Hurricane Resistant Glazing Systems

How to Ensure Installation of a Safe and Secure Building Envelope

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ASCE | KNOWLEDGE & LEARNING

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- Bachelor of Science in Architectural Engineering from the University of Miami.
- President/Founder of DLG Engineering, Inc., a structural consulting firm based in South Florida.
- 20 years experience consulting in the glazing field.
- Presented on hurricane design of glazing systems to:
  - Florida Structural Engineers Association
  - ATC-SEI 2012 Advances in Hurricane Engineering Conference
- Written articles on:
  - “Allowable Strength of Glass: How to Design Safely for Today’s Threats” (US Glass Magazine, July 2010)
  - “Growing Awareness: Changes in ASCE 7-10 to Affect Hurricane-Prone Regions” (Architects’ Guide to Glass & Metal, December 2011)

Learning Outcomes

- Learn how to properly read glazing shop drawing.
- Understand the limitations of hurricane resistant glazing systems.
- Learn to identify if the building substrate is adequate to support the loads imposed by the glazing system.
- Know the limitations of a glazing inspector and when it is proper to consult with the delegated engineer.
- Be able to identify and understand all of the critical facets needed to ensure a safe installation.
- Learn how to write a proper inspection report and statement of inspection.

HURRICANE ANDREW (1992)

http://www.magazine.noaa.gov/stories/mag205.htm

http://www.noaanews.noaa.gov/stories/s966.htm

http://www.floridamemory.com/items/show/133761

Topics:

1. Glazing Terminology
2. Products and Technologies
3. Product Certifications and Testing
4. Shop Drawings
5. Responsibilities and Limitations of Inspectors
6. Identifying Deficient Installations
7. Preparing Inspection Reports
8. Examples of Deficient Installations

1. Glazing Terminology

Active Leaf - Usually the first operating leaf in a door having a pair of leaves; the leaf to which the latching or locking mechanism is attached.

ADA Threshold - A wheelchair-accessible door threshold. This type of threshold is not to exceed 3/4" in height for exterior sliding doors or 1/2" for other types of doors.

Air Infiltration - The amount doors (the lower, the better) of air leaking in and out of a building through cracks in walls, windows.

Alloy - A composition of two or more metals to obtain a desired property.

Annealed Glass - Glass that has not been heat-treated and is essentially strain free; often referred to as " float glass."

Anodize - A process that provides a hard durable oxide film on the surface of aluminum. This coating can produce coloring and finishing that both protects and beautifies the aluminum.

Arch Window - Half-circle picture window.

Astragal - The center member of a double door, which is attached to the fixed or inactive door panel.

Awning Window - A type of window with a top-hinged sash that swings out at the bottom.

Back Bedding - The process of adhering and sealing glass to a frame or sash.

Backer Rod - A round, compressible material, either open or closed cell, that's placed into voids between materials to insulate and allow a backing for the application of sealant.

Baffle - A material used in windows and doors to impede the flow of water or air into the framing system through weep slots.

Balance - A mechanical device (normally spring-loaded) used in single- and double-hung windows as a means of counterbalancing the weight of the sash during operation.

1. Glazing Terminology (cont.)

Bay Window - A composite of three windows, usually made up of a large center unit and two flanking units at 30- or 45-degree angles to the wall. A bay projects from the wall of the structure.

Bead - A molding or stop placed around a window frame to hold the glass in place by pressure.

Bite - Distance by which the inner edge of the aluminum frame glazing pocket or stop overlaps the glass. Also termed purchase, edge cover or engagement.

Bituminous Paint - A low-cost paint containing asphalt or coal tar used to isolate aluminum from mortar, concrete or masonry.

Bottom Rail - The bottom horizontal member of a window sash.

Brake Metal Shape - Aluminum sheet stock bent or "broken" to desired shape, as required by specific job conditions, on a power or manual press brake. This shape is often used to cover conditions which cannot be covered by a stock extruded aluminum shape.

