Sprayed Polyurethane Foam in Construction

Presented by: Ryan Dalgleish

Presented in Partnership with:
Sprayed Polyurethane Foam

- Types of Foams
- Comparison between open-cell and closed cell SPF physical properties
- Standards for the foam industry – both medium density and open cell insulation
- Building code commentary – thermal Barriers, vapour barriers, cathedral Ceilings
- About CUFCA and the quality assurance program
- Resources for builders
## Types of Sprayed Polyurethane Foam

<table>
<thead>
<tr>
<th>Sealant Foams</th>
<th>Light Density Open-Cell Sprayed Polyurethane Foam</th>
<th>Medium Density Closed Cell Sprayed Polyurethane Foam</th>
<th>High Density Closed Cell Sprayed Polyurethane Foam</th>
</tr>
</thead>
<tbody>
<tr>
<td>“foam in the can, froth paks”</td>
<td>“half pound”</td>
<td>“two pound”</td>
<td>“three pound or more”</td>
</tr>
</tbody>
</table>
Light Density - Open-Cell SPF

- Insulating material with an R-value of around 3.8 per inch.
- Soft to the touch
- Open cells that traps air / not a vapour barrier
- Interior application between framing members
- Expands 100 times from liquid state
- Material Standard has been developed (CAN/ULC S712.1) – Installation standard is under development
- CCMC evaluation is only method of code compliance
Medium Density - Closed Cell SPF

- Insulating material with an R-value of 5.1 – 6 per inch.
- Rigid Material
- Closed cell with insulating gas
- Interior / exterior applications
- Expands 30 times from liquid state
- Currently has two standards (product: CAN/ULC S705.1 & Installation: CAN/ULC S705.2) – since 1988 (previously CGSB standards)
- Standards are referenced in NBC and Provincial Codes (Part 5 and Part 9)
- CCMC listing of products – insulation/air barrier
# Comparison

<table>
<thead>
<tr>
<th>Property</th>
<th>Medium Density – Closed Cell</th>
<th>Light Density – Open Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-value</td>
<td>5.1 – 6.0</td>
<td>3.6 – 3.8</td>
</tr>
<tr>
<td>Chemical Components</td>
<td>A – Iso / B – Resin</td>
<td>A – Iso / B - Resin</td>
</tr>
<tr>
<td>Air Barrier</td>
<td>Yes, at minimal thickness</td>
<td>Yes, &gt; 5.5 inches or more *</td>
</tr>
<tr>
<td>Vapour Barrier</td>
<td>Yes, at 2 inches</td>
<td>NO</td>
</tr>
<tr>
<td>Thermal Barrier</td>
<td>Required (interior living space)</td>
<td>Required (interior living space)</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>Applicator/Spray Area</td>
<td>Applicator/Spray Area</td>
</tr>
<tr>
<td>Installation</td>
<td>30 times expansion</td>
<td>100 times expansion</td>
</tr>
<tr>
<td></td>
<td>2 inch pass max</td>
<td>Full cavity</td>
</tr>
<tr>
<td>Sound</td>
<td>Blocks air leakage</td>
<td>Blocks air leakage and absorbs</td>
</tr>
<tr>
<td>VOC’s</td>
<td>CAN/ULC S774/time to occupancy</td>
<td>CAN/ULC S774/time to occupancy</td>
</tr>
<tr>
<td>Application</td>
<td>Interior/exterior/below grade/open surfaces</td>
<td>Interior only between framing members</td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>Zero ODP</td>
<td>Zero ODP</td>
</tr>
</tbody>
</table>
Building Code

- **2005** National Building Code and Provincial Codes cover “Medium Density-Closed Cell”
- American produced material NOT covered
- Light Density – Open Cell material not currently referenced – standard will be referenced in future codes
- Other materials NOT covered (high density roofing foams)
Currently, all manufacturers that produce a medium density – closed cell material that meets the CAN/ULC S705.1 have received a CCMC listing.

For Light Density – Open Cell, a CCMC evaluation report is available and should be requested.

