Building Solutions

Canadian Code Assessment Engine and Above Grade Wall Solutions
Presentation Agenda:

1. Code Tool Development and Early History (Les Yard)
2. Code Tool Introduction and Use (Keith Calder)
3. Industry Meetings & Code Tool Learnings (Les)
4. Online Code Tool Demonstration (Keith)
5. Above Grade Wall: Other Design Considerations (Les)
6. If Time .... Dow Above Grade Wall Solutions, Tools, Support
Building & Energy Codes are in Conflict!
Research Has Indicated the Construction Industry wants to make use of Foam Plastics in Above Grade Walls ... \textbf{Why?}

\textit{Increasing Energy Code Requirements are leading to ....}

✓ Greater Demand for High Performance Insulation
✓ Need for Increased Flexibility in Wall Assembly Design
✓ Need For More Thermally Efficient Cladding Attachment Methods (Subsequent Reduction in Thermal Bridging)
✓ Higher Achievable Effective R-Values
✓ Thinner Wall Assemblies

How do we know this is so...?
Ottewell Terrace Edmonton
John Paul 2 Vancouver
10 Years + US Experience
Hugh Bird – Rainscreen Stucco Wall XPS

Belt and Suspenders Wall
No Insulation in the Cavity Space, Ext Gypsum, Full Peel’n Stick A/B, 3” of SM, Flash Taped Seams & Penetrations. 7/8’s Surface Mounted Z-girt, Paper-backed Lath and 3 Coat Stucco

Cladding consisted of 25 mm of masonry or concrete (Clarified in NBC 2015 3.1.5.6)
Ottewell Terrace TWS
Inverted Wall Assembly
Exterior Gypsum was used as a thermal barrier (met building code / City of Edmonton AHJ)
John Paul 2 TWS

Belt and Suspenders Wall
1.55” Thermax, 2” SPF, Aluminum Extruded and Fiber Cement Cladding

Alternative Solution leveraging NFPA 285 US Fire Testing (City of Vancouver AHJ)
# Thermax Wall System: US Test Approvals

<table>
<thead>
<tr>
<th>CTQ</th>
<th>TEST</th>
<th>PASS/FAIL</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS A THERMAX Ci</td>
<td>ASTM E84</td>
<td>PASS</td>
<td>Commercial insulation must achieve CLASS A ratings in order to used within commercial wall assemblies.</td>
</tr>
<tr>
<td>CLASS A CM2030</td>
<td>ASTM E84</td>
<td>PASS</td>
<td>Commercial insulation must achieve CLASS A ratings in order to used within commercial wall assemblies.</td>
</tr>
<tr>
<td>CLASS A CM2045</td>
<td>ASTM E84</td>
<td>PASS</td>
<td>Commercial insulation must achieve CLASS A ratings in order to used within commercial wall assemblies.</td>
</tr>
<tr>
<td>AIR Barrier</td>
<td>ASTM E2357</td>
<td>PASS</td>
<td>Systems must now be tested in the new Full Scale Wall test.</td>
</tr>
<tr>
<td>Water Barrier</td>
<td>ASTM E331</td>
<td>PASS</td>
<td>Systems must now be tested in the new Full Scale Wall test.</td>
</tr>
</tbody>
</table>
US NFPA 285 ... CND CAN/ULC S134

National Fire Protection Association
The authority on fire, electrical, and building safety
If the Construction Industry in Canada wants to use Foam Insulation in Above Grade Walls …

Why Has This Taken Off? Why not just run an S134 test (s) to validate?

Main reason we uncovered is …

CODE Confusion!!!
200+ Exceptions in the NBC ... Straight forward? .... NOT!  We needed to a way to navigate the complexity of the NBC .... Enter Keith Calder & Jensen Hughes
Part 2: Code Tool Introduction and Use (Keith Calder)

Keith D. Calder, M.Eng., P.Eng.
Technical Director, Canada

Keith Calder provides leadership with his expertise in building codes, fire safety standards, specialized fire protection systems, and performance-based design. He focuses on assisting clients with alternative solutions for complex and innovative designs. In particular, he specializes in the use of computer fire modelling to assess new construction design with regard to smoke control and people movement.

Complementing his design expertise, Mr. Calder has a wide background in forensic fire investigation. He has investigated and analyzed many fire and explosion incidents, and has conducted forensic audits of building design and construction. An active researcher, he has developed a vast knowledge of current and historical building codes, and continues to coordinate and assist with our ongoing live burn research program.
<table>
<thead>
<tr>
<th></th>
<th>Applicable Building Code:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2015 NBCC</td>
</tr>
</tbody>
</table>
## Project Characteristics