Butt Hinge - A hinge designed for application to the edge of a door consisting of two rectangular metal plates joined together with a pin.

Cantilever - A beam, girder or truss overhanging one or more supports.

Casement Window - The whole sash swings in or out from the jamb of the window and it either uses a crank-out system or a friction system of operation. It's the best window choice for catching breezes and providing cross-ventilation.

Casing - Exposed molding or framing around a window or door, on either the inside or outside to cover the space between the window frame or jamb and the wall.

Caulking - Sealants used to seal fixed and movable construction joints to prevent infiltration.

Cladding - An exterior covering or skin applied to framing or a structure for aesthetic or protective purposes.

Countersink - To form a depression to fit the conic head of a screw or the thickness of a plate so that the face will be level with the surface.

Curtain Wall (Aluminum) - An exterior building wall which carries no roof or floor loads and consists of a combination of aluminum, glass and other surfacing materials supported by the aluminum framework.

Daylight Transmittance - The percentage of visible light that glazing transmits through a window – a standard clear dual pane without considering whether a window frame has a daylight transmittance of 82%.

Deflection - The measure of movement of a member from its static position when subjected to loads.

Design Load - The project wind load to be determined by the architect and expressed in psf. Windows ratings are determined using AAMA 101/I.S.2/A440-05.

Door Closer - A device or mechanism to control a door during its opening and closing cycle; may be overhead or floor mounted and either exposed or concealed.

Door Frame - An assembly of members, consisting of jambs and a header, into which a door or doors fit when closed. The door frame may also include transom lights and adjacent sidelights. Also see Threshold.

Door Handing - Determined by placing your back to the hinge jamb. If the door swings to your left it is a left-handed door.

Door Jamb - One of two vertical members of a door frame. The hinge jamb is the jamb to which the hinges or pivots are mounted; the lock jamb is the jamb at the leading edge of the door where a lock bolt may be engaged.

Door Opening - The opening dimension of a doorway is measured from inside of jambs and from floor line to underside of frame header. The opening size is usually the nominal door size and is equal to the actual door size plus clearances and threshold height.

Door Size (Actual) - The actual width and height of the swing door leaf.

Door Size (Nominal) - See Door Opening.

Door Stop - a) A molding or projecting element on a door frame which overlaps the edge of a door, causing it to stop in its closed position. b) A bumper mounted on the floor or wall to limit the extent of the door opening. c) An accessory feature of a door holder.

Double Glazing - In general, two thicknesses of glass separated by an air space within an opening to improve insulation against heat transfer and/or sound transmission. In factory-made double-glazing units, the air between the glass sheets is thoroughly dried and the space is sealed airtight, eliminating possible condensation and providing superior insulating properties.

Double-Acting Door - A door equipped with hardware that permits it to swing in both directions from the plane of its frame.

Double-Hung Window - A window consisting of two sashes operating in a rectangular frame, in which both the upper and lower halves can be slid up and down. A counterbalance mechanism usually holds the sash in place.

1. Glazing Terminology (cont.)

Double-Strength Glass - Sheet glass between 0.115" and 0.133" (33.38 mm) thick.

Dry Glazing - A method of securing glass in a frame that uses pre-formed resilient gaskets instead of a wet sealant or glazing compound.

Egress Window - A window meeting certain size requirements for egress. The size is determined by national or local building codes. Typically, the rule is 5.7 sq. ft. of clear opening, 20" minimum clear width and 24" minimum clear height.

Electrolysis - Chemical decomposition of a metal surface by the action of dissimilar metals and moisture.

End Dam - Used to close the ends of a subsill, so water will not leak out of the ends. It makes the subsill a complete water trough allowing it to collect excess water and drain it to the exterior.

Exterior Glazing - A method in which glass is secured in an opening from the exterior of the building.

Extruded Aluminum Shapes - There are two basic types of extruded shapes: Solid Extrusion - Any extruded shape other than a hollow or semi-hollow shape. Semi-Hollow Extrusion - An extruded shape where any part of the cross section partially encloses a void. The area of the void bears a fixed ratio to the square of the gap as shown in published tables developed by the Aluminum Association.

