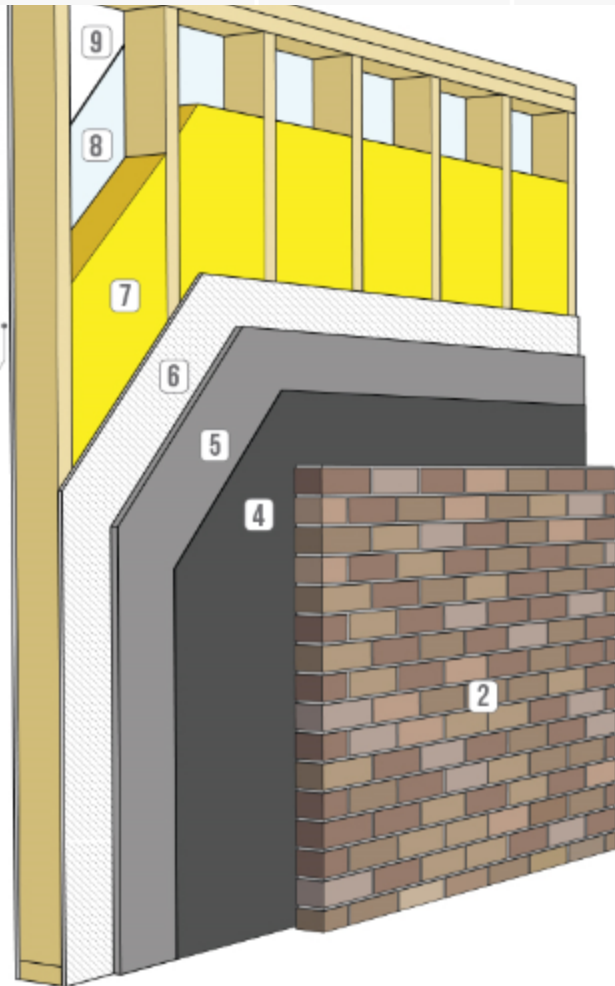


Found 1 result(s)

| Title            | Reff | Rnominal | Framing (inches) | Spacing (inches) | Cavity Fill | Sheathing (inches)   | Strapping (inches) | Cladding |
|------------------|------|----------|------------------|------------------|-------------|----------------------|--------------------|----------|
| F6.S16.I22.O1X.B | 22.8 | 27.00    | 2X6              | 16 o.c.          | R22 batt    | 7/16 OSB + 1 in. XPS | None               | Brick    |



| WALL ASSEMBLY COMPONENTS <sup>1</sup>   |   | RSI         | R           |
|---|---|-------------|-------------|
| 1   | exterior air film                                   | 0.03        | 0.17        |
| 2   | fired clay brick 4" (102 mm) <sup>2</sup>           | 0.07        | 0.40        |
| 3   | 1" (25.4 mm) air space w/weep holes at base of wall | 0.18        | 1.02        |
| 4   | asphalt impregnated paper <sup>3</sup>              | 0.00        | 0.00        |
| 5   | 1" (25.4 mm) extruded polystyrene type 3 / 4        | 0.89        | 5.00        |
| 6   | 7/16" (11.1 mm) OSB sheathing <sup>4</sup>          | 0.11        | 0.62        |
| 7   | 2x6 framing filled with R22 batt @ 16" o.c.         | 2.55        | 14.48       |
| 8   | polyethylene  | 0.00        | 0.00        |
| 9   | 1/2" (12.7 mm) gypsum board                         | 0.08        | 0.45        |
| 10  | finish: 1 coat primer                               | 0.00        | 0.00        |
| 11  | interior air film                                   | 0.12        | 0.68        |
| Effective RSI / R Value of Entire Assembly  |   | <b>4.03</b> | <b>22.8</b> |
| Centre of Cavity RSI / R Value  |   | 5.35        | 30.38       |
| Installed Insulation RSI / R Value (nominal)  |   | 4.76        | 27.00       |
| Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC 9.38.2.4.(1)) |   | 4.16        | 23.63       |



Note: <sup>1</sup>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. <sup>2</sup>The thermal resistance of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CSA-S132, "Sheathing Membranes, (leather type)". <sup>4</sup>OSB was a conservative decision due to its inferior performance in the WUFI durability analysis in comparison to plywood.

OUTBOARD to INBOARD RATIO **0.28**

LEGEND  Pass  Proceed with caution  Check permeance of materials

**SIMULATED DURABILITY ANALYSIS**

Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapor permeance less than 10 ngr/(Pa·m) must comply to NBC 9.25.5.2.

| LOCATION:                            | Vancouver                               | Edmonton                                | Toronto                                 | Montreal                                | St. John's                              |
|--------------------------------------|---|---|---|---|---|
| WUFI HYDROTHERMAL MODELING           | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     |
| OUTBOARD TO INBOARD RATIO COMPLIANCE | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.3 | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.2 |

**22.8**  
R<sub>eff</sub>

# WALL THERMAL DESIGN CALCULATOR

## STEP 3

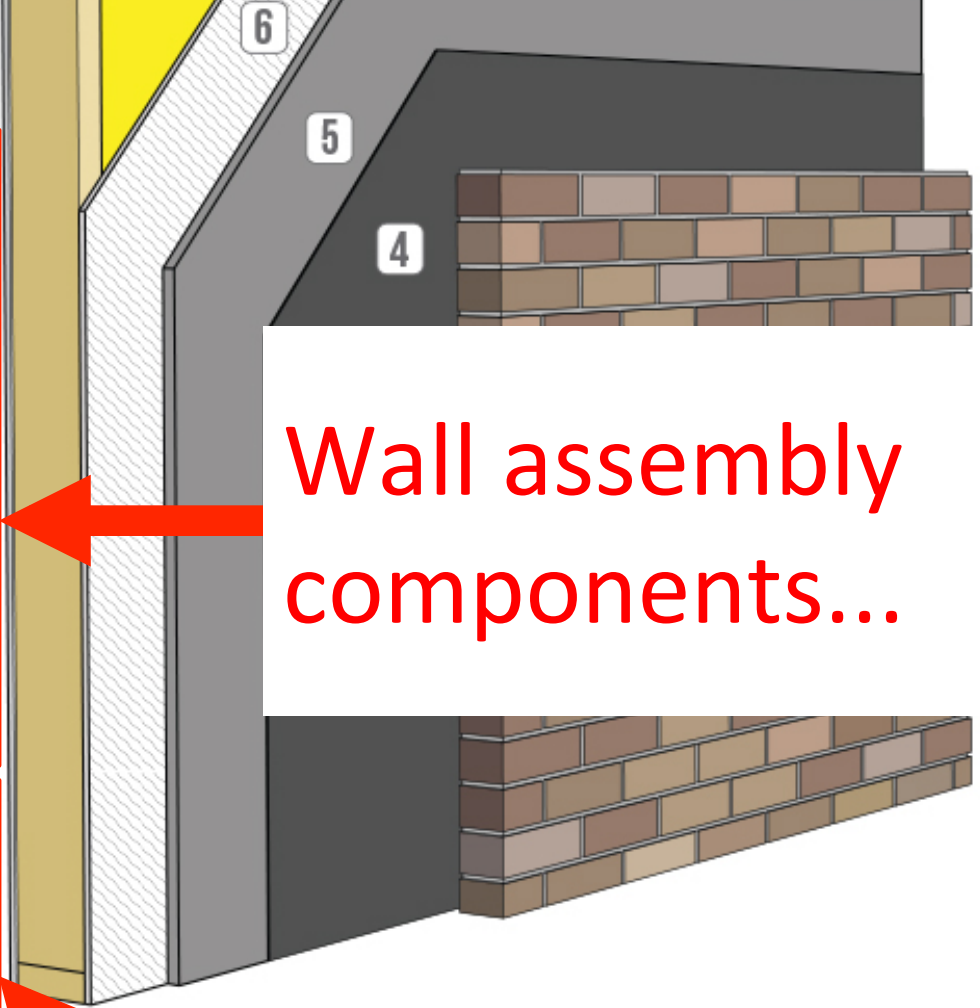
READ ABOUT YOUR WALL ASSEMBLY



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- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11