To view any CCMC reports, go to http://irc.nrc-nrc.gc.ca/ccmc/
Sprayed Polyurethane Foam

CAN/ULC S705.1-01
Material Standard –
Medium density closed cell
CAN/ULC S712.1-09 –
Material Standard
Light density open-cell
## CAN/ULC S705.01 Material Standard
### Medium Density, Closed Cell

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Requirements</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Permeance (Mandatory material only testing)</td>
<td>L/s @ 75 Pa</td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Air Permeance (Optional system testing)</td>
<td>L/s @ 75 Pa</td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Apparent Core Density</td>
<td>kg/m³</td>
<td>28</td>
<td>-</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>kPa</td>
<td>170</td>
<td>-</td>
</tr>
<tr>
<td>Dimensional Stability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume Change at:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20°C</td>
<td>%</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>80°C</td>
<td>%</td>
<td>-1</td>
<td>+8</td>
</tr>
<tr>
<td>70°C, 97 ± 3% RH</td>
<td>%</td>
<td>-</td>
<td>+14</td>
</tr>
<tr>
<td>Surface Burning Characteristics Flame Spread</td>
<td></td>
<td>-</td>
<td>500</td>
</tr>
<tr>
<td>Open Cell Content, Volume</td>
<td>%</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Initial Thermal Resistance for a 50 mm specimen after 3 d at 23 ± 2°C</td>
<td>m²·°C/W</td>
<td>Declared</td>
<td>ASTM C 177 or C518</td>
</tr>
<tr>
<td>Long Term Thermal Resistance (For a 50 mm thick specimen)</td>
<td>m²·°C/W</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>kPa</td>
<td>200</td>
<td>-</td>
</tr>
<tr>
<td>Volatile Organic Emissions</td>
<td></td>
<td>-</td>
<td>Pass</td>
</tr>
<tr>
<td>Water Absorption by Volume</td>
<td>%</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Water Vapour Permeance for a 50 mm thick specimen</td>
<td>ng/(Pa·s·m²)</td>
<td>-</td>
<td>60</td>
</tr>
</tbody>
</table>
## CAN/ULC S712.01 Material Standard

**Low Density, Open Cell**

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Requirements</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air permeance at 100 mm</td>
<td>L/(s·m²) @ 75 Pa pressure difference</td>
<td>-</td>
<td>Declare</td>
</tr>
<tr>
<td>Apparent core density</td>
<td>kg/m³</td>
<td>6.8</td>
<td>12</td>
</tr>
<tr>
<td>Dimensional stability volume change at:</td>
<td>%</td>
<td>-</td>
<td>Shrinkage: -1, -15</td>
</tr>
<tr>
<td>-20°C</td>
<td></td>
<td></td>
<td>-15</td>
</tr>
<tr>
<td>80°C</td>
<td></td>
<td></td>
<td>-15</td>
</tr>
<tr>
<td>70 °C, 97 ± 3% RH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungi resistance</td>
<td></td>
<td>No growth</td>
<td>-</td>
</tr>
<tr>
<td>Open-cell content, volume</td>
<td>%</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>Surface burning characteristics</td>
<td></td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Flame spread</td>
<td>-</td>
<td>-</td>
<td>500</td>
</tr>
<tr>
<td>Thermal resistance for a 50 mm specimen</td>
<td>m²·K/W</td>
<td>1.20</td>
<td>-</td>
</tr>
<tr>
<td>Time to occupancy</td>
<td>days</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Water absorption by volume</td>
<td>%</td>
<td>-</td>
<td>Declare</td>
</tr>
<tr>
<td>-For materials with WVP ≥1400</td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>-For materials with WVP less than 1400 and greater then 400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water vapour permeance for a 50 mm thick specimen</td>
<td>ng/(Pa·s·m²)</td>
<td>1400 or 400 depending on water absorption</td>
<td>-</td>
</tr>
</tbody>
</table>
Material Standards
Low Density, Open Cell vs. Medium Density, Closed Cell

Differences Between Standards
- Most test methods are the same for both products
- Some test methods conducted on each product that are unique to that product
  - ie. LTTR, Compressive strength for medium density
  - ie. Fungi resistance for open cell
Foam Colours

Medium Density – Closed Cell:
- Manufacturer A – Green, Peach
- Manufacturer B – Blue, Purple
- Manufacturer C – Orange
- Typically md-cc foam’s natural colour is Yellow. This would indicate a product that DOES NOT meet code.