Facade - The exterior face of a building, especially the principal face.

Fenestration - The arrangement and proportion of window and door openings in a building.

Finish Hardware - Exposed hardware such as hinges, pivots, locks, etc. that has a finished appearance as well as a function used with doors and windows.

Fixed Panel - An inoperable panel of a sliding glass door or slider window.

Fixed Window - Fixed windows are not intended to open for ventilation or egress. There are no moving parts, hinges or latches. They consist of a glazed frame or a fixed sash and frame. Fixed windows are usually more air tight than windows that open. Also called Picture Window.

Flange Frame - A window frame with the head, jamb, and sill exterior perimeter leg longer than the interior perimeter leg. Also called Flush Fin.

Flashing - Sheet Material that bridges and protects the joint (gap) between the window or door frame members and the adjacent construction for the purpose of preventing water penetration by draining water away from the window or door.

Flush Bolt - A pair of rods or bolts that are mounted flush with the edge or the face of the inactive door to lock the door to the frame at head and/or sill. A flush bolt mounted in the edge is operated by means of a recessed lever.

Flush Glazing - Glazing in which glass is set in a recess in the aluminum frame; stops are also recessed; the glazing is flush with the frame surface. These systems are also called Pocket Glazed and Center Glazed.

Framing - An assembly of structural aluminum extrusions consisting of a jamb, vertical mullion, intermediate horizontal, header and sill which are fitted together to form a structure into which glass or other infill material is installed.

Fully Tempered Glass - Glass that has been heated and quenched in a controlled operation to provide a high level of surface compression. ASTM Standard C 1048-85 specifies that the surface compression be a minimum of 10000 psi. Generally considered to have four times the strength of annealed glass and two times the strength of heat-strengthened glass.

Glass Stop - A glazing bead that is either applied to or is an integral part of the framing system. **Glazing** - The act of furnishing or fitting with glass.

Glazing Bead - A light member applied to a frame or door stile or rail to hold glass or infill in a fixed position.

Head or Header - The horizontal frame member which forms the top of a frame.

Heat-Strengthened Glass - Glass that has been heated and quenched in a controlled operation to provide a degree of surface compression. ASTM Standard C 1048-85 specifies that the surface compression be between 3500 and 10000 psi. Generally considered to have two times the strength of annealed glass.

Horizontal Slider - HS have two or more sash (panels) within a frame. They may have one moving and one fixed sash (XO or OX), two moving sash on either side of a fixed sash (XOX), or two adjacent sash may slide by each other (XX). Most have rollers to ease operation.

Inactive Door or Leaf - The last door of a pair of doors to be released when unlocking, usually the one not equipped with a primary lock.

Insulating Glass Unit (IG) - An integral glass unit made up of two or three individual lights of glass separated by an air space.

Integral Mullion - A frame member trapped within the master frame to separate vents or fixed glass.

Interior Glazing - A method in which glass is secured in an opening from the interior of the building.

1. Glazing Terminology (cont.)

Interlock - An upright frame member of a panel in a sliding window or sliding glass door which engage with a corresponding member in an adjacent panel when the window or door is closed. Also called Interlocking Stile.

Jamb - The end vertical member of an aluminum framing system which terminates at the intersection of a wall. It is often referred to as a wall jamb.

Laminated glass - Two or more sheets of glass with an inner layer of transparent plastic to which the glass adheres if broken. Used for safety glazing and sound reduction.

Leaf - An individual door used either in a single or multiples (leaves).

Light or Lite - A separately framed piece of glass in a window or door. Sometimes spelled 'Lite." A single (monolithic) glass pane or piece.

Lintel - A horizontal structural member that spans an opening at the head to carry the weight of construction above the opening.

Medium Stile - See Stile.

Meeting rail - The part of a sliding glass door, a sliding window, or a hung window where two panels meet and create a weather barrier.

