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JR

BUTLER

HELPING YOU SEE THE LIGHT

COMMERCIAL SYSTEM TYPES

STOREFRONT

Single-span, non load-bearing, stick-built system that is field glazed and anchored at the perimeter. Water is managed internally with gutters. These gutters direct water from the horizontals, down the verticals, and finally to the sill receptors, to be wept from the system.

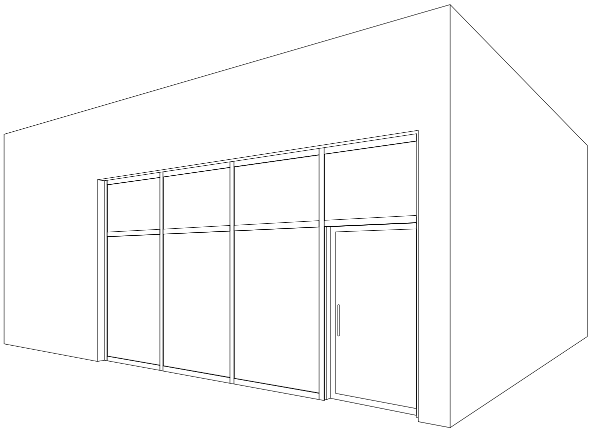
UNITIZED CURTAIN WALL

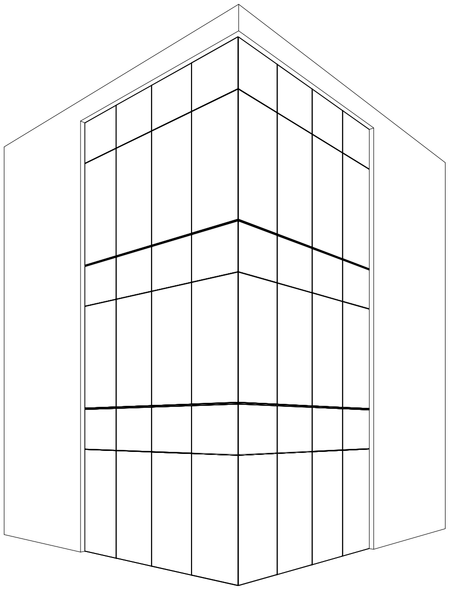
Multi-span, non-load bearing, factory-assembled and glazed system, that is anchored at vertical mullions. Water is controlled individually by each panel rather than the whole wall at the sill.

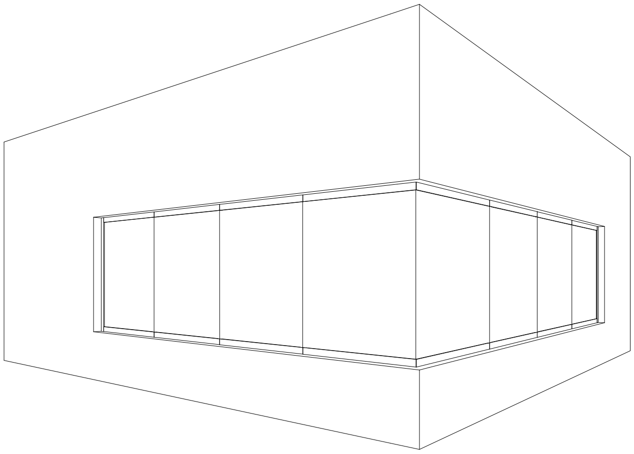
Unitized Curtain Wall is a system of interlocking panels assembled and glazed in a factory setting. Each individual panel is comprised of aluminum extrusions, infill, gaskets and sealants. The panels are shipped to site and installed in a specific sequence.

RIBBON WALL

Single-span, non-load bearing, factory assembled and glazed system, that is anchored at the perimeter. Water is managed internally with gutters. These gutters direct water from the horizontals, down the verticals, and finally to the sill receptors to be wept from the system. Ribbon Wall functions very similarly to Storefront, but is usually tested to higher levels of water performance.

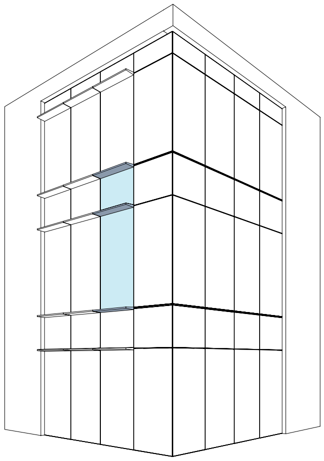




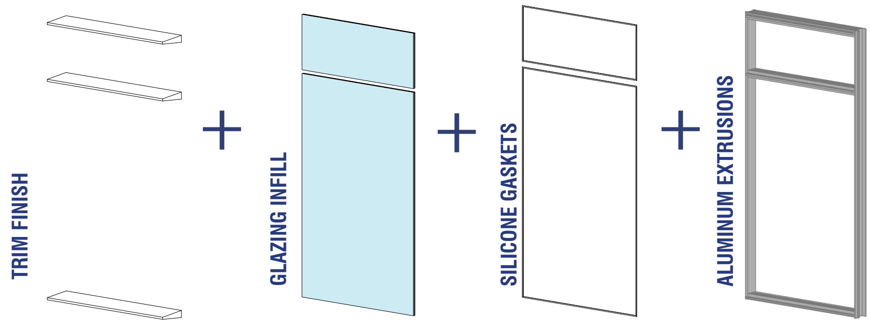


UNITIZED CURTAIN WALL

THE PANEL

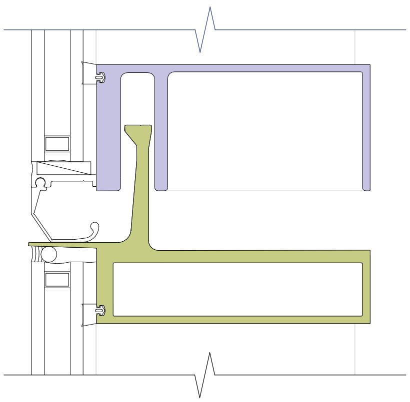


Unitized Curtain Wall is comprised of a series of interlocking panels. Each panel combines aluminum extrusions with an infill material and gaskets to create an air and water tight assembly.

