2nd Law of Thermodynamics
In an isolated system, a process can occur only if it increases the total entropy of the system

Rudolf Clausius
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
Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer
Cladding
Control layers
Structure
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)
Insulated wood stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall finish
Commercial Enclosure: Simple Layers

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

1x3 furring @ 24” o.c.
#10 screws @ 16” o.c. vertically
Result: 20 psf cladding weight
with < 2/100” deflection
Second layer of z-bars should be installed perpendicular to the first layer; orientation of the two layers will depend on the requirements of the cladding attachment system.

First layer of z-bars embedded in the insulation layer; should the first layer be installed horizontally, the exterior leg should be turned down to promote drainage to the exterior.
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
Insulating glass unit

Seal (gasket)

Seal (tape)

Setting block (typically two per unit)

Hole providing drainage and pressurization

Frame

Rough opening
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.

Flashing tape
Sealant “bedding” joint
Building wrap “wrapped” into opening
Single top plate
2x6 stud wall @ 24” o.c.
Taped and painted 1/2” gypsum wall board as interior finish
Fiberglass or cellulose insulation in stud space
OSB sheathing with water control layer facing; joints taped/sealed
Continuous insulation; rigid 1 1/2” typical
Furring strip spacer
Cladding
Spray foam insulation at rim joist
Where Is The Water Control Layer?
Where Is The Water Control Layer?
Behind The Continuous Insulation?
Or The Face of The Continuous Insulation?
Where Is The Water Control Layer?
Behind The Continuous Insulation?
Or The Face of The Continuous Insulation?
Where Is The Window?
Where Is The Water Control Layer?
Behind The Continuous Insulation?
Or The Face of The Continuous Insulation?
Where Is The Window?
Is It An Innie Or Outie Or Tweeny?
Head trim flashing

Head trim

Horizontal return trim

Drainage “gap”

Window flange flashed to face of structural sheathing with flashing tape

Sealant
1x4 wood furring attached through rigid insulation to 2x4 wood furring

2x4 wood furring mechanically attached to masonry wall

Fluid-applied water control layer and air control layer

Cladding

Joints offset horizontally and vertically with each layer taped

Masonry wall

Interior plaster and lath
Liquid-applied membrane lining, sub-sill window flashing, air and water barrier transition membrane

HD spray foam "filet" to be applied before rest of foam

HD spray foam
HD spray foam

Liquid-applied membrane lining, window flashing, air and water barrier transition membrane

Flashing

HD spray foam “filet” to be applied before rest of foam

Air seal
Liquid-applied membrane lining, sub-sill window flashing, air and water barrier transition membrane

HD spray foam "filet" to be applied before rest of foam

HD spray foam
HD spray foam

Liquid-applied membrane lining, window flashing, air and water barrier transition membrane

Flashing

HD spray foam “filet” to be applied before rest of foam

Paperless gypsum sheathing

Air seal
We assume a window unit is a single layer.

Under this assumption, it does not matter which side of the assembly we establish the $\Delta P$. 

\[ P_T = P_C + P_{WRB} + P_S + P_{CI} + P_{GWB} \]

Not all layers equally “tight”

\( \Delta P \) across each layer depends on the side of the wall the pressure is induced

Removing a layer changes everything
$p_T = p_{WRB} + p_S$

is very different than

$p_T = p_C + p_{WRB} + p_S + p_{CI} + p_{GWB}$