Meeting Stile - The stiles of the active and inactive leaves which meet when a pair of doors is closed.

Mill Finish - The original finish of aluminum before finishing.

Mullion - A major structural vertical or horizontal member between window units or sliding glass doors.

Muntin - A secondary framing member used to hold panes within a window, window wall or glazed door.

Narrow Stile - See Stile.

Neoprene - A synthetic rubber having physical properties closely resembling those of natural rubber but not requiring sulphur for vulcanization. Extremely good weather resistance (both heat and cold) with ultraviolet stability. Commonly used for commercial glaze.

Obscure Glass - Any textured glass (frosted, etched, fluted, ground, etc.) used for privacy, light diffusion, or decorative effects.

Operable Window - Window that can be opened for ventilation.

Pane - One of the compartments of a door or window consisting of a single sheet of glass in a frame; Also, a Sheet of Glass.

Panel - A major component of a sliding glass door, consisting of a light of glass in a frame installed within the main (or outer) frame of the door. A panel may be sliding or fixed.

Patio Doors - Sliding glass doors, often used for access to a deck or terrace.

Picture Window - A large, fixed window framed so that it is usually, but not always, longer horizontally than vertically to provide a panoramic view.

Polyvinylchloride (PVC) - An extruded or molded plastic material used for window framing and as a thermal barrier for aluminum windows.

Projected Window - A window fitted with one or more sashes opening on pivoted arms or hinges. Refers to casements, awnings, and hoppers.

PSF (Pounds Per Square Foot) - A measurement of air pressure used in window testing, e.g., 1.56 psf (25 mph) or 6.24 psf (50 mph).

Rail - A horizontal member located at the top and bottom of a window or door.

Rough Opening - The opening in a wall into which a door or window is to be installed.

Soffit - The exposed undersurface of any overhead component of a building, such as an arch, balcony, beam, cornice, lintel, or vault.

Spandrel - Opaque glazing material most often used to conceal building elements between floors of a building, so they cannot be seen from the exterior.

Steel Reinforcing - A steel component placed within a vertical mullion to add stiffness and increase the windload capability of the system. Steel reinforcing may also be used to limit deadload deflection in intermediate horizontals.

Stiffener - A reinforcing member which serves to limit the deflection of the member to which it is attached.

Stile - A vertical member of a window or door, exclusive of applied glazing beads. Stiles are usually designated by function, such as lock stile, hinge stile or meeting stile.

Stop - The molding on the inside of a window frame against which the window sash closes; in the case of a double-hung window, the sash slides against the stop. Also used to describe a glazing bead.

1. Glazing Terminology (cont.)

Subsill - An aluminum extruded profile installed beneath the primary sill of a framing system specifically designed to function as a secondary defense for collecting infiltrated water which is then weeped to the exterior.

Sweep Strip or Door Sweep - A weatherstrip mounted at the top or bottom edge of a swing door.

Swing - The direction a swing door opens. Also see Hand of Door.

Temper (Aluminum) - Process used to bring a proper degree of hardness or elasticity by heat treatment. T5 - Artificially aged to improve mechanical properties and stability. T6 - Solution treated and artificially aged to improve the allowable stresses and consequently the capacity to resist greater movements.

Tempered Glass - Strong, break-resistant glass created in a secondary process via controlled air cooling of the heated glass. Tempered glass is four times stronger than annealed glass; a form of safety glazing. When shattered, it breaks into small pieces.

Tempering - Strengthening glass with heat and controlled air cooling.

Thermal Expansion and Contraction - An increase in the dimensions of a material in direct proportion to the rise in its temperature and conversely a dimensional shrinking as a result of a drop in temperature.

Threshold - The member that lies at the bottom of a sliding glass door or swinging door; the sill of a doorway.

Throw - The distance which a lock bolt or latch bolt projects when in the locked position.

Tinted glass - Glass colored by incorporation of a mineral admixture. Any tinting reduces both visual and radiant transmittance.

Transom Bar - The horizontal frame member (header) which separates the door opening from the transom.