| WALL ASSEMBLY COMPONENTS <sup>1</sup>  |  | RSI         | R            |
|--|--|-------------|--------------|
| 1  | exterior air film                                    | 0.03        | 0.17         |
| 2  | fired clay brick 4" (102 mm) <sup>2</sup>            | 0.07        | 0.40         |
| 3  | 1" (25.4 mm) air space w/ weep holes at base of wall | 0.18        | 1.02         |
| 4  | asphalt impregnated paper <sup>3</sup>               | 0.00        | 0.00         |
| 5  | 1" (25.4 mm) extruded polystyrene type 3 / 4         | 0.89        | 5.00         |
| 6  | 7/16" (11.1 mm) OSB sheathing <sup>4</sup>           | 0.11        | 0.62         |
| 7  | 2x6 framing filled with R24 batt @ 16" o.c.          | 2.66        | 15.10        |
| 8  | polyethylene   | 0.00        | 0.00         |
| 9  | 1/2" (12.7 mm) gypsum board                          | 0.08        | 0.45         |
| 10   | finish: 1 coat primer                                | 0.00        | 0.00         |
| 11   | interior air film                                    | 0.12        | 0.68         |
| <b>Effective RSI / R Value of Entire Assembly</b>  |  | <b>4.14</b> | <b>23.51</b> |
| Centre of Cavity RSI / R Value   |  | 5.71        | 32.42        |
| Installed Insulation RSI / R Value (nominal)   |  | 5.10        | 29.00        |
| Effective RSI / R Value of Assembly with Advanced Framing<br>(advanced framing as defined by NBC 9.36.2.4.(1)) |  | 4.29        | 24.36        |

Note: <sup>1</sup>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



Wall assembly components...

...and assembly RSI and R values.

D RATIO 0.26

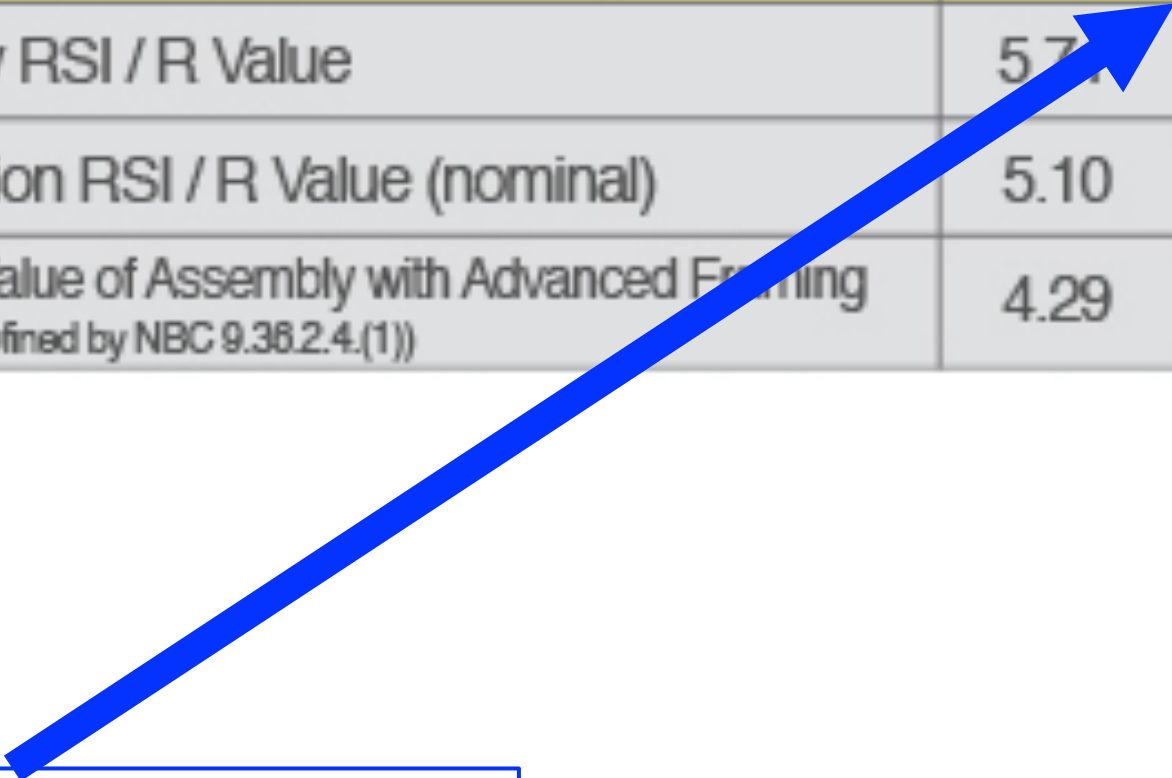
St. Labels



41

**23.5**  
R<sub>eff</sub>

|  |             |              |
|--|-------------|--------------|
| Effective RSI / R Value of Entire Assembly   | <b>4.14</b> | <b>23.51</b> |
| Centre of Cavity RSI / R Value   | 5.71        | 32.42        |
| Installed Insulation RSI / R Value (nominal)   | 5.10        | 29.00        |
| Effective RSI / R Value of Assembly with Advanced Framing<br>(advanced framing as defined by NBC 9.36.2.4.(1)) | 4.29        | 24.36        |



Effective insulation  
for NECB and NBC  
9.36

|  |             |              |
|--|-------------|--------------|
| Effective RSI / R Value of Entire Assembly   | <b>4.14</b> | <b>23.51</b> |
| Centre of Cavity RSI / R Value   | 5.71        | 32.42        |
| Installed Insulation RSI / R Value (nominal)   | 5.10        | 29.00        |
| Effective RSI / R Value of Assembly with Advanced Framing<br>(advanced framing as defined by NBC 9.36.2.4.(1)) | 4.29        | 24.36        |

Also displays nominal  
and total insulation  
values:

- nominal (ON)
- total (QB)



# Nominal thermal insulation:



Ontario

MINISTRY OF MUNICIPAL AFFAIRS AND HOUSING

Thermal resistance of “**insulation**” only

Régie  
du bâtiment

Québec 

“**Centre of cavity**” thermal resistance

|  |             |              |
|--|-------------|--------------|
| Effective RSI / R Value of Entire Assembly   | <b>4.14</b> | <b>23.51</b> |
| Centre of Cavity RSI / R Value   | 5.71        | 32.42        |
| Installed Insulation RSI / R Value (nominal)   | 5.10        | 29.00        |
| Effective RSI / R Value of Assembly with Advanced Framing<br>(advanced framing as defined by NBC 9.36.2.4.(1)) | 4.29        | 24.36        |

Advanced framing options to increase  $R_{eff}$

# Durability




Note: <sup>1</sup>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. <sup>2</sup>The thermal resistance of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane, Breather Type."