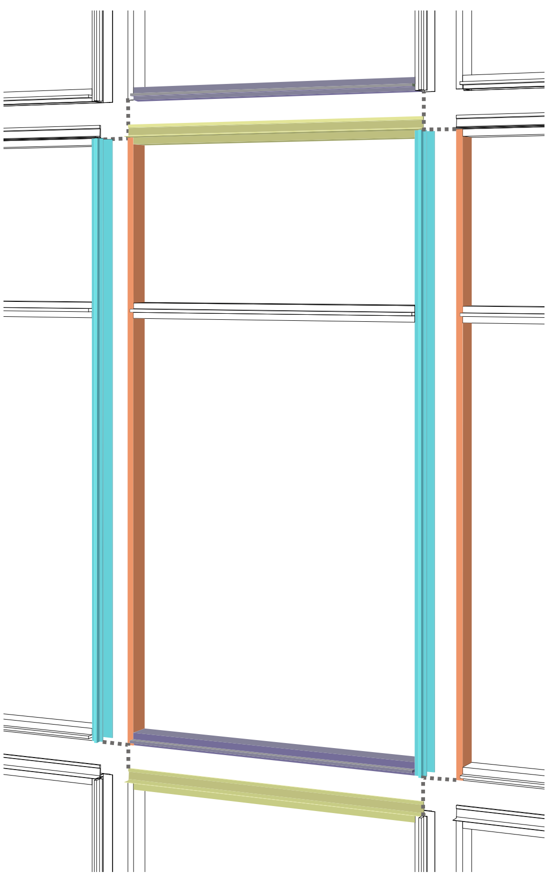


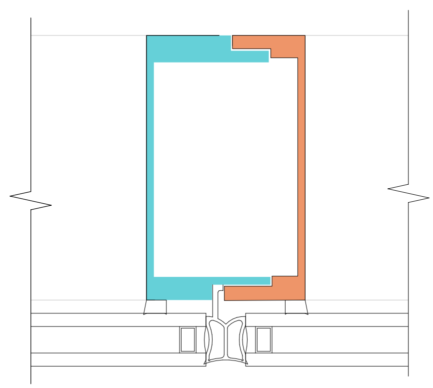
EXTRUSIONS

Each aluminum extrusion profile determines how the panel will be locked into place. These interlocking segments are referred to as the stack joints and consist of one extrusion coupled with a corresponding extrusion on an adjacent panel.



The Horizontal Stack Joint connects panels above and below. It is the marriage of the head of one panel and the sill of the panel above. This joint is designed to accommodate movement, such as, live load deflection, inter-story drift and thermal expansion, all while maintaining the air and water seal.





The Intermediate Vertical (or Vertical Stack Joint) connects panels side by side. These intermediate verticals accommodate lateral building movement and thermal expansion. Loads acting on the curtain wall are transferred back to the building structure by vertical mullion anchors.

For project specific details, please contact JR Butler

INFILL

While it is generally thought of as a glazed system, vision or spandrel, the infill of a curtain wall panel can be a variety of materials.

IGU - INSULATED GLASS UNIT

The IGU is made up of two (or more) plies or substrates hermetically sealed and separated by an air or gas space. Glass substrates are available in a variety of tints and offer varied reflectivity, aesthetics, and other performance options.

SPANDREL

At locations where vision glass is not desired, spandrel glass can be utilized to conceal interior conditions. Spandrel glass has a surface painted with an opaque coating to prevent light transmission. Insulation and/or other backing can be used to improve the thermal performance of the system while also preventing the spandrel glass from being back lit.

METAL PANEL

Metal panel infill provides a range of color and texture options for a unitized system. Metal panels can be perforated or ribbed. Many products have integral insulation for improved thermal performance.

LOUVER

Louvers as an infill offer an efficient way to provide ventilation without breaking the unitized system and transitioning to a different wall assembly.

STONE PANEL

Thin-cut stone panels glazed into a curtain wall system provide a natural textured look, available in a variety of color options.

TERRACOTA

Terracota is another natural-look infill option,available in a variety of colors, and can also be cut to custom profiles.

SILICONE GASKETS

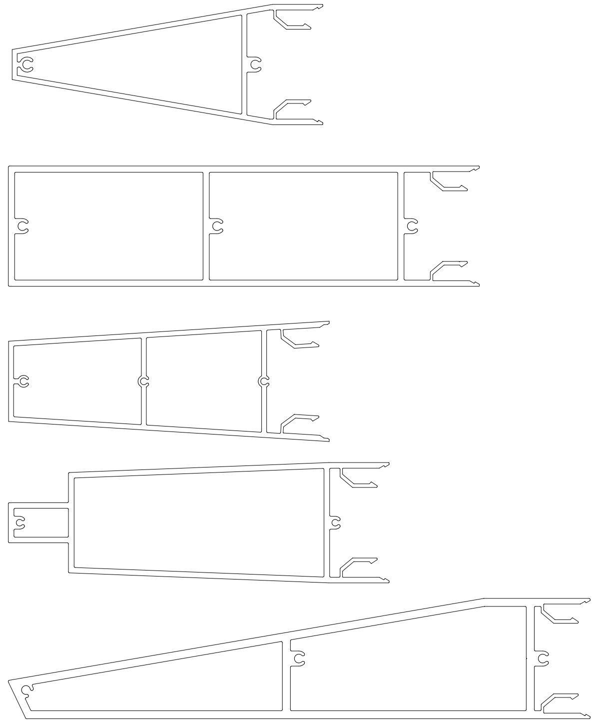
During panel assembly, gaskets are fitted onto the panel to help prevent air and water penetration. Gaskets also function to prevent metal on metal contact, eliminating any potential rattles or noise. Different materials, such as EPDM, *can* be chosen on a economic-basis, however, extruded silicone provides the most consistent profiles and is compatible with adjacent structural silicone.

TRIM FINISH

After the panel assembly, captured systems are fitted with pressure plates to receive the face caps. Often standard 1/2” face caps are used, but extended caps in a variety of profile options can also be used. This provides a simple way to customize a project and create a unique design feature. Due to structural limitations, the max depth for a single extended face cap is 14”. For profiles deeper than this, a vertical or horizontal sunshade is an option, with 48” projections possible.

CUSTOM CAP

EXAMPLES

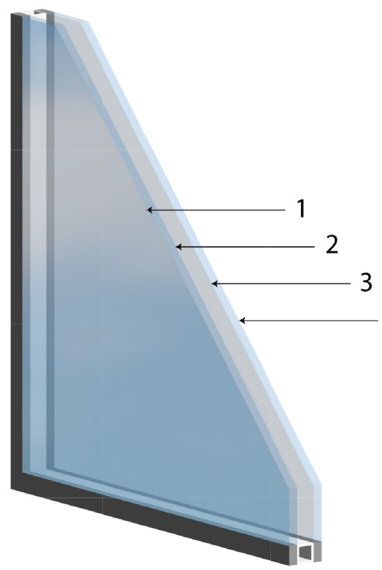


JR Butler has a close relationship with Viracon, and has chosen them as the preferred supplier for glazing products. These pages highlight information from Viracon about glazing units, including cost impacts and design considerations.

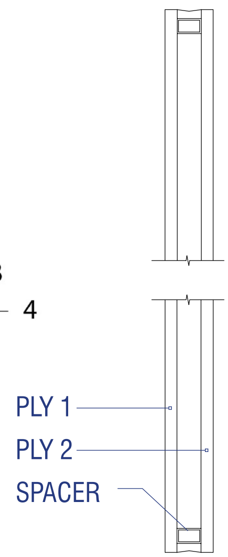
The glass lites of curtain wall panels are IGUs or Insulated Glass Units. The IGU is made up of two (or more) plies or substrates hermetically sealed and separated by an air / gas space. Typically a 1” IGU consists of two 1/4” substrates separated by a 1/2” air space.

Each ply of glass has two surfaces. The exterior surface of the exterior ply is referred to as surface #1, the inside of this glass ply is surface #2. The next ply hosts the #3 surface toward the exterior and #4 on the interior side. For additional substrates, the count continues to increase at each new surface (5 & 6, etc.)