Transom Window - The window sash located above a door. Also called transom light.

Vent - The operating portion of a window that slides, swings or projects in or out.

Vestibule - A small entrance hall or passage between the outer door and the interior of a building.

Vinyl - Polyvinyl chloride material, which can be both rigid or flexible, used for window frames.

Weatherstripping - A strip of resilient material for covering the joint between the window sash and frame in order to reduce air leaks and prevent water from entering the structure.

Wedge Glazing - A flexible, continuous gasket that ensures a high-compression seal between the glass and glazing bead by applying pressure.

Weep Hole - A small opening in a wall or window sill member through which water may drain to the building exterior.

Windload - Force exerted on a surface by moving air.

Window - A glazed opening in an external wall of a building; an entire unit consisting of a frame sash and glazing, and any operable elements

2. Products and Technologies

- Windows
- Doors
- Storefront
- Curtain Walls
- Sky Lights
- Railings

- Glass
- Aluminum
- Anchors
- Substrate
- Structural Silicone
- Glass Interlayer

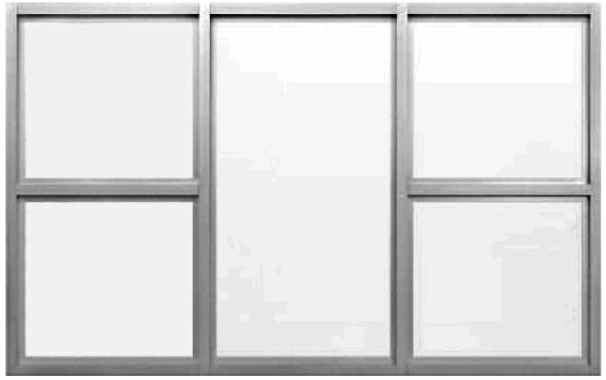
2. Products and Technologies (cont.)



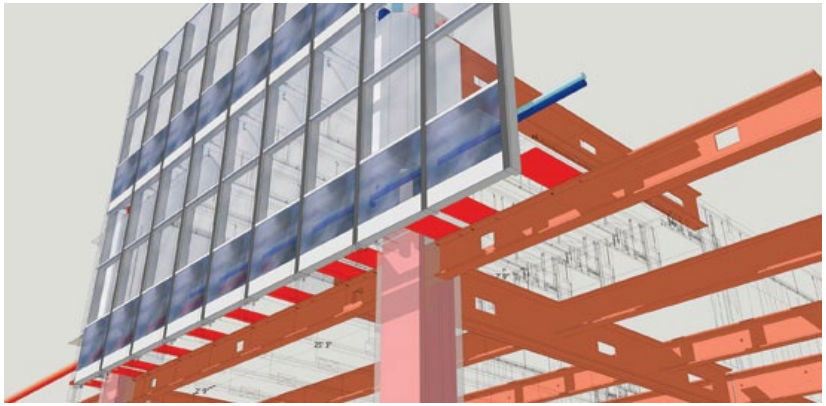

Windows


Doors

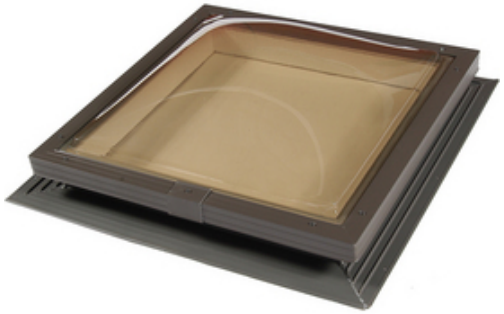
2. Products and Technologies (cont.)