**OUTBOARD TO INBOARD RATIO 0.26**

LEGEND  Pass  Proceed with caution  Check permeance of material

| SIMULATED DURABILITY ANALYSIS        |  | LOCATION :  |   |   |   |   |
|--------------------------------------|--|---|---|---|---|---|
|                                      |  | Vancouver   | Edmonton  | Toronto   | Montreal  | St. John's  |
| WUFI HYGTROHERMAL MODELING           |  |      |      |      |      |      |
| OUTBOARD TO INBOARD RATIO COMPLIANCE |  |  0.2 |  0.3 |  0.2 |  0.2 |  0.2 |

Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapour permeance less than 60 m(Pa·s·m<sup>2</sup>) must comply to NBC 9.25.5.2.

 Check detailed cautionary notes below regarding Exterior moisture and Air leakage.

1. Outboard: Inboard ratio
2. Hygrothermal modelling
3. **Low perm exterior sheathing**






Note: <sup>1</sup>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. <sup>2</sup>The thermal resistance of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane, Breather Type."

**OUTBOARD TO INBOARD RATIO 0.26**

LEGEND  Pass  Proceed with caution  Check permeance of material

**SIMULATED DURABILITY ANALYSIS**

Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapour permeance less than 60 ng/(Pa·s·m<sup>2</sup>) must comply to NBC 9.25.5.2.

| LOCATION :                           | Vancouver   | Edmonton  | Toronto   | Montreal  | St. John's  |
|--------------------------------------|---|---|---|---|---|
| WUFI HYGTROHERMAL MODELING           |      |      |      |      |      |
| OUTBOARD TO INBOARD RATIO COMPLIANCE |  0.2 |  0.3 |  0.2 |  0.2 |  0.2 |

1. **Outboard: Inboard ratio**
2. Hygrothermal modelling



# Durability – Outboard : Inboard

## 9.25.5 Properties and Position of Materials in the Building Envelope

9.25.5.1: For materials with...

- Low air leakage characteristics ( $< 0.1 \text{ L/s}$ ) and
- Low water vapour permeance ( $< 60 \text{ ng}/(\text{Pa s m}^2)$ )

# Durability – Outboard : Inboard

## 9.25.5 Properties and Position of Materials in the Building Envelope

Insulation

|  |            |                   |
|--|------------|-------------------|
| 27-mm foil-faced polyisocyanurate              | negligible | 4.3               |
| 27-mm paper-faced polyisocyanurate             | negligible | 61.1              |
| 25-mm extruded polystyrene                     | negligible | 23 – 92           |
| 25-mm expanded polystyrene (Type 2)            | 0.0214     | 86 – 160          |
| fibrous insulations                            | very high  | very high         |
| 25-mm polyurethane spray foam – low density    | 0.011      | 894 – 3791        |
| 25-mm polyurethane spray foam – medium density | negligible | 96 <sup>(2)</sup> |

# Durability – Outboard : Inboard

Outboard to inboard ratio for most of Canada's population is 20% to 30%

Table 9.25.5.2.  
Ratio of Outboard to Inboard Thermal Resistance  
Forming Part of Sentence 9.25.5.2.(1)

| Heating Degree-Days of <i>Building</i> Location <sup>(1)</sup> , Celsius degree-days | Minimum Ratio of Total Thermal Resistance Outboard of Material's Inner Surface to Total Thermal Resistance Inboard of Material's Inner Surface |
|--|--|
| up to 4999   | 0.20   |
| 5000 to 5999   | 0.30   |
| 6000 to 6999   | 0.35   |
| 7000 to 7999   | 0.40   |
| 8000 to 8999   | 0.50   |
| 9000 to 9999   | 0.55   |
| 10000 to 10999   | 0.60   |
| 11000 to 11999   | 0.65   |
| 12000 or higher  | 0.75   |

Table 9.25.5.2.

# WALL THERMAL DESIGN CALCULATOR

## Outboard to Inboard Ratio Compliance

This scale represents the result of an outboard to inboard analysis on the wall assemblies using low permeance exterior sheathings:



Green indicates that the wall meets the climate's required minimum ratio



Red indicates that the wall does not meet the climate's required minimum ratio and the outboard sheathing's permeance must be examined to verify Code compliance











Note: <sup>1</sup>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. <sup>2</sup>The thermal resistance of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane, Breather Type."

**OUTBOARD TO INBOARD RATIO 0.26**

LEGEND  Pass  Proceed with caution  Check permeance of material

**SIMULATED DURABILITY ANALYSIS**

Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapour permeance less than 60 ng/(Pa·s·m<sup>2</sup>) must comply to NBC 9.25.5.2.

| LOCATION:                            | Vancouver   | Edmonton  | Toronto   | Montreal  | St John's   |
|--------------------------------------|---|---|---|---|---|
| WUFI HYGROTHERMAL MODELING           |      |      |      |      |      |
| OUTBOARD TO INBOARD RATIO COMPLIANCE |  0.2 |  0.3 |  0.2 |  0.2 |  0.2 |

1. Outboard: Inboard ratio
2. **Hygrothermal modelling**





# WUFI<sup>®</sup> PRO, 2D, Plus

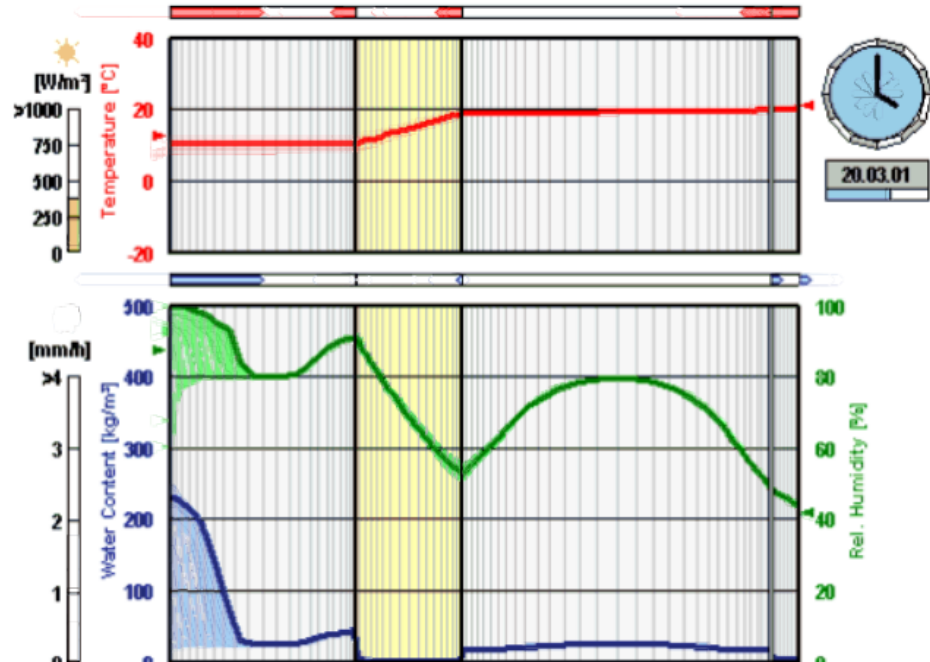
Software for calculating the coupled heat and moisture transfer in building components



Location: Holzkirchen

double-leaf masonry wall exposed to driving rain

WUFI<sup>®</sup>



The WUFI Pro software package from the Fraunhofer Institute for Building Physics in Germany ([www.wufi.de](http://www.wufi.de)) is one of the most widely used hygrothermal models in the building science community.