Substrates are available in a variety of tints (see below) and a variety of thicknesses including 1/4”, 3/16”, 5/16”, and 3/8”. Substrates can have a reflective or Low-E coating and digital or silk-screen print applied.



IGU SURFACES



IGU

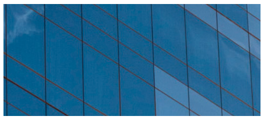
VIRACON SUBSTRATES

1 CLEAR | 2 GREEN | 3 GRAY | 4 BRONZE | 6 BLUE GREEN | 7 AZURIA GLASS

13 STARPHIRE GLASS (LOW IRON) | 18 OPTIBLUE GLASS | 19 CRYSTAL GRAY | 24 OPTIWHITE (LOW IRON) | 26 SOLARBLUE GLASS | 27 PACIFICA GLASS

30 OPTIGRAY GLASS | 31 ULTRACLEAR (LOW IRON | 32 CRYSTAL BLUE | 33 MAJESTIC GREY | 34 ACUITY (LOW IRON)

VRE1-46



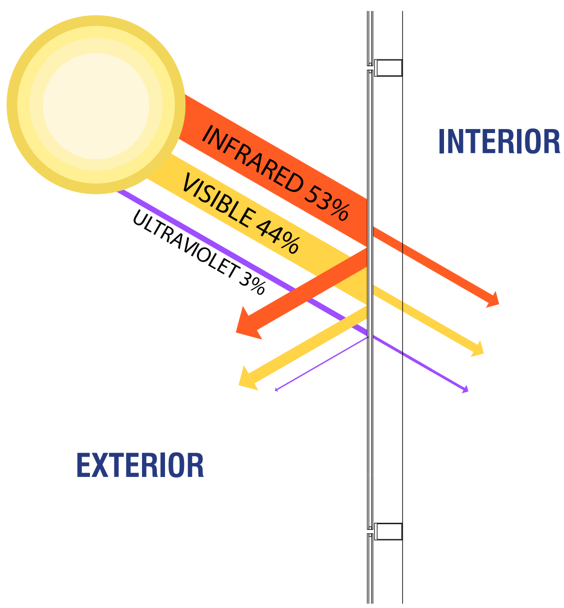
VRE27-38

VRE2-54

GLAZING

SOLAR ENERGY

Glass can absorb, transmit, or reflect each component of the solar energy spectrum. The IGU make-up and coating influence the ratio by which each solar energy component is either rejected or allowed through, contributing to solar heat gain and visible light transmittance



THERMAL PERFORMANCE

Solar Heat Gain Coefficient (SHGC) is the measurement of the solar energy that is either transmitted or absorbed. SHGC is expressed as a number between 0 and 1. The higher the SHGC, the worse the energy performance.

Different combinations of low-e (low-emissivity) coatings, substrate tints, and silk screen patterns influence solar heat gain and can improve energy efficiency by reducing mechanical loads and their associated costs. For the best thermal performance, coatings should be applied to the #2.

Low-e coatings
Historically highly reflective coatings were used to reflect solar energy, but resulting in poor visible light transmission. Today, low-e technology has improved significantly, making low-e coatings the better option. Low-e coatings are microscopically thin, metallic layers that are applied to the glass to reduce heat transfer. Low-e coatings allow for more light transfer to the interior, providing a better work environment for employees.

Silk-screen
A silk-screen pattern can also be incorporated for even better thermal performance. Silk-screen patterns allow the architect to customize the look of the building and control the amount of heat transfer into the building, while having a very minor visual impact on the building user looking out through the glass.

DECODING GLASS TYPE

Viracon utilizes an alphanumeric code for each coated glass product. The code designates the coating as well as the glass substrate the coating is applied to.

Different combinations of coatings and substrate tints create a variety of visual effects. When choosing glass, it is important to consider the desired aesthetic, the SHGC, and the desired visible light transmittance to the interior.

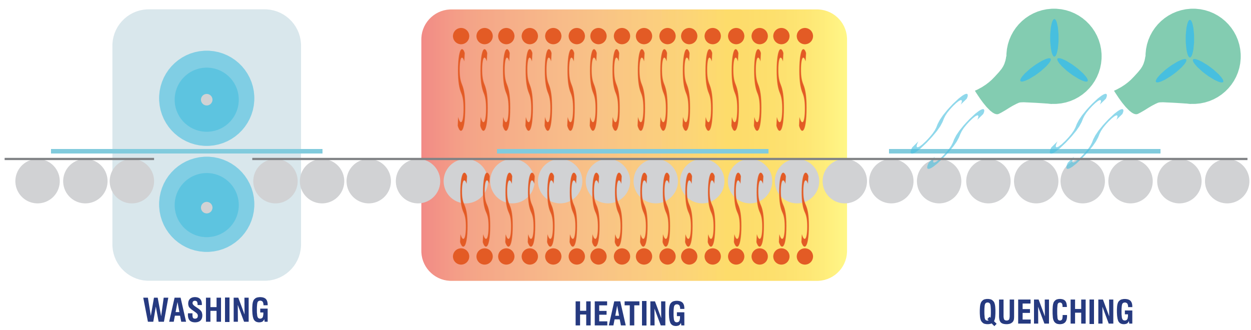
COATING TYPE	OUTBOARD GLASS SUBSTRATE	TRANSMITTANCE OF COATING
VRE	1	54

VIRACON LOW-E COATING FAMILY

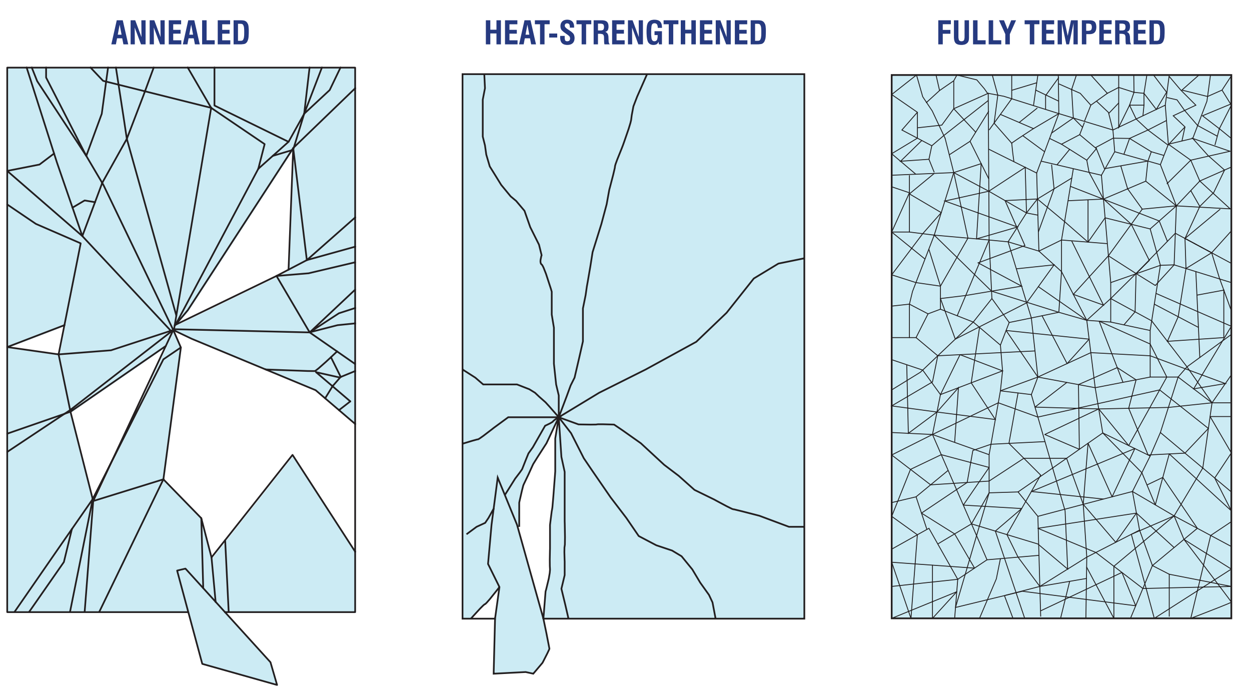
STANDARD COST			PREMIUM COST		
VE	VUE	VRE	VZRE	VNE	VRE
85	50	65	65	63	43
2M	40	59	59	53	
48	30	54	54		
45		46	46		
42		38	38		