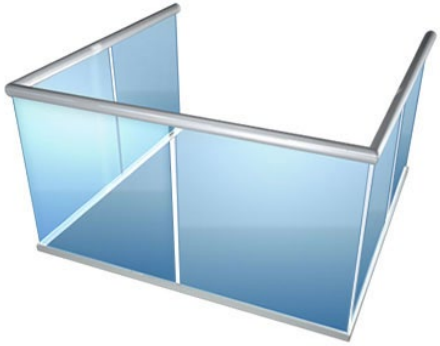
Window Walls & Storefronts



Curtain Walls



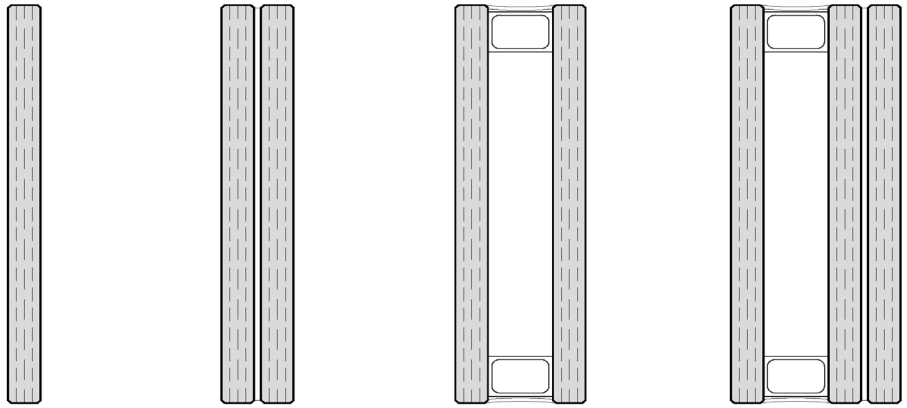
Skylights



Railings

2. Products and Technologies (cont.)
Glass

- Glass Types:
  - Monolithic:
    - Annealed
    - Heat Strengthened
    - Tempered
  - Laminated
  - Insulated
  - Insulated-Laminated

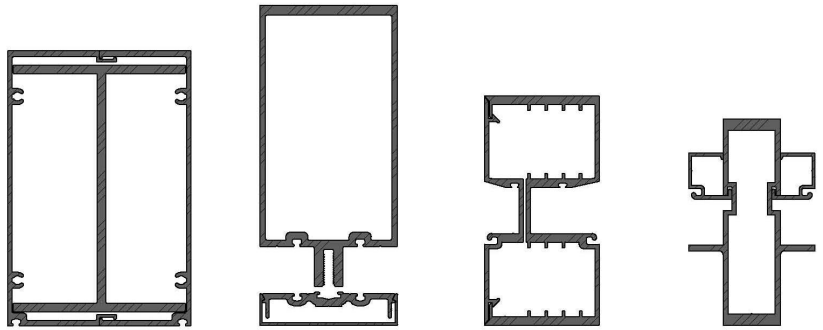


- Glass Strength Factors
  - **Annealed 1.0**
  - **Heat Strengthened 2.0**
  - **Tempered 4.0**

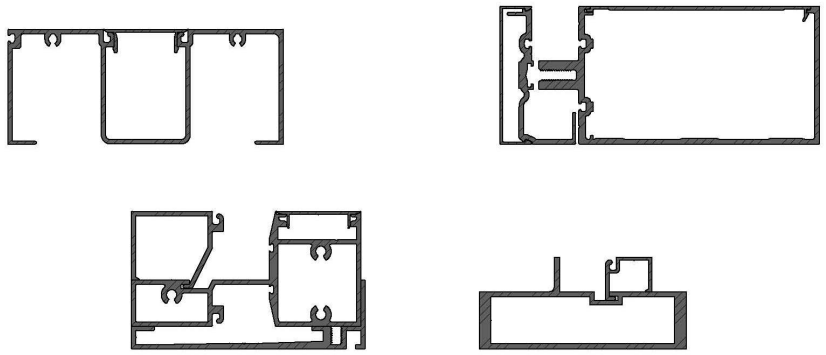
2. Products and Technologies (cont.)
Aluminum