# WALL THERMAL DESIGN CALCULATOR

## WUFI Hygrothermal Modeling

This represents the result of a comprehensive WUFI analysis on the selected wall assembly in each of the 5 climate conditions:

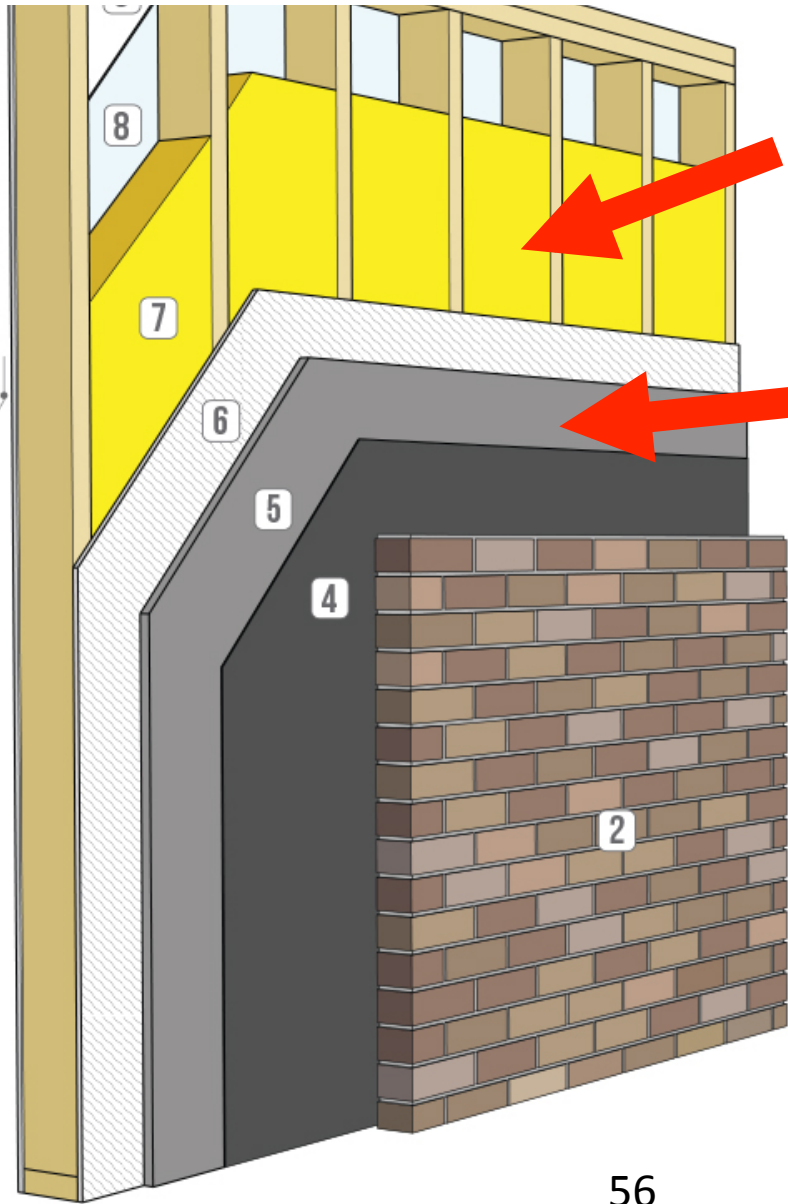
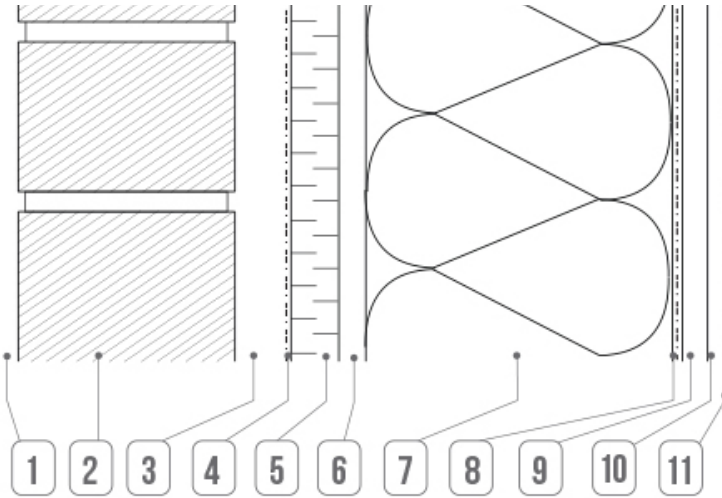


Green indicates that the wall performed well and is suitable for the said climate zone



Yellow indicates that the wall performed moderately and one should take caution in selecting this wall for the said climate zone - refer to the detailed building science notes to learn how to improve the durability of the selected wall assembly

# Is this wall a durable wall in Climate Zone 7A?



**R24 batt**  
cavity

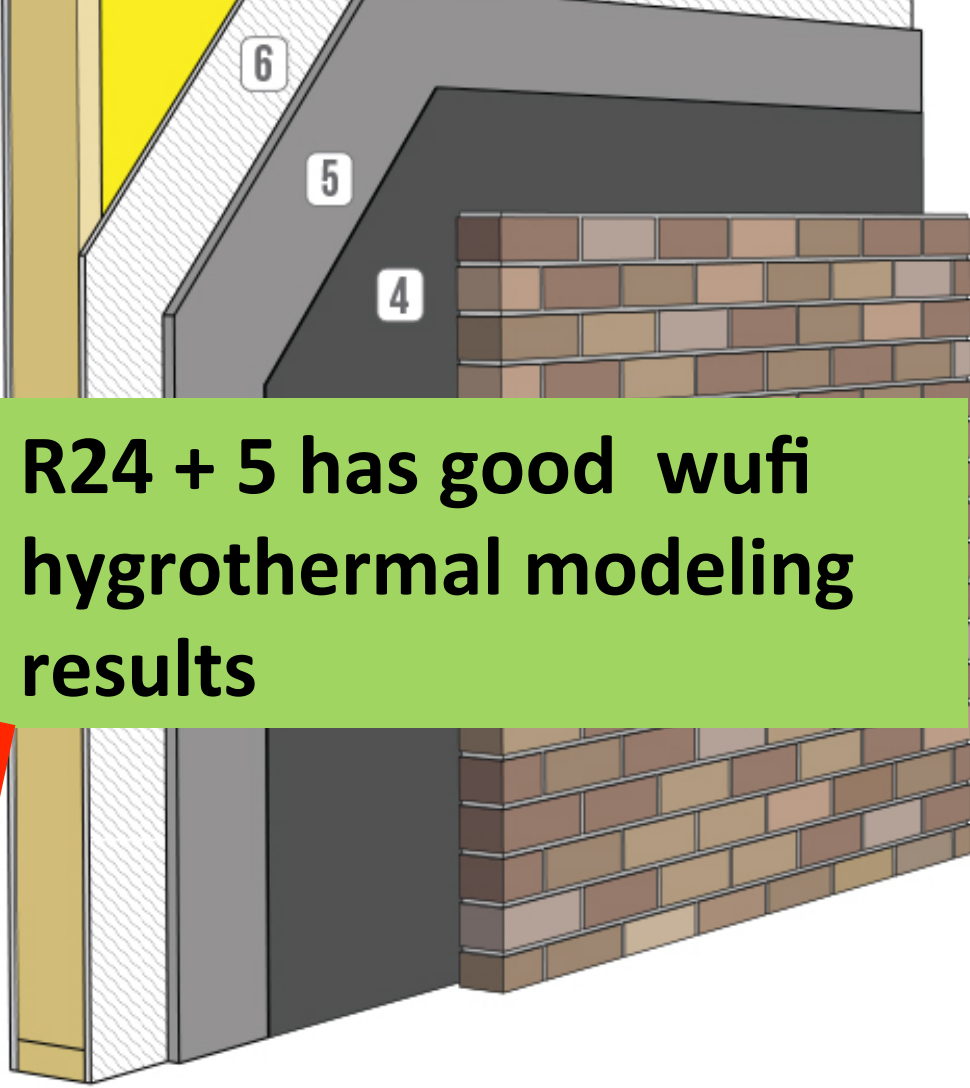
**R5 XPS**  
"low perm"