<table>
<thead>
<tr>
<th>Project Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Area (m²):</td>
<td>1200</td>
</tr>
<tr>
<td>Building Height (Storeys):</td>
<td>4</td>
</tr>
<tr>
<td>Building Height (m):</td>
<td>17</td>
</tr>
<tr>
<td>High Building (Subsection 3.2.6):</td>
<td>No</td>
</tr>
<tr>
<td>Streets Facing:</td>
<td>2</td>
</tr>
<tr>
<td>Sprinklered:</td>
<td>Yes</td>
</tr>
<tr>
<td>Major Occupancies:</td>
<td>C, D, E</td>
</tr>
</tbody>
</table>
Project Characteristics – Grade

\[ h_{a, b, c, d} : \text{Average height of finished ground above benchmark} \]
Project Characteristics – Building Area

› Building Area:
Project Characteristics – Building Height

- Basement: 1.9 m
- First Storey: 2.1 m
- Second Storey: 2.1 m
- Third Storey: 2.1 m
- Fourth Storey: 2.1 m
Project Characteristics – Streets Facing

› 2 Streets Facing:

50% of perimeter within 15 m of a street

Plan view

Building facing two streets

15 m
3 Streets Facing:
3.2.2.49. **Group C, up to 3 Storeys, Noncombustible Construction**

1) A building classified as Group C is permitted to conform to Sentence (2) provided:
   a) it is not more than 3 storeys in building height, and
   b) it has a building area not more than the value in Table 3.2.2.49.

Table 3.2.2.49.
Maximum Building Area, Group C, up to 3 Storeys
Forming Part of Sentence 3.2.2.49.(1)

<table>
<thead>
<tr>
<th>No. of Storeys</th>
<th>Facing 1 Street</th>
<th>Facing 2 Streets</th>
<th>Facing 3 Streets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>not limited</td>
<td>not limited</td>
<td>not limited</td>
</tr>
<tr>
<td>2</td>
<td>6 000</td>
<td>not limited</td>
<td>not limited</td>
</tr>
<tr>
<td>3</td>
<td>4 000</td>
<td>5 000</td>
<td>6 000</td>
</tr>
</tbody>
</table>

2) The building referred to in Sentence (1) shall be of noncombustible construction, and:
   a) except as permitted by Sentence (3), floor assemblies shall be fire separations with a fire-resistance rating not less than 1 h,
   b) mezzanines shall have a fire-resistance rating not less than 1 h,
   c) roof assemblies shall have a fire-resistance rating not less than 1 h, and
   d) loadbearing walls, columns and arches shall have a fire-resistance rating not less than that required for the supported assembly.

3) In a building that contains dwelling units that have more than one storey, subject to the requirements of Sentence 3.3.4.2.(3), the floor assemblies, including floors over basements, which are entirely contained within these dwelling units, shall have a fire-resistance rating not less than 1 h but need not be constructed as fire separations.
Building Classification - Type of Construction

› Combustibility:

FIGURE 2
DIAGRAM OF COMBUSTIBILITY FURNACE
Noncombustible Construction: “a type of construction in which a degree of fire safety is attained by the use of noncombustible materials for structural members and other building assemblies”
Building Classification - Type of Construction

› **Combustible Construction**: “a type of construction that does not meet the requirements for noncombustible construction”
Spatial Separation

<table>
<thead>
<tr>
<th>Spatial Separation (Tables 3.2.3.1.-B to 3.2.3.1.-E):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North Wall</strong></td>
</tr>
<tr>
<td>Occancy: C</td>
</tr>
<tr>
<td>Wall Height (m): 3</td>
</tr>
<tr>
<td>Wall Width (m): 40</td>
</tr>
<tr>
<td>Wall Area (m²): 120.0</td>
</tr>
<tr>
<td>Limiting Distance (m): 4</td>
</tr>
<tr>
<td>Permitted UPO (%): 33%</td>
</tr>
</tbody>
</table>
Spatial Separation - Exposing Building Face

Wall enclosing attic space constructed to the same standard as exposing building face

Unfinished attic space

Uppermost ceiling

Exposing building face
Spatial Separation - Exposing Building Face

- **Wall Height (A):**
  - The height of the exposing building face

- **Wall Width (B):**
  - The width of the exposing building face

- **Wall Area = A x B**

- **Actual % of Unprotected Openings:**
  - \((C \times D)/(A \times B)\)
Spatial Separation – Limiting Distance

› Limiting Distance (LD) and Absolute Distance (D)

Building 1

Lot Line

Building 2

LD

D

LD
Spatial Separation – Limiting Distance

- Limiting Distance (Red) and Absolute Distance (Green)

Building 1

Lot Line

Building 2a

Imaginary Line

Building 2b

Street
Spatial Separation – Limiting Distance

- Limiting Distance – Irregular Building Face - Projection onto Closest Plane Perpendicular to the

![Diagram showing spatial separation with dimensions labeled a, b, c, and d. The area where limiting distance applies is indicated.]
Spatial Separation – Limiting Distance