Light Density – Open Cell:
- No requirement for colour at this time
Medium Density – Closed Cell Standard

CAN/ULC S705.2-05
Installation Standard
Medium Density – Closed Cell

CAN/ULC S705.2-05 Installation Standard
Requirements for:
- Installer must carry photo-identification card
- Installer must meet all installation requirements for environmental conditions, substrate preparation, application requirements and limitations
- Installer must have spill containment materials
- On-site testing (density/adhesion/cohesion)
Medium Density – Closed Cell

CAN/ULC S705.2-05 Installation Standard

- Installer must properly store material and decontaminate & dispose of empty drums properly
- Installer must conduct daily density, adhesion and cohesion testing
- Installer must complete Daily Work Record
- Installer must attach Job Site Label
- Troubleshooting (on-site QC)
Medium Density – Closed Cell

Job Site Documentation

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**CUFCA Daily Work Record**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td>[Contractor Name]</td>
</tr>
<tr>
<td>Certification</td>
<td>[Certification Number]</td>
</tr>
<tr>
<td>CUFCA Number</td>
<td>[CUFCA Number]</td>
</tr>
<tr>
<td>Project Name</td>
<td>[Project Name]</td>
</tr>
<tr>
<td>Project Address</td>
<td>[Project Address]</td>
</tr>
<tr>
<td>Project Manager</td>
<td>[Project Manager]</td>
</tr>
<tr>
<td>Project Type</td>
<td>[Project Type]</td>
</tr>
<tr>
<td>Material Type</td>
<td>[Material Type]</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>[Manufacturer]</td>
</tr>
<tr>
<td>Manufacturer Numb.</td>
<td>[Manufacturer Numb.]</td>
</tr>
<tr>
<td>Location Code</td>
<td>[Location Code]</td>
</tr>
<tr>
<td>Quantity Used</td>
<td>[Quantity Used]</td>
</tr>
<tr>
<td>Date of Work</td>
<td>[Date of Work]</td>
</tr>
</tbody>
</table>

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**CUFCA Thermal Insulation**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer Numb.</td>
<td>[Manufacturer Numb.]</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>[Manufacturer]</td>
</tr>
<tr>
<td>Material Type</td>
<td>[Material Type]</td>
</tr>
<tr>
<td>Thermal Insulation Type</td>
<td>[Thermal Insulation Type]</td>
</tr>
<tr>
<td>Date of Inspection</td>
<td>[Date of Inspection]</td>
</tr>
<tr>
<td>Inspector Name</td>
<td>[Inspector Name]</td>
</tr>
<tr>
<td>Inspector Address</td>
<td>[Inspector Address]</td>
</tr>
<tr>
<td>Inspector Phone</td>
<td>[Inspector Phone]</td>
</tr>
</tbody>
</table>

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**CUFCA Job Site Documentation**

- **Symbol of Quality**: Represents the highest standard of quality and expertise in the spray polyurethane foam industry.
- **Independent Third Party Quality Assurance Program**: Ensures unbiased assessment and adherence to industry standards.
- **Job Site Documentation**: Critical for maintaining quality and accountability in construction projects.
Medium Density – Closed Cell
Installer Identification

BPQI Certified Polyurethane Foam Sprayer
This certificate acknowledges that

John Smith
is a Building Professionals Quality Institute Inc. (BPQI) Certified Polyurethane Foam Sprayer, thereby successfully meeting all requirements for certification as set forth in the certification scheme by BPQI and thereby demonstrating the high level of technical knowledge and professionalism that meets the industry standards established by the CAN/ULC S612 Standard.

BPQI Certification Number: 300000

Certified Installer Card

Ryan Dalgleish
Building Professionals Certification 
Expiry Date: July 1, 2008

The above individual is certified by the Professional Skills Development Institute Inc. (PSDI) in the SPF Quality Assurance Program used by CUFCA as a:

Medium Density Spray Foam Licensed Installer

Registered Apprentice Card

Ryan Dalgleish
Building Professionals Consortium Certification 
Expiry Date: June 30, 2007

The above individual is registered by the Professional Skills Development Institute Inc. (PSDI) in the SPF Quality Assurance Program used by CUFCA as a:

Medium Density Spray Foam Registered Apprentice
Light Density – Open Cell

CAN/ULC S712.2 Installation Standard
Requirements very similar to CAN/ULC S705.2
- In draft at ULC / SPF Task Group level
- Includes items such as on-site testing, substrate preparation, job site set-up, troubleshooting/repair, safety, documentation, etc.
Light Density – Open Cell