| WALL ASSEMBLY COMPONENTS <sup>1</sup>   |  | RSI         | R            |
|---|--|-------------|--------------|
| 1   | exterior air film                                    | 0.03        | 0.17         |
| 2   | fired clay brick 4" (102 mm) <sup>2</sup>            | 0.07        | 0.40         |
| 3   | 1" (25.4 mm) air space w/ weep holes at base of wall | 0.18        | 1.02         |
| 4   | asphalt impregnated paper <sup>3</sup>               | 0.00        | 0.00         |
| 5   | 1" (25.4 mm) extruded polystyrene type 3 / 4         | 0.89        | 5.00         |
| 6   | 7/16" (11.1 mm) OSB sheathing <sup>4</sup>           | 0.11        | 0.62         |
| 7   | 2x6 framing filled with R24 batt @ 16" o.c.          | 2.66        | 15.10        |
| 8   | polyethylene   | 0.00        | 0.00         |
| 9   | 1/2" (12.7 mm) gypsum board                          | 0.08        | 0.45         |
| 10  | finish: 1 coat primer                                | 0.00        | 0.00         |
| 11  | interior air film                                    | 0.12        | 0.68         |
| <b>Effective RSI / R Value of Entire Assembly</b>   |  | <b>4.14</b> | <b>23.51</b> |
| Centre of Cavity RSI / R Value  |  | 5.71        | 32.42        |
| Installed Insulation RSI / R Value (nominal)  |  | 5.10        | 29.00        |
| Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC 9.36.2.4.(1)) |  | 4.29        | 24.36        |

Note: <sup>1</sup>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.

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| WALL ASSEMBLY COMPONENTS <sup>1</sup>  |  | RSI         | R           |
|--|--|-------------|-------------|
| 1  | exterior air film                                    | 0.03        | 0.17        |
| 2  | fired clay brick 4" (102 mm) <sup>2</sup>            | 0.07        | 0.40        |
| 3  | 1" (25.4 mm) air space w/ weep holes at base of wall | 0.18        | 1.02        |
| 4  | asphalt impregnated paper <sup>3</sup>               | 0.00        | 0.00        |
| 5  | 1" (25.4 mm) extruded polystyrene type 3 / 4         | 0.89        | 5.00        |
| 6  | 7/16" (11.1 mm) OSB sheathing <sup>4</sup>           | 0.11        | 0.62        |
| 7  | 2x6 framing filled with R24 batt @ 16" o.c.          | 2.66        | 15.10       |
| 8  | polyethylene   | 0.00        | 0.00        |
| 9  | 1/2" (12.7 mm) gypsum board                          | 0.08        | 0.45        |
| 10   | finish: 1 coat primer                                | 0.00        | 0.00        |
| 11   | interior air film                                    | 0.12        | 0.68        |
| <b>Effective RSI / R Value of Entire Assembly</b>  |  | <b>4.14</b> | <b>23.5</b> |
| Centre of Cavity RSI / R Value   |  | 5.71        | 32.42       |
| Installed Insulation RSI / R Value (nominal)   |  | 5.10        | 29.0        |
| Effective RSI / R Value of Assembly with Advanced Framing<br>(advanced framing as defined by NBC 9.38.2.4.(1)) |  | 4.29        | 24.0        |



**R24 + 5 has good wufi hygrothermal modeling results**

**OUTBOARD TO INBOARD RATIO 0.26**

Note: <sup>1</sup>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 literature of such a product. <sup>2</sup>The thermal resistance of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane, Breather Type." <sup>4</sup>OSB was a conservative decision due to its inferior performance in the WUFI durability analysis in comparison to plywood.

LEGEND  Pass  Proceed with caution  Check permeance of material

| SIMULATED DURABILITY ANALYSIS | LOCATION:                  | Vancouver                           | Edmonton                            | Toronto                             | Montreal                            | St. John's                          |
|-------------------------------|----------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
|                               | WUFI HYGROTHERMAL MODELING | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