HEAT TREATED GLASS

Commercial-grade glass is usually heat treated to take the extra thermal stress caused by low-e coatings. Heat treated glass can either be Heat-strengthened (HS) to simply increase strength, or Fully Tempered (FT) to meet safety glazing requirements. Heat treating glass is the process by which annealed (raw, untreated if post-temperable) glass is put into a furnace, where it is heated to approximately 1,150° F. Once this temperature has been reached, the glass is removed from the furnace and is cooled or quenched. This cooling process, and the rate at which it is done, creates a state of high compression at the glass surfaces while the central core of the glass is in a compensating tension. Fully Tempered glass is quenched more rapidly than Heat-strengthened, creating greater internal stress and thus, higher strength. The only physical characteristics of the glass that change are the improved strength and resistance to thermal stress and shock.



Heat-strengthened glass is twice as strong as annealed glass of the same thickness, size and type. When broken, either annealed or Heat-strengthened glass will break into large, dangerous shards. Fully Tempered glass is typically four times stronger than annealed glass, or twice as strong as Heat-strengthened glass, of the same thickness size and type. When fully tempered glass is broken, it breaks into very small pieces, reducing the chance of injury from fall-out.



GLAZING

HEAT SOAK TEST

Fully tempered glass may break without warning due to the expansion of nickel sulfide inclusions (NiS) naturally present within float glass. Although the incidence of tempered glass spontaneous breakage due to these inclusions is rare, greater publicity of their occurrence has resulted in an increased awareness. Manufacturers can perform a heat soak test on the glass which provides some assurance that spontaneous breakage will not occur. While this can bring some security, design teams should be careful to balance the risk of glass breakage with the cost to perform such a test.

LAMINATED GLASS

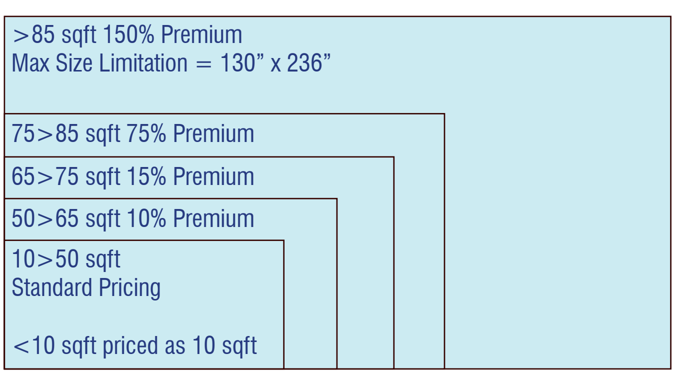
Laminated glass units can be used for fall-out prevention. These units are constructed with two plies of glass permanently bonded together with one or more interlayers. The interlayer is able to support and hold the glass when broken and also reduces the probability of penetration. The ability to resist various kinds of penetration is dependent upon a number of factors including thickness of the glass and the type of interlayer selected. Other benefits include additional UV protection and acoustical performance.

GLASS DEFLECTION LIMITATIONS

As noted in most building codes, the framing members for each individual pane of glass shall be designed so the deflection of the edge of the glass perpendicular to the glass pane shall not exceed L/ 175 or L/240 + 1/4”. For spans greater than 13’-6” at the edge length, or 3/4 inch, whichever is less. In addition, it is recommended to limit center-of-glass deflection at wind pressures to not more than 1/50 times the short-side length or 1in., whichever is less.

GLASS SIZE LIMITATIONS

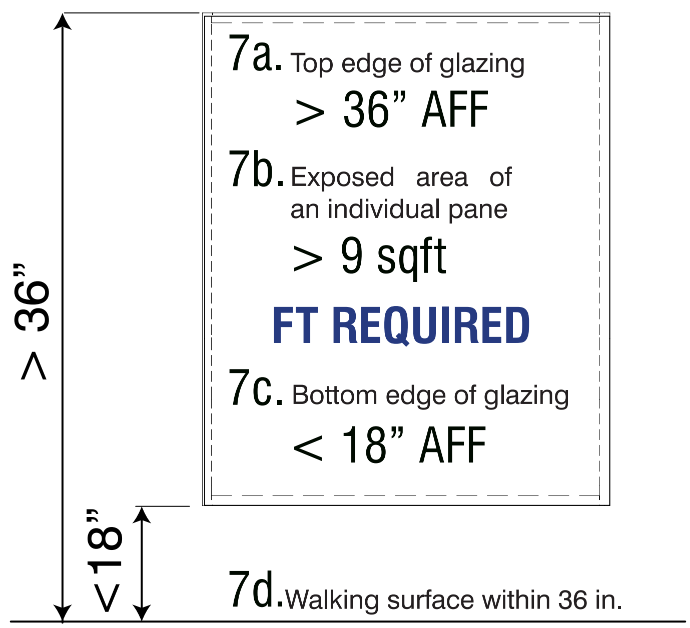
The size of glass lites are limited by manufacturing constraints. Limitations and cost premiums set by Viracon are shown below.



SAFETY GLAZING

Code requires fully tempered or laminated glass in areas defined as Hazerdous. According to IBC 2406 the following shall be considered specific hazardous locations requiring safety glazing:

1. Swinging doors except jalousies.
2. Fixed and sliding panels of sliding door assemblies.
3. Storm doors.
4. Unframed swinging doors.
5. Doors and enclosures of wet areas where the bottom exposed edge of the glazing is <60 in. above a standing surface.
6. An individual fixed or operable panel adjacent to a door
7. Glazing in an individual fixed panel that meets all of the following four conditions shall be considered a hazardous location and requires safety glazing.

