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

\[ k = Ae^{-E_a/(RT)} \]
Damage Functions
Water
Heat
Ultra-violet Radiation
$2^{nd}$ 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
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

Concrete block

Metal channel or wood furring

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
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
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)

Insulated wood stud cavity

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Dewpoint (50% RH, 70°F)
Location of condensation and frost

Outside

Inside

0°F

70°F

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:
- Dew point temp. at 50% R.H., 70°F
- Mean monthly outdoor temperature
- Potential for condensation

Chart showing temperatures from April to May: Dew point temp. at 35% R.H., 70°F and Dew point temp. at 20% R.H., 70°F.
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

The chart shows the monthly outdoor temperature for different months.

- Mean monthly outdoor temperature
- Insulation/sheathing interface temperature (R-7.5 sheathing, R-13 cavity insulation as shown in adjacent drawing)
- Potential for condensation
- Dew point temp. at 35% R.H., 70°F

Month: APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY
Figure 8-7. Outside vapour pressure, saturated vapour pressure and inside vapour pressure for Winnipeg.
<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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<tr>
<td>4C</td>
<td>R-2.5</td>
<td>R-13</td>
<td>R-15.5</td>
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<tr>
<td></td>
<td>R-3.75</td>
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<td>R-23.75</td>
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<td>5</td>
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<td>R-13</td>
<td>R-18</td>
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<td>R-7.5</td>
<td>R-20</td>
<td>R-27.5</td>
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<td>6</td>
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<td>R-13</td>
<td>R-20.5</td>
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<td>7</td>
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<td>R-13</td>
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<tr>
<td>8</td>
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<td>R-28</td>
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<td>R-20</td>
<td>R-20</td>
<td>R-40</td>
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*Adapted from Table R 702.1 2015 International Residential Code*
<table>
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<th>Pascals</th>
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<td>500 Pa</td>
<td>65 mph</td>
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<tr>
<td>1,000 Pa</td>
<td>90 mph</td>
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Rain Screen
Beer Screen?
Commercial Enclosure: Simple Layers

- Structure
- Rain/Air/Vapor
- Insulation
- Finish
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

Entire wind pressure taken here

Cup can still drain water to exterior
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.
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
Life is Tough Enough As it Is…
Life is Tough Enough As it Is…
It’s Harder When You Are Stupid
Don’t Do Stupid Things
WEDGE SHIMS INSERTED BEHIND/FRONT OF ANGLE TO ENSURE DIRECT BEARING ON BRACKET AND PROVIDE LEVEL (IF NECESSARY)
Don’t Do Stupid Things