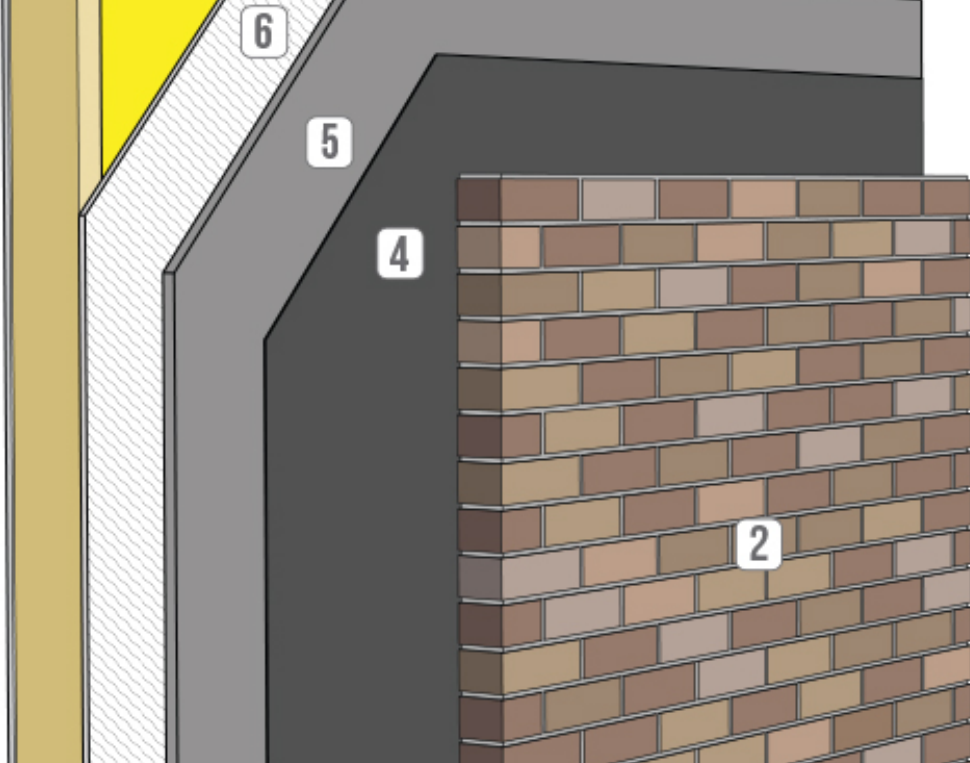
23.5

57



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| WALL ASSEMBLY COMPONENTS <sup>1</sup>   |  | RSI         | R            |
|---|--|-------------|--------------|
| 1   | exterior air film                                    | 0.03        | 0.17         |
| 2   | fired clay brick 4" (102 mm) <sup>2</sup>            | 0.07        | 0.40         |
| 3   | 1" (25.4 mm) air space w/ weep holes at base of wall | 0.18        | 1.02         |
| 4   | asphalt impregnated paper <sup>3</sup>               | 0.00        | 0.00         |
| 5   | 1" (25.4 mm) extruded polystyrene type 3 / 4         | 0.89        | 5.00         |
| 6   | 7/16" (11.1 mm) OSB sheathing <sup>4</sup>           | 0.11        | 0.62         |
| 7   | 2x6 framing filled with R24 batt @ 16" o.c.          | 2.66        | 15.10        |
| 8   | polyethylene   | 0.00        | 0.00         |
| 9   | 1/2" (12.7 mm) gypsum board                          | 0.08        | 0.45         |
| 10  | finish: 1 coat primer                                | 0.00        | 0.00         |
| 11  | interior air film                                    | 0.12        | 0.68         |
| <b>Effective RSI / R Value of Entire Assembly</b>   |  | <b>4.14</b> | <b>23.51</b> |
| Centre of Cavity RSI / R Value  |  | 5.71        | 32.42        |
| Installed Insulation RSI / R Value (nominal)  |  | 5.10        | 29.00        |
| Effective RSI / R Value of Assembly with Advanced Framing<br><small>(advanced framing as defined by NBC 9.36.2.4.(1))</small> |  | 4.29        | 24.36        |



R24 + 5 fails outboard inboard ratio

Note: <sup>1</sup>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. <sup>2</sup>The thermal resistance of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane, Breather Type." <sup>4</sup>OSB was a conservative decision due to it's inferior performance in the WUFI durability analysis in comparison to plywood.

LEGEND ✔ Pass ⚠ Proceed with caution ❌ Check permeance of material

| SIMULATED DURABILITY ANALYSIS        | LOCATION:                  | Vancouver                                | Edmonton                               | Toronto                                  | Montreal                                 | St. John's                               |
|--------------------------------------|----------------------------|--|--|--|--|--|
|                                      | WUFI HYGROTHERMAL MODELING | <span style="color: green;">✔</span>     | <span style="color: green;">✔</span>   | <span style="color: green;">✔</span>     | <span style="color: green;">✔</span>     | <span style="color: green;">✔</span>     |
| OUTBOARD TO INBOARD RATIO COMPLIANCE |                            | <span style="color: green;">✔</span> 0.2 | <span style="color: red;">❌</span> 0.3 | <span style="color: green;">✔</span> 0.2 | <span style="color: green;">✔</span> 0.2 | <span style="color: green;">✔</span> 0.2 |

Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapour permeance less than 60 ng/(Pa·s·m<sup>2</sup>) must comply to NBC 9.25.5.2.