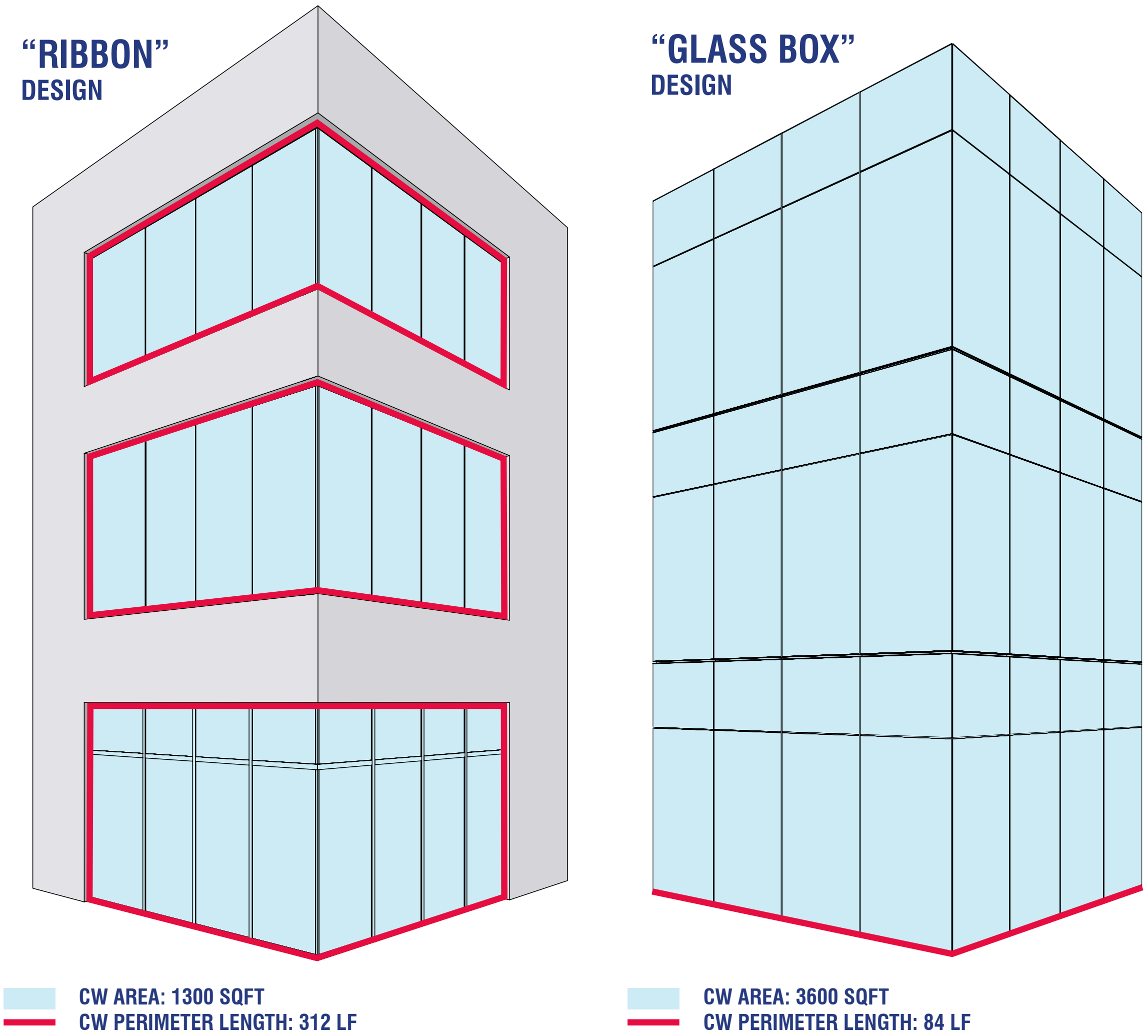


EXCEPTIONS
- Decorative glazing
- Horizontal rail on accessible side is 34 to 38 in. AFF
- Outboard panes ≥ 25 feet above any exterior grade, roof, or walking surface

8. Glazing in guards and railings,
9. Glazing in walls and fences enclosing wet areas.
10. Glazing adjacent to stairways, landings and ramps within 36 in. horizontally of a walking surface; when the exposed surface of the glass is <60 in. above the plane of the adjacent walking surface.
11. Glazing adjacent to stairways within 60 in. horizontally of the bottom tread in any direction when the exposed surface of the glass is <60 inches above the nose of the tread.

COST CONSIDERATIONS

OVERALL BUILDING COST



PERIMETER LENGTH

The way in which curtain wall is incorporated into the overall building design affects cost, but not just in terms of square footage. The Perimeter Length is also a key factor. This metric is tracks where a curtain wall system transitions to adjacent wall, roof, or floor assemblies. This is at the jambs, head, and sill of the system.

The perimeter is where the primary seal is located and where the system must work the hardest to keep water out. However, if the system does not terminate, the challenge of keeping water out is relieved. This can be realized by introducing continuous glazing around each corner of the building or by terminating the head of the system with a curtain wall parapet rather than tying into a different wall assembly. By limiting the perimeter length, the design team can limit potential leak locations and, in turn, limit the quantity of caulk and labor needed, thus reducing cost.

SCHEDULE

Project cost is inevitably affected by project schedule, and design can play key role in the construction time line. In a "Ribbon" design scenario, predecessor trade delays can impact the curtain wall installation time frame. Where as, the "Glass Box" approach lends itself to one trade, uninhibited by other trades' timelines.

SYSTEM COST

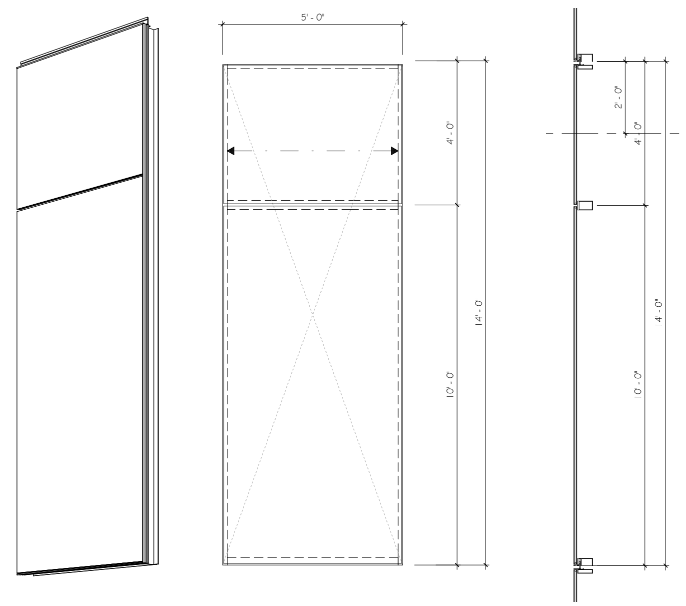
PANEL TYPE + QUANTITY

Understanding the varying types of panels within a system is important to controlling the cost to produce it. Panel types are determined by their location within the system, types and quantity of joints, inclusion or exclusion of specialty items such as extended caps, sunshades or louvers, glass type, and quantity and layout of glass lites.

Controlling the number of unique panels is one way to control cost. The greater the repetition, the greater the savings. Reducing overall panel quantity can also contribute to overall cost savings. This can be achieved by utilizing larger panel sizes while maintaining the same overall area of glass. However, larger panels must be balanced with the quantity of joints, lites, panel engineering, and manufacturing constraints.