No interior fire separations

Areas where limiting distance applies

Property lines
Spatial Separation – Unprotected Opening

area of exposing building face (south side) = 15 \times 3 = 45 \, \text{m}^2

area of unprotected openings = 15 \, \text{m}^2

percentage of unprotected openings = \left(\frac{15}{45}\right) \times 100 = 33\%
## Exterior Wall Construction

### East Exterior Wall Construction

<table>
<thead>
<tr>
<th>Combustible (Article 3.2.2.65.)</th>
<th>45-min FRR (Table 3.2.3.7.)</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IB01, IB02, IB03, IB04, IB05, IB10, IB11, IB12, IB13, IB14, IB15</td>
<td>Internal Barrier</td>
</tr>
<tr>
<td></td>
<td>Foam Plastic (25 &lt; FSR ≤ 500)</td>
<td>Insulation</td>
</tr>
<tr>
<td></td>
<td>Not Required</td>
<td>External Barrier</td>
</tr>
<tr>
<td>Combustible (Table 3.2.3.7. and Sentence 3.2.3.7.(4))</td>
<td>Cladding</td>
<td></td>
</tr>
</tbody>
</table>

### South Exterior Wall Construction

<table>
<thead>
<tr>
<th>Combustible (Article 3.2.2.65.)</th>
<th>45-min FRR (Table 3.2.3.7.)</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IB01, IB02, IB03, IB04, IB05, IB10, IB11, IB12, IB13, IB14, IB15</td>
<td>Internal Barrier</td>
</tr>
<tr>
<td></td>
<td>Foam Plastic (25 &lt; FSR ≤ 500)</td>
<td>Insulation</td>
</tr>
<tr>
<td></td>
<td>Not Required</td>
<td>External Barrier</td>
</tr>
<tr>
<td>Combustible (Table 3.2.3.7. and Sentence 3.2.3.7.(4))</td>
<td>Cladding</td>
<td></td>
</tr>
</tbody>
</table>

### West Exterior Wall Construction

<table>
<thead>
<tr>
<th>Combustible (Article 3.2.2.65.)</th>
<th>45-min FRR (Table 3.2.3.7.)</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IB01, IB02, IB03, IB04, IB05, IB10, IB11, IB12, IB13, IB14, IB15</td>
<td>Internal Barrier</td>
</tr>
<tr>
<td></td>
<td>Foam Plastic (25 &lt; FSR ≤ 500)</td>
<td>Insulation</td>
</tr>
<tr>
<td></td>
<td>Not Required</td>
<td>External Barrier</td>
</tr>
<tr>
<td>Combustible (Table 3.2.3.7. and Sentence 3.2.3.7.(4))</td>
<td>Cladding</td>
<td></td>
</tr>
</tbody>
</table>

### General Exterior Wall Construction

<table>
<thead>
<tr>
<th>Combustible (Article 3.2.2.65.)</th>
<th>2-hour FRR (Table 3.2.3.7.)</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IB01, IB02, IB03, IB04, IB05, IB10, IB11, IB12, IB13, IB14, IB15</td>
<td>Internal Barrier</td>
</tr>
<tr>
<td></td>
<td>Foam Plastic (25 &lt; FSR ≤ 500)</td>
<td>Insulation</td>
</tr>
<tr>
<td></td>
<td>Not Required</td>
<td>External Barrier</td>
</tr>
<tr>
<td>Noncombustible or Article 3.1.5.5.</td>
<td>Cladding</td>
<td></td>
</tr>
</tbody>
</table>
Required type of construction for the whole wall based on the required type of construction for the building. Can be overridden by the Spatial Separation Requirements.
Exterior Wall Construction – Spatial Separation Based

Table 3.2.3.7.  
Minimum Construction Requirements for Exposing Building Faces  
Forming Part of Sentences 3.2.3.7.(1) and (2)

<table>
<thead>
<tr>
<th>Occupancy Classification of Building or Fire Compartment</th>
<th>Maximum Area of Unprotected Openings Permitted, % of Exposing Building Face Area</th>
<th>Minimum Required Fire-Resistance Rating</th>
<th>Type of Construction Required</th>
<th>Type of Cladding Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A, B, C, D, or Group F, Division 3</td>
<td>0 to 10</td>
<td>1 h</td>
<td>Noncombustible</td>
<td>Noncombustible</td>
</tr>
<tr>
<td></td>
<td>&gt; 10 to 25</td>
<td>1 h</td>
<td>Combustible or Noncombustible</td>
<td>Noncombustible</td>
</tr>
<tr>
<td></td>
<td>&gt; 25 to 50</td>
<td>45 min</td>
<td>Combustible or Noncombustible</td>
<td>Noncombustible</td>
</tr>
<tr>
<td></td>
<td>&gt; 50 to &lt; 100</td>
<td>45 min</td>
<td>Combustible or Noncombustible</td>
<td>Noncombustible</td>
</tr>
<tr>
<td>Group E, or Group F, Division 1 or 2</td>
<td>0 to 10</td>
<td>2 h</td>
<td>Noncombustible</td>
<td>Noncombustible</td>
</tr>
<tr>
<td></td>
<td>&gt; 10 to 25</td>
<td>2 h</td>
<td>Combustible or Noncombustible</td>
<td>Noncombustible</td>
</tr>
<tr>
<td></td>
<td>&gt; 25 to 50</td>
<td>1 h</td>
<td>Combustible or Noncombustible</td>
<td>Noncombustible</td>
</tr>
<tr>
<td></td>
<td>&gt; 50 to &lt; 100</td>
<td>1 h</td>
<td>Combustible or Noncombustible</td>
<td>Noncombustible</td>
</tr>
</tbody>
</table>