- Typical Alloys:
  - 6063-T5, 6063-T6
  - 6061-T6
  - 6005-T5

- Allowable Strength
  - Non-Welded:
    - 9.5 Ksi (6063-T5)
    - 19.0 Ksi (6061-T6)
  - Welded:
    - 4.8 Ksi (6063-T5)
    - 9.0 Ksi (6061-T6)



MULLION EXTRUSIONS

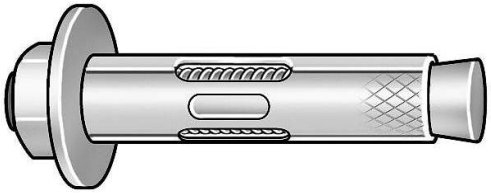


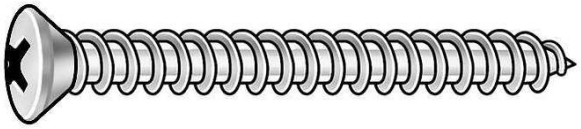
SILL EXTRUSIONS

Protection against Interaction with dissimilar materials is important

2. Products and Technologies (cont.)
Anchors

- Fasteners Types:
  - Mechanical
  - Wedge
  - Sleeve
  - Sheet Metal
  - Self Tapping
  - Lag
- Load Reduction Factors:
  - Edge Distance
  - Spacing
  - Embedment
  - Load Path
- Load Types:
  - Shear
  - Tension
  - Bending
  - Prying



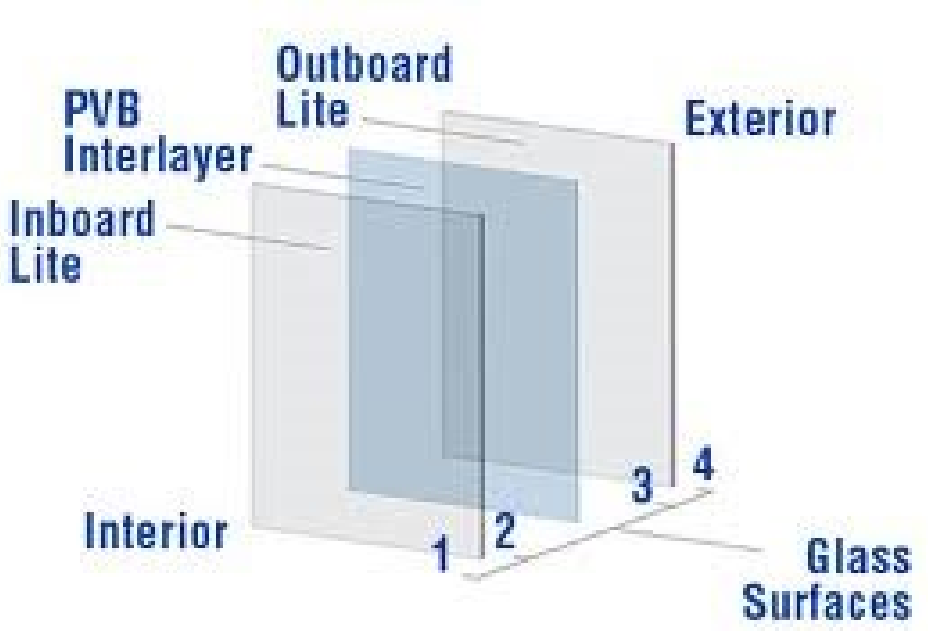


2. Products and Technologies (cont.)
Substrate

- Substrate Types:
  - Wood Bucks
  - Metal Studs
  - Hollow Masonry Block
  - Filled Masonry Block
  - Stone or Brick Veneer
  - Steel Frame
  - Concrete
  - Wood Frame

2. Products and Technologies (cont.)
Glass Interlayer

- Interlayer types:
  - **Ethyl Vynyl Acetate (EVA)**
  - **Poly Vinyl Butyral (PVB)**
  - **Sentry Glass Plus (SGP)**