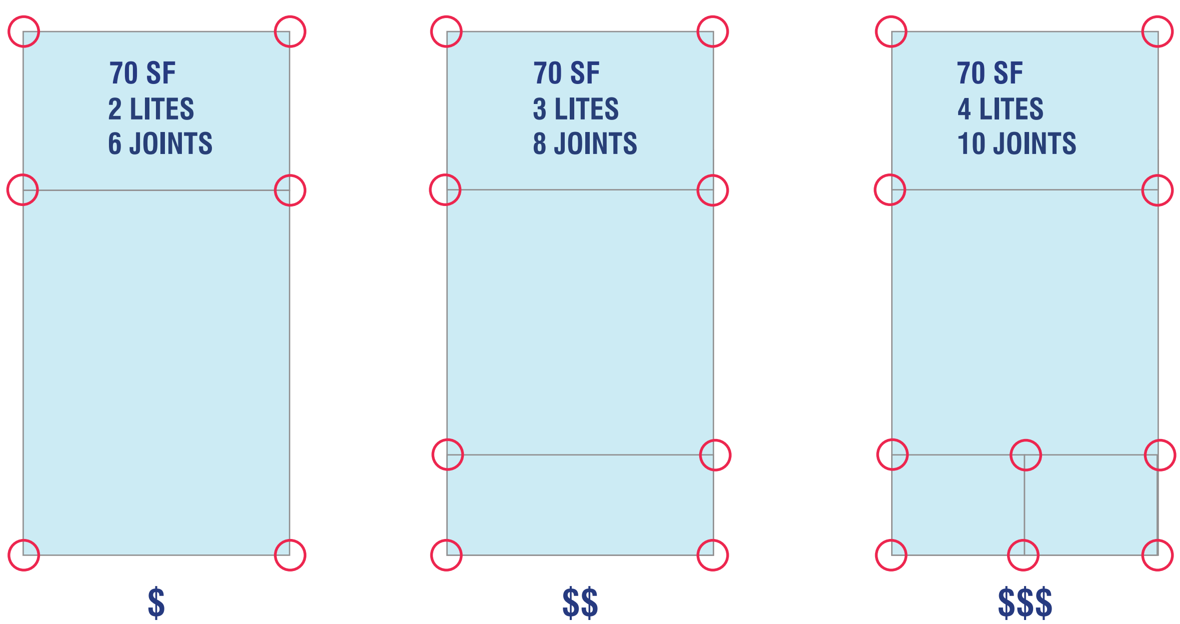
QUANTITY OF JOINTS + LITES

The quantity of joints and lites play a significant role in determining the cost of a specific panel type. Traditional construction square foot pricing does not apply to these panel configurations due to their individual complexities. While each of the three panels below have the same area of glass, the number of joints and lites varies. In the end, more joints = more cost.



“IDEAL PANEL”

Design teams looking to optimize design intent with dollars may consider developing their system around a panel which works well with typical floor-to-floor heights and provides anchor concealment via spandrel glass, while minimizing number of joints and lites. The panel as illustrated above has a typical 5’ width and a 14’ height, broken into two lites (one vision and one spandrel) and six joints.



STRUCTURAL PERFORMANCE

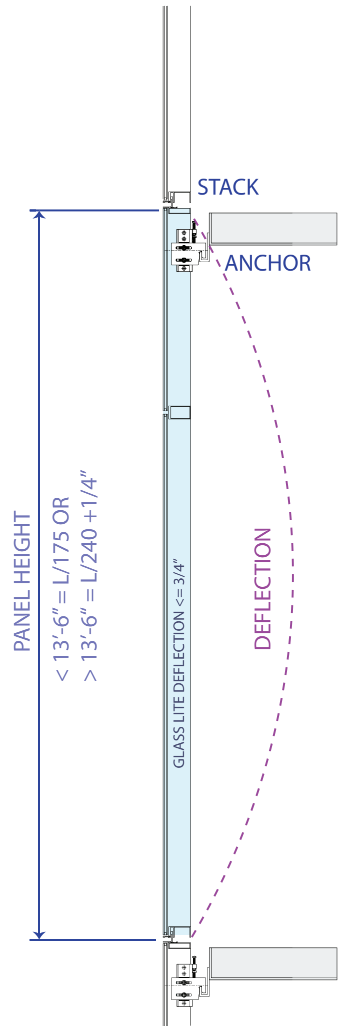
MOVEMENT

Unitized Curtain Wall is designed to resist lateral loads such as wind. The IBC limits the amount of deflection for both the aluminum and glass lites. Panel height (L, in inches), if less than 13'-6", is limited to a deflection of L/175 and if greater than 13'-6" is limited to L/240 + 1/4". Each individual glass lite is also limited to a maximum of 3/4" of deflection along an edge. Thus the panel configuration, dimensions, and anchorage must be balanced to stay within the limitations of both deflection criteria.

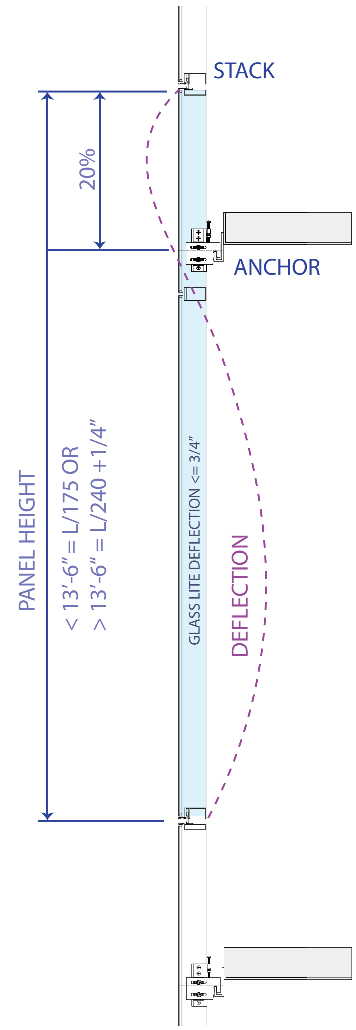
The anchor acts as a pin connection and has zero deflection. By strategically locating the anchors along the y-axis of the panel height, the amount of deflection due to wind loads can be controlled.

When anchors are located at the top and bottom of a panel, the panel is subjected to the maximum possible deflection. However, if an anchor point is mid-span, the amount of deflection is split between the two spans, decreasing the amount of deflection.

In unitized fly-by curtain wall, a good rule of thumb is to locate the anchor point at 20% the length of the panel away from the stack. This location promotes a balance between minimizing deflection and maximizing glass area.