General Exterior Wall Construction

<table>
<thead>
<tr>
<th>2-hour FRR (Table 3.2.3.7.)</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
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<td>Internal Barrier</td>
</tr>
<tr>
<td>Foam Plastic (25 &lt; FSR ≤ 500)</td>
<td>Insulation</td>
</tr>
<tr>
<td>Not Required</td>
<td>External Barrier</td>
</tr>
<tr>
<td>Noncombustible or Article 3.1.5.5.</td>
<td>Cladding</td>
</tr>
</tbody>
</table>

www.jensenhughes.com
Exterior Wall Construction – Cladding (3.1.5.5.)

- Cladding (3.1.5.5.)
- Dimensions:
  - Width: > 6 m
  - Height: > 7 m
- Features:
  - 2.5 m depth
  - 1.4 m height
  - Combustion Chamber ≥ 60 m³
Exterior Wall Construction – Cladding (3.1.5.5.)
Part 3: Code Tool Learnings & Dow Above Grade Wall Solutions (Les Yard)

NBC Building Code Tool
How has it been Received? Vetted?

Dialog, Architecture49, Morrison Hershfield, RDH Building Engineering, Canadian Code Centre....
Late Spring 2016 … Through YE 2016 … May 2017 …
…We provided a **Simple Output based on Simple Inputs using NBCC 2015**

Fantastic!… NBC 2015 … but we want to use this now
Initial Feedback from Industry Sessions

• This is more than a marketing tool … it is a Design Tool
• Original version was based on NBC2015. We want to use this now … please add (NBC2010, BCBC, VBBL, ABC, OBC, QBC capability)
• Keep the Code Tool generic and show your work
• Allow users to Opt-In for more information and access to Dow Solutions (I.E. Keep the Tool Generic and Not Result in Dow Products)
• Code Tool has ability to provide education and consensus on complex articles in Part 3 -- from those who write and develop the code, the design community and code enforcement (AHJ)
So Keith went back to work… NBCC 2010, OBC 2012, QBC 2013, ABC 2014, VBBL 2014

Oh and BTW… This should not be a design tool just for Dow. We want access to it on our desktops …
Code Assessment Engine – Web Interface

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Code Assessment Engine – Web Interface

### Project Characteristics

<table>
<thead>
<tr>
<th>Building Code</th>
<th>2010 NBCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Facing</td>
<td>*</td>
</tr>
<tr>
<td>Building Area (sq yr)</td>
<td>4000</td>
</tr>
<tr>
<td>Building Height (stories)</td>
<td>3</td>
</tr>
<tr>
<td>Building Height (in ft)</td>
<td>15</td>
</tr>
</tbody>
</table>

Please refer to the 2012 National Building Code of Canada for further explanation on project characteristics and building classifications.

### Walls

<table>
<thead>
<tr>
<th>Wall Name</th>
<th>North Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (in ft)</td>
<td>5</td>
</tr>
<tr>
<td>Lintel Distance</td>
<td>5</td>
</tr>
<tr>
<td>Major Occupancy Code</td>
<td>C</td>
</tr>
</tbody>
</table>

Please refer to the 2012 National Building Code of Canada for further explanation on wall construction.

### Building Classification

- **Governing Occupancy**
  - C
- **Governing Article**
  - 3 2 2 4 6
- **Type of Construction**
  - Noncombustible
- **Max Area (sq ft)**
  - 12999
- **Max Height (in ft)**
  - 3

The Code Assessment Engine has been developed for informational purposes only. Although all efforts have been made to ensure that the information on this tool is accurate, The Dow Chemical Company assumes no obligation or liability for the information and cannot under any circumstances guarantee the completeness, accuracy or usefulness of such information. Reference should always be made to the National Building Code of Canada.

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[www.canadabuildingcode.dow.com](http://www.canadabuildingcode.dow.com)
Learnings from the Code Assessment Engine

Generally … Where One Can & Cannot Use Foam?