Canadian Construction Materials Center


- Evaluated as thermal insulation
- Physical Property testing such as Thermal Resistance, Dimensional stability, Water Vapour Transmission, Water Absorption, Off-gassing
- Manufacturer’s Quality Assurance and third party field audits
- Limitations of Application noted in CCMC evaluation
Building Code Requirements

Thermal Barriers

- Fire Protection
  - Interior Finishes described in 9.29.4 to 9.29.9
  - Bottom Line, **SPF requires a thermal barrier** from adjacent spaces in a building, other than adjacent concealed spaces (wall assembly, attic/roof spaces, crawl space) – drywall is a thermal barrier

- Application on Ducts / Plenums
  - **9.33.6.4**: Foam insulation in direct contact with heating ducts and plenums
  - ASTM C411 testing requirement
  - Approvals vary from municipality to municipality
Building Code

Building Code Commentary

- Is an Extra Vapour Barrier Required (6 mil poly)
  - CAN/ULC S705.1 requires material must meet *Maximum 60 ng/(Pa·s·m²) using ASTM E 96 @ 50 mm thick*
  - SPF applied to a substrate (concrete/OSB, etc), vapour permeance decreases
  - University of Waterloo (2 year vapour barrier research project)
Building Code

Code Commentary

- Is an Extra Vapour Barrier Required (6 mil poly)
  - Reviews fibreglass, open-cell foam & medium density closed cell foam in wall assembly with no vapour barrier.
  - Provides test results for various climates across Canada (Vancouver, Winnipeg, Toronto) and various HDD – Heating Degree Days
Building Code

Code Commentary

- Is an Extra Vapour Barrier Required (6 mil poly)
  - Results: no additional vapour barrier required with 2 inches of md-cc foam
  - Vapour barrier required for fibreglass and open-cell foam
  - Assumes water barrier/air barrier
  - Tested wood studs (2 x 4 and 2 x 6 studs) – less than 60 ng
## Maximum Predicted Annual Wood Moisture Content in Walls Subjected to Various Canadian Climates & Interior Relative Humidities

<table>
<thead>
<tr>
<th>Wall Construction</th>
<th>Representative Location</th>
<th>Vancouver</th>
<th>Toronto</th>
<th>Montreal</th>
<th>Calgary</th>
<th>Winnipeg</th>
<th>Yellowknife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Insulation</td>
<td>Depth of Cavinty</td>
<td>Type of Vapour Control</td>
<td>HDD 3000</td>
<td>HDD 4000</td>
<td>HDD 4500</td>
<td>HDD 5000</td>
<td>HDD 6000</td>
</tr>
<tr>
<td>fiberglass</td>
<td>5.5&quot;</td>
<td>Polyethylene sheet</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>5.5&quot;</td>
<td>Latex primer + paint</td>
<td>14%</td>
<td>15%</td>
<td>21%</td>
<td>18%</td>
<td>25%</td>
</tr>
<tr>
<td>studs</td>
<td>3.5&quot; or 5.5&quot;</td>
<td>Latex paint + primer</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>foam</td>
<td>Open Cell</td>
<td>5.5&quot;</td>
<td>Latex paint + primer</td>
<td>14%</td>
<td>15%</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Closed Cell</td>
<td>2&quot;SPF + 3.5&quot;FG</td>
<td>13%</td>
<td>14%</td>
<td>14%</td>
<td>12%</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2&quot;SPF in 3.5/5.5&quot;</td>
<td>12%</td>
<td>13%</td>
<td>13%</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>spray polyurethane</td>
<td>Closed Cell</td>
<td>3.5&quot; SPF in 3.5/5.5&quot;</td>
<td>12%</td>
<td>13%</td>
<td>13%</td>
<td>12%</td>
<td>12%</td>
</tr>
</tbody>
</table>

Includes Locations (Heating Degree Days):
- Vancouver (2520)
- Abbotsford (2031)
- Victoria (2040)
- Windsor (3524)
- Kitchener-Waterloo (4086)
- St. John's (4881)
- Toronto (4028)
- Edmonton (5708)
- Calgary (5039)
- Prince George (5132)
- Yellowknife (5250)
- Niagara Falls (3861)
- Kingston (4039)
- Thunder Bay (5717)
- Halifax (4038)
- Montreal (4516)
- Winnipeg (5777)
- Shubenacadie (5151)
- Quebec City (6320)
- Whitehorse (6811)
- Hamilton (4012)
- Moncton (4516)
- Winnipeg (6320)
- Sudbury (5431)
- London (4057)
- Ottawa (4002)
- Whitehorse (6811)
- Toronto (4005)