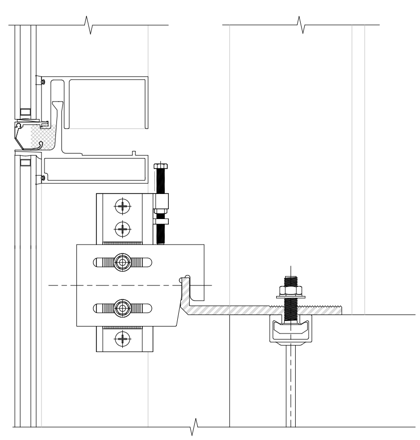


STACK AT FLOOR

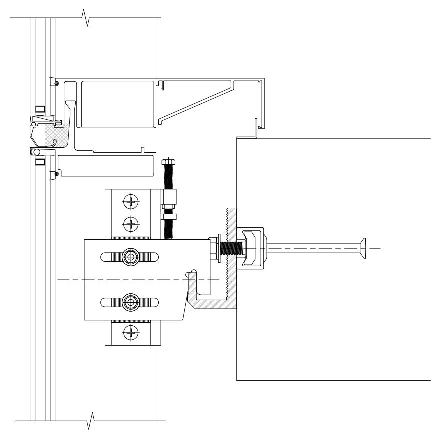


STACK ABOVE FLOOR

BOLTED TOP OF SLAB



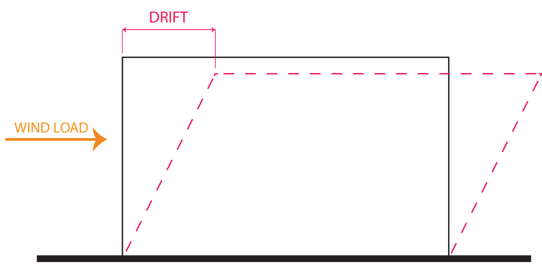
BOLTED FACE OF SLAB



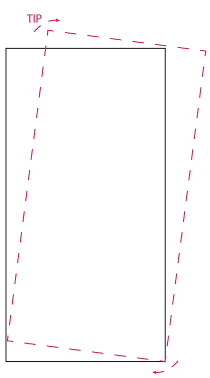
For project specific details, please contact JR Butler

STACK JOINT

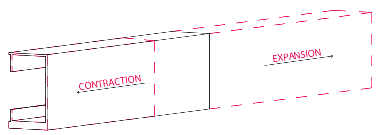
One strategy for accommodating building movement is the sizing of the Stack Joint. Functionally, the Stack Joint is the interlocking connection between panels above and below, but it also provides the space needed for movement between panels. The amount of movement allowed within the Stack Joint is determined by several key factors.



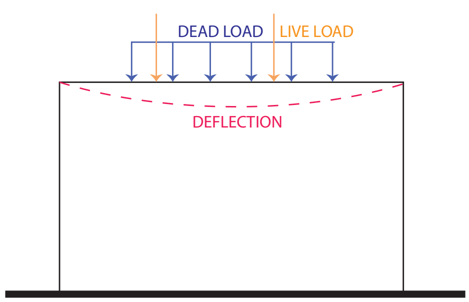
INTER-STORY DRIFT



VERTICAL TIP



THERMAL EXPANSION



LIVE LOAD DEFLECTION

Inter-story or lateral drift is the amount of relative displacement between two consecutive floors caused by lateral (wind or seismic) loads. It can be calculated by dividing the floor-to-floor height by 400, which is the maximum set forth by code. This factor is used in calculating curtain wall Vertical Tip and is also a factor in determining perimeter joint size.

Vertical Tip is the potential for a panel within a unitized system to rotate in the x-y axis. It is largely controlled by the panel's aspect ratio. The shorter and wider the panel is, the greater potential for tip as the building moves. It is calculated by dividing the worst case secenario panel's height by its width and multiplying by the Inter-story Drift.

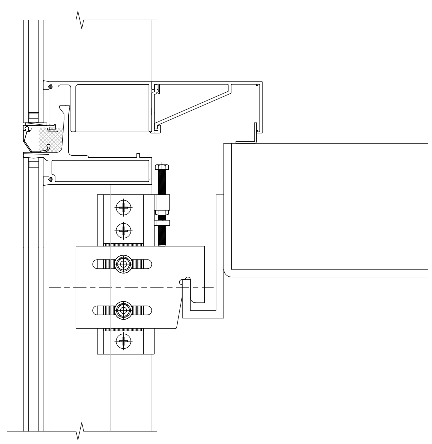
Thermal Expansion/Contraction also plays a part in the movement capacity of the stack joint. This factor is based on the properties of the aluminum extrusions that make up the assembled panel. Aluminum expands/contracts linearly +/- 1/8" every ten feet for every 180 degree change [(0.000013 x 180 x 120")

Live load forces also affect how the building may shift and move. Live loads are any temporary or transient forces (people, furniture, or equipment) that act on a building or structural element. The corresponding deflection due to these loads are controlled by code and are typically calculated by a project's structural engineer.

Total Stack Movement

(Vertical Tip + Live Load Deflection + Thermal Expansion) * AAMA501.7 reduction = Stack Capacity

WELDED FACE OF SLAB



ANCHOR LOCATION

The method of curtain wall attachment is determined by structural conditions and interior finishes. Although typically attached at or near floor lines, factors such as floor-to-floor height, live loads, dead loads, thermal movement and inter-story drift can all impact specific anchorage location. Furthermore, an interior knee wall can aid in covering up some anchoring types. Three typical anchoring conditions are illustrated to the left.

THERMAL PERFORMANCE

Overall curtain wall thermal performance is a function of several components.

Glazing Infill

The glazing infill controls the amount of solar heat (via radiation and conduction) transmitted, as well as, visible light.

Aluminum Frame

Aluminum has a high thermal conductance and the inclusion or exclusion of thermal breaks impacts the amount of heat transmitted.

Sprandrel Areas

The construction behind opaque spandrel areas and the inclusion or exclusion of insulation impacts heat transmittance.

Thermal performance can be assessed by a number of factors.

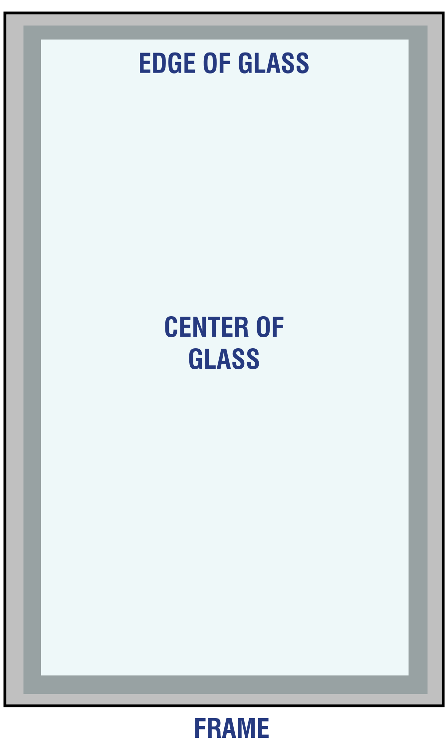
AAMA Condensation Resistance Factor (CRF) is a physical test and rates the relative performance with regards to condensation formation on the interior surfaces of a product. It is based on a dimensionless scale generally in the range of 30 – 80 with a higher number representing a greater resistance to condensation formation.

NFRC Condensation Resistance (CR)
Scale of 0-100, a higher number represents a greater resistance to condensation. Unlike the AAMA CRF, the CR is determined with a software simulation.

U-Value is the rate of conductive heat loss through a given assembly. It can be determined by a standard test, the NRFC 100. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating properties. U-Value is expressed as a number between 0 and 1.