OUTBOARD TO INBOARD RATIO 0.26



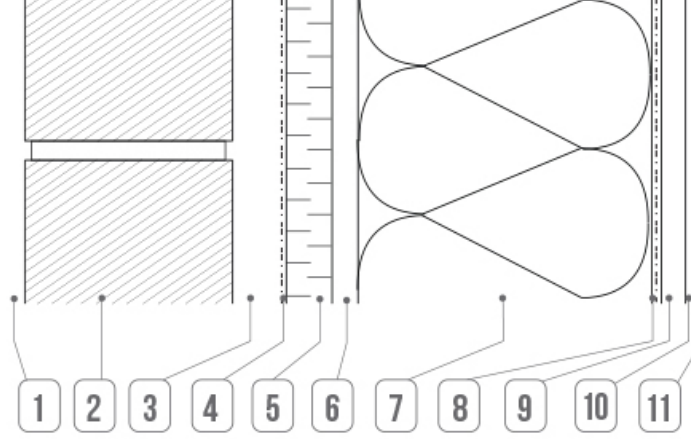
23.5

58

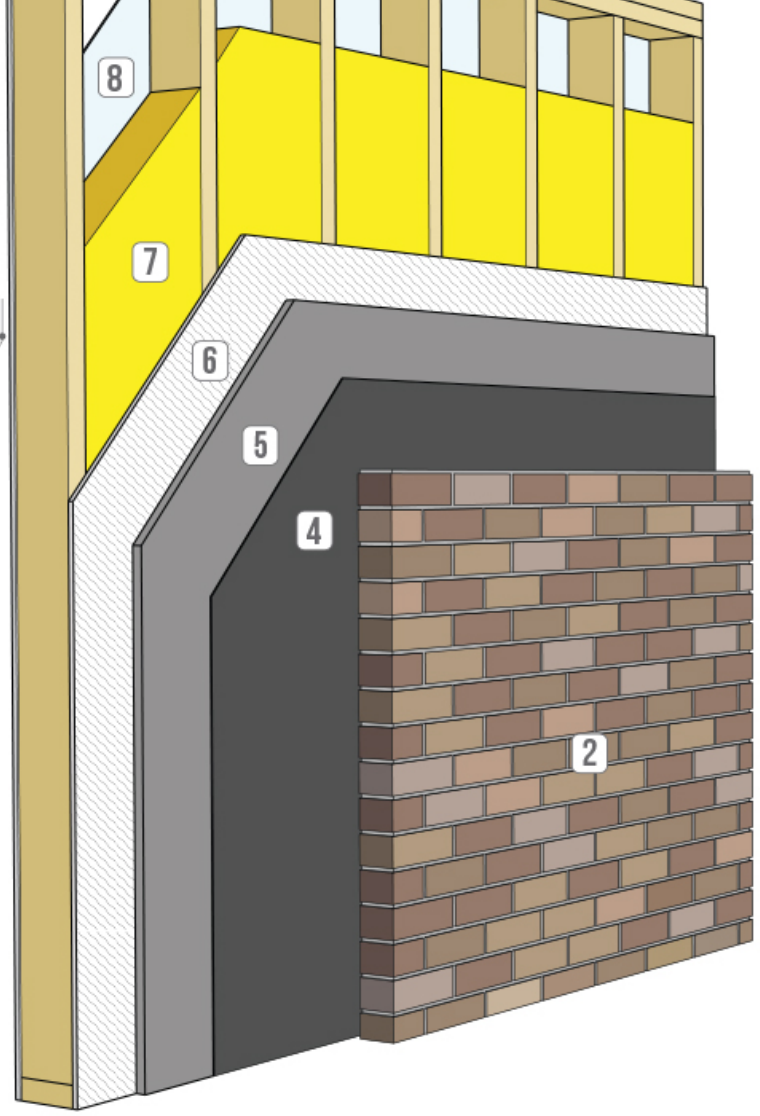
R<sub>eff</sub>



Reducing cavity insulation increases “Outboard: Inboard” ratio sufficiently



| WALL ASSEMBLY COMPONENTS <sup>1</sup>   |  | RSI         | R            |
|---|--|-------------|--------------|
| 1   | exterior air film                                    | 0.03        | 0.17         |
| 2   | fired clay brick 4" (102 mm) <sup>2</sup>            | 0.07        | 0.40         |
| 3   | 1" (25.4 mm) air space w/ weep holes at base of wall | 0.18        | 1.02         |
| 4   | asphalt impregnated paper <sup>3</sup>               | 0.00        | 0.00         |
| 5   | 1" (25.4 mm) extruded polystyrene type 3 / 4         | 0.89        | 5.00         |
| 6   | 7/16" (11.1 mm) OSB sheathing <sup>4</sup>           | 0.11        | 0.62         |
| 7   | 2x6 framing filled with R19 batt @ 16" o.c.          | 2.36        | 13.40        |
| 8   | polyethylene   | 0.00        | 0.00         |
| 9   | 1/2" (12.7 mm) gypsum board                          | 0.08        | 0.45         |
| 10  | finish: 1 coat primer                                | 0.00        | 0.00         |
| 11  | interior air film                                    | 0.12        | 0.68         |
| Effective RSI / R Value of Entire Assembly  |  | <b>3.84</b> | <b>21.80</b> |
| Centre of Cavity RSI / R Value  |  | 4.83        | 27.42        |
| Installed Insulation RSI / R Value (nominal)  |  | 4.23        | 24.00        |
| Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC 9.36.2.4.(1)) |  | 3.95        | 22.45        |



Note: <sup>1</sup>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. <sup>2</sup>The thermal resistance of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane, Breather Type." <sup>4</sup>OSB was a conservative decision due to it's inferior performance in the WUFI durability analysis in comparison to plywood.

R19 + 5

LEGEND  Pass  Proceed with caution  Check performance of material

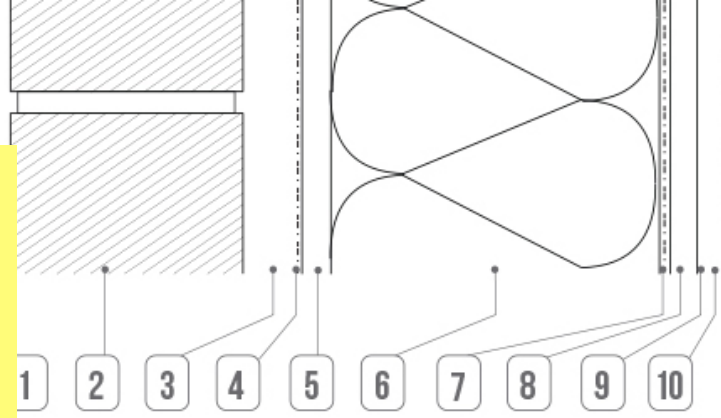
| SIMULATED DURABILITY ANALYSIS        | LOCATION:                  | Vancouver                               | Edmonton                                | Toronto                                 | Montreal                                | St. John's                              |
|--------------------------------------|----------------------------|---|---|---|---|---|
|                                      | WUFI HYGROTHERMAL MODELING | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     |
| OUTBOARD TO INBOARD RATIO COMPLIANCE |                            | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.3 | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.2 |

Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapour permeance less than 60 ng/(Pa·s·m<sup>2</sup>) must comply to NBC 9.25.5.2.

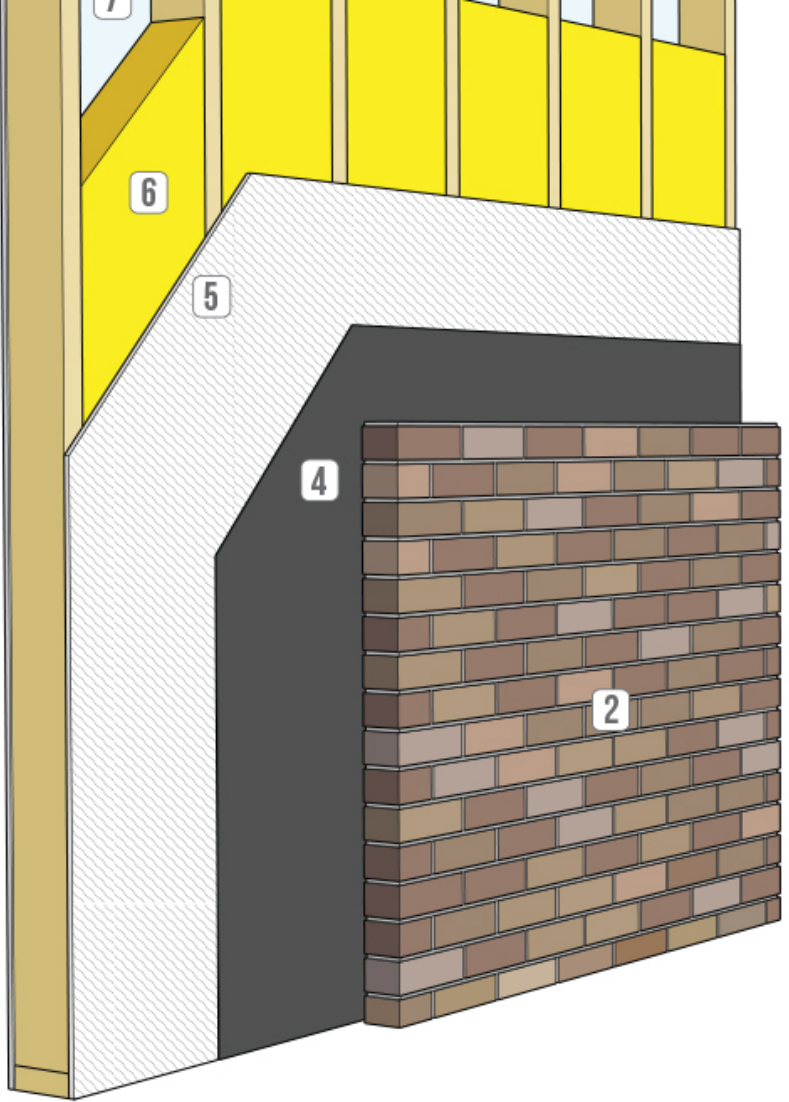


**21.8**  
R<sub>eff</sub>

Not using low-perm exterior insulation removes requirement for ratio, but wufi analysis has some improvement suggestions.



| WALL ASSEMBLY COMPONENTS <sup>1</sup>   |  | RSI         | R            |
|---|--|-------------|--------------|
| 1   | exterior air film                                    | 0.03        | 0.17         |
| 2   | fired clay brick 4" (102 mm) <sup>2</sup>            | 0.07        | 0.40         |
| 3   | 1" (25.4 mm) air space w/ weep holes at base of wall | 0.18        | 1.02         |
| 4   | asphalt impregnated paper <sup>3</sup>               | 0.00        | 0.00         |
| 5   | 7/16" (11.1 mm) OSB sheathing <sup>4</sup>           | 0.11        | 0.62         |
| 6   | 2x6 framing filled with R22 batt @ 16" o.c.          | 2.55        | 14.48        |
| 7   | polyethylene   | 0.00        | 0.00         |
| 8   | 1/2" (12.7 mm) gypsum board                          | 0.08        | 0.45         |
| 9   | finish: 1 coat primer                                | 0.00        | 0.00         |
| 10  | interior air film                                    | 0.12        | 0.68         |
| <b>Effective RSI / R Value of Entire Assembly</b>   |  | <b>3.14</b> | <b>17.83</b> |
| Centre of Cavity RSI / R Value  |  | 4.46        | 25.33        |
| Installed Insulation RSI / R Value (nominal)  |  | 3.87        | 22.00        |
| Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC 9.38.2.4.(1)) |  | 3.27        | 18.57        |



Note: <sup>1</sup>Values are 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 determined by the Canadian Construction Materials Centre (CCMC) in the evaluation of such a product. <sup>2</sup>The thermal conductivity of mortar was not considered. <sup>3</sup>Sheathing membrane material must comply with CAN/CGSB-51.32, Type I Membrane, Breather Type. <sup>4</sup>OSB was a conservative decision due to it's inferior performance in the WUFI analysis in comparison to plywood.