Examples of Where Foam Plastic Permitted:

• Combustible Buildings and 3 Stories & Below Non-Combustible … Above That?
• Behind Concrete and Masonry 25mm and thicker Cladding or Wall Assemblies that meet Article 3.1.5.5. (Assembly has passed the CAN/ULC S134 Fire Test)
• Protected by a Thermal Barrier that meets CAN/ULC S101 (Article 3.2.3.8.(1)(b) PLUS Non-Combustible Cladding
• Required … Fire Block Required At Floors and Ceilings or Every 20 m horizontally and every 3 m vertically if cavity gap is greater than 25 mm (NBC Article 3.1.11.2.)

Examples of Buildings Where Foam Plastic NOT Permitted:

• Where Spatial Separation allows less than 10% UPO (only non-combustible insulation acceptable)
• High Rise Buildings with Fire Sensitive Claddings (I.E. everywhere where claddings are not 25mm of Concrete or Masonry)
• Unsprinklered Buildings
Building Code: In Summary Fire …

- Fire behavior and the associated code requirements are … Complicated
- Significant work by professional consultants, researchers and forensic study has resulted in sufficiently complex and well vetted regulations (NBCC Part 9 / Part 3)
- Fire can be managed by preventing it, or controlling it or reducing the impact of fire if it occurs.
- Ensuring the safety of a building’s occupants is a fundamental goal of fire design and of The Entire Industry
- A designer must meet multiple criteria to ensure a structure’s success while under construction and once in service … Fire is Number One!
- A good place to start evaluating the use of Foam Insulation … is the Code Assessment Engine

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Can I Use Foam Insulation?

If Yes …
Great … I can Use Foam Insulation …
Where do I go from here? So many Options …?
Did I Say … So Many Options … Slide from RDH Presentation on CoV’s Effective R-22 … Many Vetted Methods to Approach Walls …
Wall Design and Construction Must Meet:

1. Structural and Design Safety
2. Fire Safety
3. Bulk Water Control
4. Air Control
5. Vapour Control
6. Thermal Control
7. Thermal Efficiency
8. Environmental Effectiveness
9. Product / System Transparency
10. Product / System Acceptance
Wall Design and Construction Must Meet:

1. Structural and Design Safety
2. Fire Safety
3. Bulk Water Control
4. Air Control
5. Vapour Control
6. Thermal Control
7. Thermal Efficiency
8. Environmental Effectiveness
9. Product / System Transparency
10. Product / System Acceptance
Energy & Moisture

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Effective Building Practice: Traditional Vapour Control
Vapor Barrier

Warm
70°F

Cold
32°F

Remember Temperature Causes Condensation!
Misconceptions “debunked”

1) Vapor is **not bad**
2) Vapor & humidity are **almost always present**
3) The goal is to **eliminate liquid water**
4) Need to **prevent vapor from becoming liquid water**
Thermal Layer | Relating to Moisture

Example Conditions
Indoor Temperature: 70°F
Indoor RH (Relative Humidity) 30%
Outdoor Temperature: 30°F

Dry Zone | Wet Zone

Dew Point
37.1°F

70°F

Ok! If in the Wet Zone

batt insulation (R19)
WUFI vs Dew Point Analysis
3rd Party Resources – Exterior Insulation & Condensation Control

CMHC Best Practice Guide “Brick Veneer Steel Stud”

“Danger of condensation in the stud space is absent in only one instance, where there is 75 mm (3 in.) of cavity insulation and no insulation in the stud space.”

PERSIST Wall (AB Infrastructure – Red Book / Blue Book)

The design approach recommended may be described as the “Pressure Equalized Rain Screen Insulated Structure Technique”, or “PERSIST”. This approach is characterized by the following:

• An air barrier system installed exterior to and supported by the structure.
• Insulation installed tight to the exterior of the air barrier system.
• A cladding system designed based on rain screen principles, installed over an air space that is pressure equalized with the exterior and drained to the exterior.

Also … NRC (1960’s), Alaska REMOTE, many others recognize the benefits of an exterior insulated wall with empty cavity
Effective Building Practice: Thermal Control ... Efficient Use of Materials
Effective R-Value of Batt @ 16” & 24”

Type of Batt

R-Value

Want & expect
Get

WHO SAYS?

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### Thermal Layer | Building Science

**TABLE A9.2B Effective Insulation/Framing Layer R-Values for Wall Insulation Installed Between Steel Framing**

<table>
<thead>
<tr>
<th>Nominal Depth of Cavity (in.)</th>
<th>Actual Depth of Cavity (in.)</th>
<th>Rated R-Value of Airspace or Insulation</th>
<th>Effective Framing/Cavity R-Value at 16 in. on Center</th>
<th>Effective Framing/Cavity at 24 in. on Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty Cavity, No Insulation</td>
<td></td>
<td>R-0.91</td>
<td>0.79</td>
<td>0.91</td>
</tr>
<tr>
<td>4</td>
<td>3.5</td>
<td>R-11</td>
<td>5.5</td>
<td>6.6</td>
</tr>
<tr>
<td>4</td>
<td>3.5</td>
<td>R-13</td>
<td>6.0</td>
<td>7.2</td>
</tr>
<tr>
<td>4</td>
<td>3.5</td>
<td>R-15</td>
<td>6.4</td>
<td>7.8</td>
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<td>6</td>
<td>6.0</td>
<td>R-19</td>
<td>7.1</td>
<td>8.6</td>
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<td>6</td>
<td>6.0</td>
<td>R-21</td>
<td>7.4</td>
<td>9.0</td>
</tr>
<tr>
<td>8</td>
<td>8.0</td>
<td>R-25</td>
<td>7.8</td>
<td>9.6</td>
</tr>
</tbody>
</table>