Assembly U-Value is the "area weighted" average thermal transmittance of all components. It can be calculated as shown below.

$$\frac{\left(U_{\text{FRAME}} \times U_{\text{FRAME AREA}}\right) + \left(U_{\text{EOG}} \times U_{\text{EOG AREA}}\right) + \left(U_{\text{COG}} \times U_{\text{COG AREA}}\right)}{\text{TOTAL AREA}} = \text{ASSEMBLY U-VALUE}$$



Three components are used to calculate the Assembly U-Value

Center of Glass
Typical value 0.29 BTU/ ft^2-hr-°F
(low-e IGU)

Edge of Glass
Typical value 0.34 BTU/ ft^2-hr-°F
(aluminum spacer)

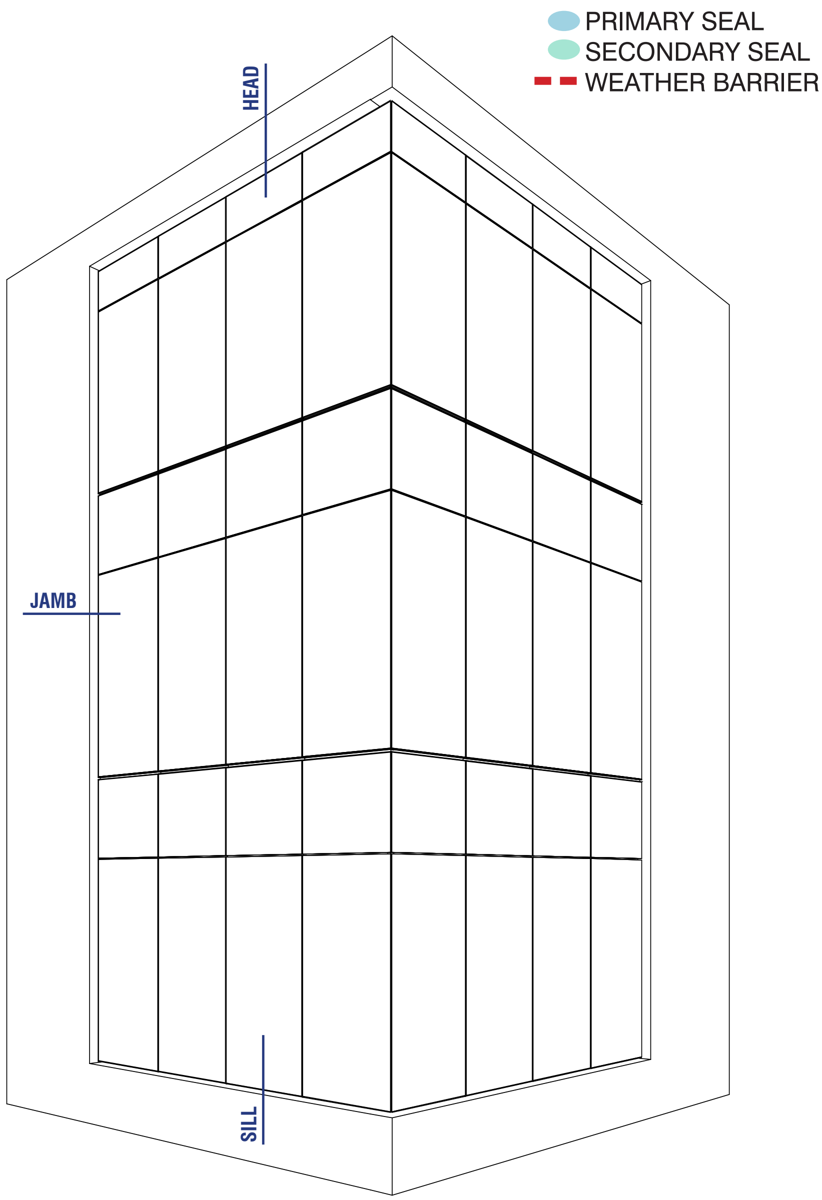
Frame
Typical value 0.90 BTU/ ft^2-hr-°F
(thermal break)

Area and configuration can significantly affect the Assembly U-Value. As a lite size changes, the ratios of each component change. If a lite size is decreased, the COG (the best performing component) decreases, while the lower performing Frame increases, thus decreasing the overall assembly U-Value.

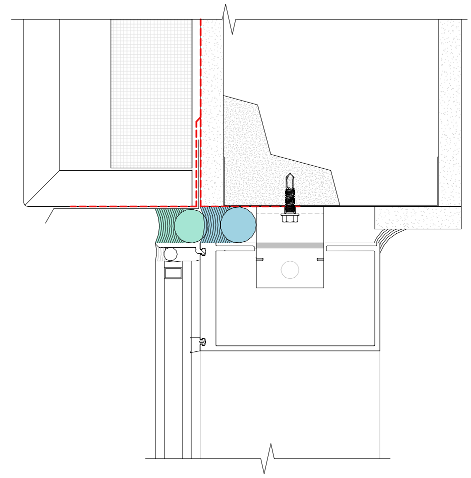
PERIMETER JOINTS

Maintaining a continuous air/water barrier at the perimeter of the system provides the most resistance to air and water infiltration. This is achieved by careful detailing of glazing units, frame construction, system drainage, weatherstripping, gaskets, and sealants, both internal to the system and at perimeter primary seals. Water infiltration is lab tested via ASTM E331, while air infiltration is lab tested via ASTM E283. These standard testing procedures govern the rate at which air and water can penetrate the system at given levels of applied pressure.

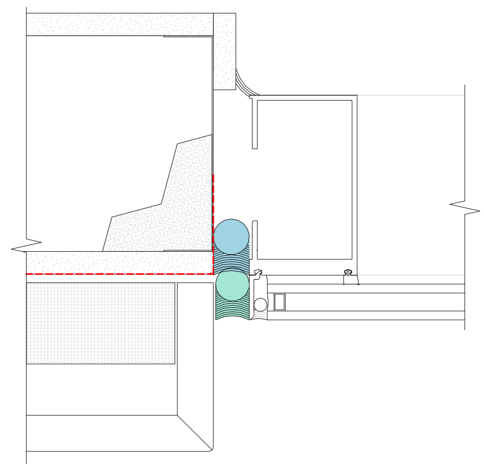
The water line is maintained by the primary seal, which is between the weather barrier of the building and the water line (shoulder) of the system.



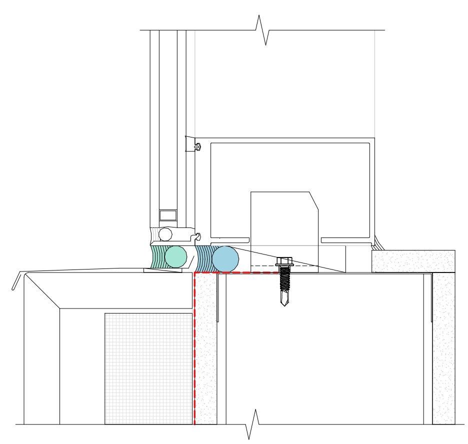
HEAD DETAIL



JAMB DETAIL



SILL DETAIL



AIR/WATER PERFORMANCE