LEGEND  Pass  Proceed with caution

| SIMULATED DURABILITY ANALYSIS | LOCATION:                  | Vancouver                           | Edmonton                            | Toronto                             | Montreal                            | St. John's                          |
|-------------------------------|----------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
|                               | WUFI HYGROTHERMAL MODELING | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

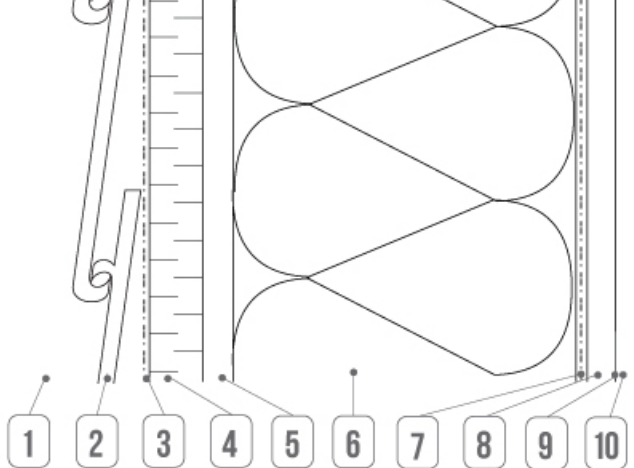
Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapour permeance less than 60 ng/(Pa·s·m<sup>2</sup>) must comply with NBC 9.25.5.2.

60

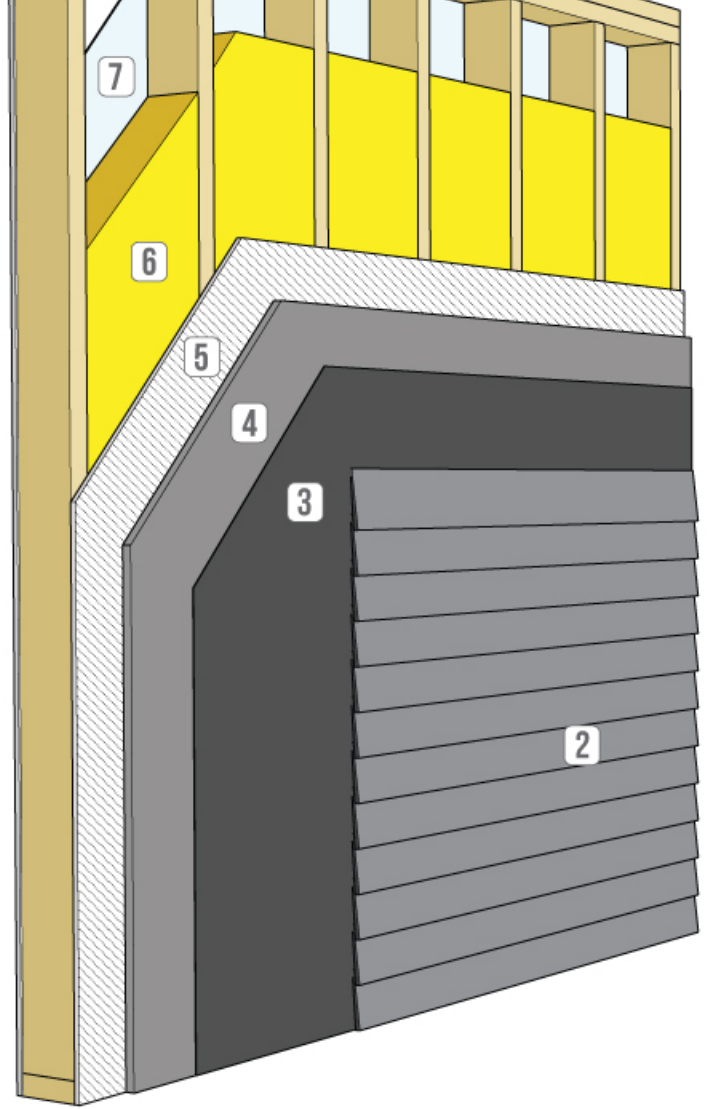
R22 + 0

**17.8**  
R<sub>eff</sub>

Increasing exterior insulation increases “Outboard: Inboard” ratio sufficiently



| WALL ASSEMBLY COMPONENTS <sup>1</sup>   |  | RSI         | R            |
|---|--|-------------|--------------|
| 1   | exterior air film                            | 0.03        | 0.17         |
| 2   | vinyl siding (no air space)                  | 0.11        | 0.62         |
| 3   | asphalt impregnated paper <sup>2</sup>       | 0.00        | 0.00         |
| 4   | 7/16" (11.1 mm) OSB sheathing <sup>3</sup>   | 0.11        | 0.62         |
| 5   | 2" (50.8 mm) extruded polystyrene type 3 / 4 | 1.78        | 10.00        |
| 6   | 2x6 framing filled with R24 batt @ 24" o.c.  | 2.80        | 15.90        |
| 7   | polyethylene                                 | 0.00        | 0.00         |
| 8   | 1/2" (12.7 mm) gypsum board                  | 0.08        | 0.45         |
| 9   | finish: 1 coat primer                        | 0.00        | 0.00         |
| 10  | interior air film                            | 0.12        | 0.68         |
| Effective RSI / R Value of Entire Assembly  |  | <b>5.03</b> | <b>28.55</b> |
| Centre of Cavity RSI / R Value  |  | 6.46        | 36.67        |
| Installed Insulation RSI / R Value (nominal)  |  | 5.99        | 34.00        |
| Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC 9.36.2.4.(1)) |  | 5.19        | 29.44        |



Note: <sup>1</sup>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. <sup>2</sup> Sheathing membrane material must comply with CAN/CGSB-51.32, "Sheathing Membrane, Breather Type." <sup>3</sup>OSB was a conservative decision due to it's inferior performance in the WUFI durability analysis in comparison to plywood.

OUTBOARD TO INBOARD RATIO **0.42**

LEGEND  Pass  Proceed with caution  Check permeance of material

| SIMULATED DURABILITY ANALYSIS        | LOCATION :                 | Vancouver                               | Edmonton                                | Toronto                                 | Montreal                                | St. John's                              |
|--------------------------------------|----------------------------|---|---|---|---|---|
|                                      | WUFI HYGROTHERMAL MODELING |   | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     | <input checked="" type="checkbox"/>     |
| OUTBOARD TO INBOARD RATIO COMPLIANCE |                            | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.3 | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.2 | <input checked="" type="checkbox"/> 0.2 |

Note: See WUFI Assumptions. Non-wood based exterior sheathing material that has a water vapour permeance less than 60 ng/(Pa·s·m<sup>2</sup>) must comply to NBC 9.25.5.2.



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**28.6**  
R<sub>eff</sub>



# WALL THERMAL DESIGN CALCULATOR

[URL: www.cwc.ca/wtd](http://www.cwc.ca/wtd)

Email: [wtd@cwcc.ca](mailto:wtd@cwcc.ca)