Based on Calculated and Measured Data

Table shown taken from ASHRAE 90.1-2007
Fasteners and Thermal Bridging (Effective R-Value)

Z ≠ C1
Dow – Knight Wall CI-System & Thermal Bridging

• 3-Dimensional Thermal Analysis of Dow-Knight CI-System
• Morrison Hershfield
• Minimal Thermal Bridge and High Effective R-Value
3,500 lb Concrete Block supported by 4’x8’ grid / metal furring on Dow Thermax rigid insulation.

Deflection minimal.

25 PSI = 3600 PSF (compressive strength)
Interrelated System & Performance

Thermal Control

Air Control  ↔  Vapor Control

Also … Number of & Sequencing of Layers, Clarity of Material Purpose, Buildability, Cost of Installation, …
Wall Design and Construction Must Meet:

1. Structural and Design Safety
2. Fire Safety
3. Bulk Water Control
4. Air Control
5. Vapour Control
6. Thermal Control
7. Thermal Efficiency
8. Environmental Effectiveness
9. Product / System Transparency
10. Product / System Acceptance
Energy Code: **Thermal Efficiency**

Definitions & Key Terms

USI or U-Value (Metric or Imperial)

A U value is a measure of heat loss in a building element such as a wall, floor or roof. It can also be referred to as an ‘overall heat transfer co-efficient’ and measures how well parts of a building transfer heat. This means that the higher the U value the worse the thermal performance of the building envelope.

R-Value (Imperial) or 1/U
RSI (Metric) or 1/USI (x 5.678263 for R)
Nominal R-Value
Effective R-Value
Continuous Insulation
HDD-C (18 C) NECB / NBC 9.36
HDD-F (65 F) ASHRAE 90.1

Source: DBS Technote 513 & NRC MECB Presentation
Long Term Thermal Resistance (LTTR) Styrofoam XPS R5+

1. Description

The product contains a CAPS/LOCATION. The values are based on the following criteria:

- **Temperature**: 70°F (21°C)
- **Humidity**: 50%
- **Air Velocity**: 0 mph

2. Standard and Regulatory Information

The product complies with the requirements specified in the American Society for Testing and Materials (ASTM) standards. The values are not revised under any environmental conditions.

**Listed In:**
- **LTTR:** The values are listed in the LTTR database.
- **UL94:** The values are listed in the UL94 database.

**Plant Information:**
- **Location:** 
  - **Name:** 
  - **Address:**
  - **City:**
  - **State:**
  - **Zip Code:**

**Legal Information:**
- **© 2017 The Dow Chemical Company**
R-Value and Mean Temperature

ISO

Temperature Dependence of Polyiso Thermal Performance

Figure 2. Thermal resistance dependency of various Roofing ISO Insulations

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Low Mean Temp Performance

- THERMAX outperforms all Competitive ISO’s in this Area.
- Only ISO to increase in R-Value below 55 Degrees
- 37% Higher R-Value at 40 Degree Mean Temp

Ask Architect to inquire on competitive ISO’s performance at low mean temperatures.

Figure 3: Common Representation of Selected Insulation R-Values as a function of Mean Temperature with THERMAX Brand Insulation properties added.
Energy Code Requirements will ramp up along with research in resiliency of buildings and infrastructure. New and existing buildings. Both Provincially and Federally
Wall Design and Construction Must Meet:

- Structural and Design Safety
- Fire Safety
- Bulk Water Control
- Air Control
- Vapour Control
- Thermal Control
- Thermal Efficiency
- Environmental Effectiveness
- Product / System Transparency
- Product / System Acceptance
Sustainability: Environmental Effectiveness

Innovative, High Molecular Weight, Non-PBT (Persistent, Bioaccumulative, Toxic) Polymeric Flame Retardant (Polymeric FR) additive for extruded polystyrene (XPS) and expanded polystyrene (EPS) foam insulation Applications. Dow Trademark BlueEdge™

All Canadian XPS and EPS required to comply. Deadline was December 23rd, 2016

©The Dow Chemical Company 2017
Wall Design and Construction Must Meet:

1. Structural and Design Safety
2. Fire Safety
3. Bulk Water Control
4. Air Control
5. Vapour Control
6. Thermal Control
7. Thermal Efficiency
8. Environmental Effectiveness
9. Product / System Transparency
10. Product / System Acceptance
Sponsored “ci” Research, Case Studies and Pilot Projects
Comparing Products / Systems?
Example “Reality Check” Checklist