### Values in Moisture Content
- **N%** = Moisture Content < 20%, no mold growth
- **N%** = Moisture Content is 20 to 28%, strong potential for moisture problems, reconsider this design
- **N%** = Moisture Content is over 28%, moisture problems are certain, this design is NOT recommended

### General Notes
- Walls are residential wood frame with light colored thin cladding facing north: this is a worse-case scenario for cold-weather diffusion wetting
- Results are for OSB sheathing. Plywood sheathing values will be equal or lower. OSB permeance is always over 60 ngPa m² s in exterior sheathing applications.
- Sheathing of DensGlas, FiberBoard, and Gypsum Board are all very vapor permeable and hence will have lower moisture contents
- Thicker foam will always result in lower wintertime sheathing moisture contents
- Effective Air Barrier is assumed to be installed, as is proper rain control

### Specific Notes:
- 1. Apply SPF directly onto back of exterior sheathing
- 2. RH range indicates the lowest daily interior RH in winter and the highest average daily RH in summer
Building Code

Code Commentary

- Cathedral Ceilings and Required Venting
  - Is venting required when using a md-cc foam?
  - Code indicates venting is required unless it can be shown to not have an adverse affect
Code Commentary

- Cathedral Ceilings and Required Venting
  - An airtight assembly is critical in this area
  - MD-CC SPF has been found to provide the required airtightness, vapour performance and protection of exterior wood sheathing.
  - Ontario Municipal Housing and Affairs Branch Opinion issued in 1995 and recent Building Code Commission rulings have indicated that venting is not required
Quality Assurance

CUFCA
Quality Assurance Program
Quality Assurance

CUFCA Quality Assurance Program

- Chosen by a manufacturer as their QAP delivery agent (voluntary)
- CUFCA has had the QAP developed, implemented and is delivered by 3rd party organizations
  - Including certification, licensing, complaint resolution, manufacturer licensing, 3rd party warranty program, technical assistance
Quality Assurance

CUFCA Quality Assurance Program

- NEW: Personnel certification program for sprayers is in compliance with ISO 17024 and accredited by the Standards Council of Canada
THE SPRAY POLYURETHANE FOAM INDUSTRY’S ONLY INDEPENDENT THIRD PARTY QUALITY ASSURANCE PROGRAM

Accredited Contractors
Contractor Identification

Accredited Contractors

Contractor Look Up Service

Company Name
as a Registered Licensed Contractor in good standing with the Canadian Urethane Foam Contractors Association Inc.

The Contractor is licensed under the CUFCA Quality Assurance Program and will remain so only provided that the Contractor continues to meet all requirements as outlined by the Canadian Urethane Foam Contractors Association Inc. and the Quality Assurance Program. The Licensed Contractor is subject to the requirements of the Underwriters Laboratories of Canada CAN/ULC S752 product installation standard and is approved to install spray-applied high-performance cellular plastic foam insulation which has been tested and evaluated to CAN/ULC-S609. The Licensed Contractor agrees to install polyurethane foam in a manner which will meet the ISO 9001 series quality standard.

[Certificate Image]

This Certificate is Valid
July 1, 2005 to June 30, 2006

This Certificate is void and revoked by the Canadian Urethane Foam Contractors Association Inc.

This certificate must be returned on request.

[Signature]
Resources for the Building Industry

Resources available to builders (CUFCA)

- Product Handbook, Technical Bulletins, Research Reports, Engineering Reports, Technical Assistance, Website, Site Inspections, Complaint Resolution

On the Web:

- [www.cufca.ca](http://www.cufca.ca) (resources, approved contractors, technical information)
- [www.nrc.ca/ccmc](http://www.nrc.ca/ccmc) (ccmc evaluations of all products)
- [www.sprayfoam.com](http://www.sprayfoam.com) (general information and news)
- [www.sprayfoam.org](http://www.sprayfoam.org) (US industry association)
- [www.buildingscience.com](http://www.buildingscience.com) (good technical info)