What is a Building?
A Building is an Environmental Separator
• Control heat flow
• Control airflow
• Control water vapor flow
• Control rain
• Control ground water
• Control light and solar radiation
• Control noise and vibrations
• Control contaminants, environmental hazards and odors
• Control insects, rodents and vermin
• Control fire
• Provide strength and rigidity
• Be durable
• Be aesthetically pleasing
• Be economical
Arrhenius Equation
For Every 10 Degree K Rise
Reaction Rate Doubles

\[ k = A e^{-E_a/(RT)} \]
Damage Functions
Water
Heat
Ultra-violet Radiation
2\textsuperscript{nd} Law of Thermodynamics
Heat Flow Is From Warm To Cold
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less
Air Flow Is From A Higher Pressure to a Lower Pressure
Gravity Acts Down
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion

Vapor Diffusion
Thermodynamic Potential
PSYCHROMETRIC CHART
NORMAL TEMPERATURES
SI METRIC UNITS
Barometric Pressure 101.325 kPa
SEA LEVEL
Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer
Building Science Corporation

Window

Parapet

Roof

Wall

Footage

Slab
Configurations of the Perfect Wall
Brick veneer/stone veneer
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Uninsulated steel stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Building Science Corporation

Brick veneer/stone veneer
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Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Insulated wood stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Outside

Inside

0°F

70°F

Dewpoint
(50% RH, 70°F)

Location of condensation and frost

Exterior sheathing
Simple linearized energy-temperature relation for water

From Straube & Burnett, 2005
The inside face of the exterior sheathing is the condensing surface of interest.

- Wood-based siding
- Building paper
- Exterior sheathing
- R-19 cavity insulation in wood frame wall
- Gypsum board with any paint or wall covering

![Graph showing temperature changes over months]

- Mean monthly outdoor temperature
- Dew point temp. at 50% R.H., 70°F
- Dew point temp. at 35% R.H., 70°F
- Dew point temp. at 20% R.H., 70°F

Potential for condensation
The inside face of the insulating sheathing is the condensing surface of interest.

Wood-based siding

R-7.5 rigid insulation

R-13 cavity insulation in wood frame wall

Gypsum board with any paint or wall covering

Insulation/sheathing interface temperature (R-7.5 sheathing, R-13 cavity insulation as shown in adjacent drawing)

Mean monthly outdoor temperature

Potential for condensation

Dew point temp. at 35% R.H., 70°F

Month

Temperature (°F)
Figure 8-7. Outside vapour pressure, saturated vapour pressure and inside vapour pressure for Winnipeg.
## Insulation for Condensation Control

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Rigid Board or Air Impermeable Insulation</th>
<th>Total Cavity Insulation</th>
<th>Total Wall Assembly Insulation</th>
<th>Ratio of Rigid Board Insulation or Air Impermeable R-Value to Total Insulation R-Value</th>
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<tbody>
<tr>
<td>4C</td>
<td>R-2.5</td>
<td>R-13</td>
<td>R-15.5</td>
<td>15%</td>
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<tr>
<td></td>
<td>R-3.75</td>
<td>R-20</td>
<td>R-23.75</td>
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<td>R-13</td>
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<td>R-20</td>
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<td>45%</td>
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<tr>
<td>8</td>
<td>R-15</td>
<td>R-20</td>
<td>R-40</td>
<td>50%</td>
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</tbody>
</table>

*Adapted from Table R 702.1 2015 International Residential Code*
Hydrostatic pressure
Pascals  mph
50 Pa = 20 mph
100 Pa = 30 mph
150 Pa = 35 mph
250 Pa = 45 mph
500 Pa = 65 mph
1,000 Pa = 90 mph

Wind Speed (mph) vs. Stagnation Pressure (Pa)
Plywood/OSB sheathing

Water control layer

3/8” spacer strip
Rain Screen
Beer Screen?
Commercial Enclosure: Simple Layers

- Structure
- Rain/Air/Vapor
- Insulation
- Finish
The diagram illustrates a flashing installation. The term "Flashing" is written across the central section. Arrows indicate the direction of "DOWN" and "OUT," with specific labels for "Upturned leg," "Base sloped to exterior," and "Drip edge."
Rain enters cup due to momentum ("kinetic energy")

Cup drains water to exterior
Rain enters cup due to momentum ("kinetic energy")

Wind enters cup—pressurizing cup; no rain entry due to wind driven rain

Cup can still drain water to exterior

Entire wind pressure taken here
Baffle to deflect raindrops hitting face of cup due to momentum ("kinetic energy")

Pressure in cup is same as pressure outside on face of baffle

Momentum driving force converted to gravity—water drains away

Wind enters cup—pressurizing cup; no rain entry due to wind driven rain

Cup can still drain water to exterior

Entire wind pressure taken here
Outer seal sees water but not pressure; no pressure difference across this seal, therefore no rain entry.

Key seal is interior seal as it takes maximum wind load but it does not see water.

Pressure in chamber is same as pressure outside on face of assembly.

Air enters and pressurizes chamber.

Entire wind pressure taken here.

Pressure chamber.
Intent of sealant is to limit this lateral flow of water between sheathing and building wrap.

Flashings tape

Sealant “bedding” joint

Building wrap “wrapped” into opening
Sealant backer rod

Inner seal

Wind pressurizes chamber between inner and outer seal

Sealant backer rod

Outer seal

Vent tube
Inner, protected seal  

Outer, exposed seal

Drain and vent opening
Open Joints vs Closed Joints
Open Joints vs Closed Joints
Limits of Pressure Equalization
Pressure Equalization Needs to be Perfect
Pressure Equalization Reduces Drying
Prevention of Wetting Is Not As Important As Drying
Assume Things Get Wet…Design Them to Dry
Ventilated Claddings Promote Drying