• System / Product Tried and Tested? What testing and/or case studies have been done? Lab Only? In Situ?
• Prove It? Research – Manufacturer only? And/or 3rd party peer reviewed?
• What is the Cost? Product, System, Installed?
• Buildability? Standard Practice, Differentiated Skills?
• Compatibility? Is the product / system play well with others?
• ……
• Primary Focus of Presentation: Can we use Foam Insulation in Above Grade Walls? *Use Code Assessment Engine to determine Yes? or No? & what conditions?*

• Bigger Question …Should We? or Why Would We Consider the Use of Foam Insulation in Above Grade Walls?
Does the wall meet the intent of the building code, use sound building science, what about cost (labour & materials), does the wall have a track record (in the lab and in the field), what support is available, …. ???
Thank You

Les Yard CTR
Building Science Specialist
Dow Building Solutions

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604-472-7266 | lyard@dow.com

Keith Calder | Technical Director - Canada

JENSEN HUGHES
Advancing the Science of Safety

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O: +1 604-295-4000 | F: +1 604-295-3434
kcalder@jensenhughes.com | www.jensenhughes.com
WARNING! Dow Stuff .....
Can I Use Foam Insulation?

If Yes ...

Did I Mention? ... We are only at Step One
What Tools Are Available To Help Determine Which Wall Assembly Is Best For My Project?

Can one use Foam Insulation?
- Wall Builder
- Code Assessment Engine

Which Above Grade Wall Solution?
- Interactive/Consultative Presentation

Why use Dow Wall Assembly?
- Wall Analysis

Technical Support Available From Dow?
- Website
- Details
Which Above Grade Wall Solution?

Interactive Presentation
Which Above Grade Wall Solution?

Interactive Presentation

**BETTER BUILDING STARTS HERE**

**DOW WALL SYSTEMS**

**MAX ARMOR WALL SERIES**
Combines all control layers (thermal, water, vapor and air) while acting as primary external sheathing material. Most efficient design with the lowest cost for material and labor.

**DUAL ARMOR WALL SERIES**
Multi-functionality of the rigid insulation layer brings complete protection (thermal, water, vapor and air) with an added layer of gypsum for additional protection.

**CLASSIC WALL SERIES**
Long-used wall type using discrete layers for WRB/air barrier, thermal continuous insulation and primary exterior gypsum.

**OTHER WALL ASSEMBLIES**
Limited in functionality, but available for use to meet certain code or project requirements.

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Which Above Grade Wall Solution?
Interactive Presentation

MAX ARMOR WALL SERIES

- THERMAX XARMOR™ Exterior Insulation + SPF
- THERMAX XARMOR™ Exterior Insulation + Batt
- THERMAX XARMOR™ Exterior Insulation + Empty
- STYROFOAM™ Brand ULTRA SL XPS Insulation + Batt
- STYROFOAM™ Brand ULTRA SL XPS Insulation + Empty
Which Above Grade Wall Solution?
Interactive Presentation

THERMAX XARMOR™ Exterior Insulation + SPF

- Most robust performance with thinnest wall profile
- THERMAX XARMOR™ (oi) Exterior Insulation: 4-mil facing offers the most protection from damage during construction
- LIQUIDARMOR™ Flashing and Sealant: the most advanced protection at all seams and punch openings
- STYROFOAM™ Brand SPF Insulation in stud cavity: secondary air/water sealing
- 15-year water resistance and thermal warranty available
- Other THERMAX™ Brand Insulation options available; trade-off provides cost savings
Why Use Dow Products and Assemblies?

- Can one use Foam Insulation?
- Wall Builder
- Code Assessment Engine

- Which Above Grade Wall Solution?
- Interactive/Consultative Presentation

- Why use Dow Wall Assembly?
- Wall Analysis

- Technical Support Available From Dow?
- Website
- Details
### Why Use Dow Products & Solutions?

#### Wall Analysis Tool (Project Input)

#### Edit Project Details

<table>
<thead>
<tr>
<th>Project Name*</th>
<th>Test Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Name*</td>
<td>Lee Yard</td>
</tr>
<tr>
<td>City*</td>
<td>USA</td>
</tr>
<tr>
<td>State*</td>
<td>Washington</td>
</tr>
<tr>
<td>Zip Code*</td>
<td>Clarkston</td>
</tr>
<tr>
<td>Square Footage*</td>
<td>7150</td>
</tr>
<tr>
<td>Material Type*</td>
<td>Non-Residential</td>
</tr>
<tr>
<td>Finish*</td>
<td>Non-Union</td>
</tr>
<tr>
<td>Internal Humidity (U)*</td>
<td>35</td>
</tr>
<tr>
<td>Summer Humidity (N)*</td>
<td>0</td>
</tr>
<tr>
<td>Winter Humidity (N)*</td>
<td>0</td>
</tr>
<tr>
<td>Internal Temperature (°F)*</td>
<td>72</td>
</tr>
<tr>
<td>Summer Temperature (°F)*</td>
<td>0</td>
</tr>
<tr>
<td>Winter Temperature (°F)*</td>
<td>0</td>
</tr>
</tbody>
</table>

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## Wall Analysis Tool (Wall Comparison / Input)

**Wall Name**: Usual Wall

**Drywall**: 1/2"

**Interior Vapor Barrier**: Polyethylene

**Stud Spacing**: 16" O.C.

**R-Value**: 19

**Exterior Sheathing**: 5/8"

**Water-Resistant Barrier**: Sheet

**Permeance**: Class 1(<0.1 Perm)

**Continuous Insulation**: Mineral Wool (R4.2/in)

**Wall Name**: TWS Wall

**Drywall**: 1/2"

**Interior Vapor Barrier**: None

**Stud Spacing**: 16" O.C.

**R-Value**: 19

**Exterior Sheathing**: 2" Spray Foam

**Water-Resistant Barrier**: None

**Continuous Insulation**: Thermax Sheathing (3.5 in)

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Why Use Dow Products & Solutions?

Wall Analysis Tool (Output = Energy & Condensation Performance and Material & Labour Cost Comparison)

Wall Analysis
Fiber Cement / Knight CI / XPS / SPF
Generated on 04/06/2017 for Philip Harris

<table>
<thead>
<tr>
<th>Project Conditions</th>
<th>Project Code Requirements</th>
<th>Temperatures &amp; Humidity</th>
<th>Cost &amp; Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashrae Climate Zone</td>
<td>Prescriptive Requirement</td>
<td>Interior - Temperature</td>
<td>Est. Savings in Cost &amp; Labor</td>
</tr>
<tr>
<td>Code Adoption**</td>
<td>R-13 + R-7.5 ci</td>
<td>70</td>
<td>37%</td>
</tr>
<tr>
<td>Construction Type</td>
<td>Assembly MAX U-Value</td>
<td>Interior - Humidity</td>
<td>Est. Change in R-Value</td>
</tr>
<tr>
<td>Non-Residential</td>
<td>0.064</td>
<td>35</td>
<td>1.68%</td>
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<tr>
<td>Project State</td>
<td>Project State</td>
<td>Summer - Humidity</td>
<td>4.0 MW and BATT</td>
</tr>
<tr>
<td>North Dakota</td>
<td></td>
<td>40</td>
<td>25.142</td>
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<tr>
<td>RS Means Nearest City</td>
<td>RS Means Nearest City</td>
<td>Summer - Temperature</td>
<td>2.0 XPS and 2&quot; SPF</td>
</tr>
<tr>
<td>Bismarck</td>
<td></td>
<td>80</td>
<td>25.572</td>
</tr>
<tr>
<td>Number Of Stories</td>
<td></td>
<td>Winter - Humidity</td>
<td>Improvement Code</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>80</td>
<td>37.55%</td>
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<tr>
<td>Labor Type</td>
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<td>Winter - Temperature</td>
<td>Effective R-Value</td>
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<td>10</td>
<td>22.490</td>
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<td>Project Size (SF of Wall)</td>
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<td></td>
<td>Effective U-Value</td>
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<td>20000</td>
<td></td>
<td></td>
<td>0.0399</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Cavity Thickness (in)</td>
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<tr>
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<td></td>
<td></td>
<td>4.675</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>IECC Compliance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

Cost Analysis

<table>
<thead>
<tr>
<th>Cavity Thickness</th>
<th>R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot; MW and BATT</td>
<td>21</td>
</tr>
<tr>
<td>4&quot; XPS and 2&quot; SPF</td>
<td>0.0399</td>
</tr>
<tr>
<td>4&quot; MW and BATT</td>
<td>14.0</td>
</tr>
<tr>
<td>4&quot; XPS and 2&quot; SPF</td>
<td>0.0391</td>
</tr>
</tbody>
</table>
What Resources are there to Support? – *Product Information, Details, Specifications*

**Can one use Foam?**
- Wall Builder
- Code Assessment Engine

**Which Above Grade Wall Solution?**
- Interactive/Consultative Presentation

**Why use Dow Wall Assembly?**
- Wall Analysis

**Technical Support Available From Dow?**
- Website
- Details
What Resources Are Available?
Website, Product Information, Tech Solutions, White Papers
What Resources Are Available?

Generic Details (Masonry & Cladding Sets Available)
What Resources Are Available?

Specifications

THERMAL, WATER, AND AIR BARRIER WALL ASSEMBLY [Public Bid]

March 2015
What Resources Are Available?

SpecLink … Coming Soon

Intelligent Specifications

SpecLink-E saves you time when it comes to managing specifications production for your projects.

FREE EVALUATION COPY
Thank You

Les Yard CTR
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