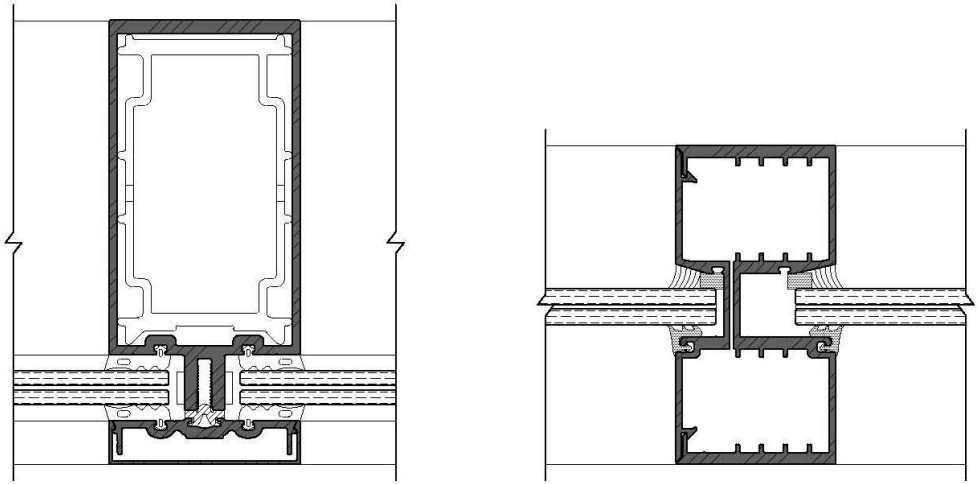
The glass interlayer is what bonds the individual glass sheets together to form a laminated glass panel.

2. Products and Technologies (cont.)
Structural Silicone

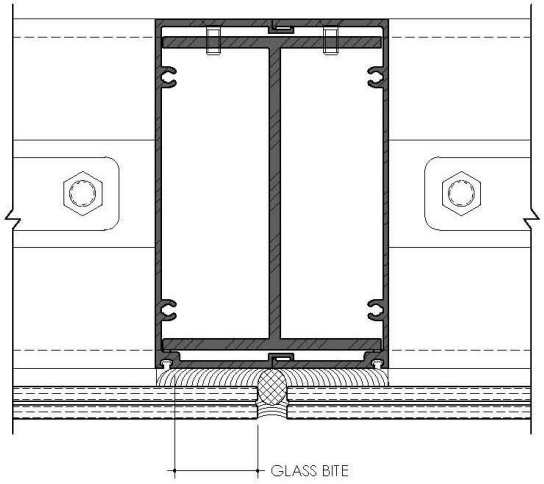
- Structural Silicone Applications:
  - Captured Systems
  - Structural Silicone Systems

- Allowable Strength:
  - **Wind Load: 20 psi**
  - **Dead Load: 1 psi**

- Glass Bite:
  - Refers to penetration of the glass into the frame pocket for captured systems or the contact width in common with the glass and aluminum for structural silicone systems.



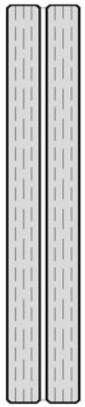
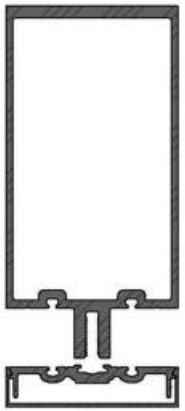
Captured System



Structural Silicone System

2. Products and Technologies (cont.)
The Critical Load Path

The critical facets of impact resistant glazing system installations is in ensuring that the load path remains unbroken.

Each of the materials mentioned prior have a critical task to perform in order for the product to perform it's intended task.

2. Products and Technologies (cont.)
The Critical Load Path

The GLASS absorbs the first wind load forces and must be sufficiently strong to transfer those forces to the aluminum frames.

The ALUMINUM FRAMES must absorb the load from the glass and transfer them to the anchors.

The ANCHORS must transfer the forces imposed on it by the frame to the building substrate.

The SUBSTRATE must take the entirety of the force and transfer it safely to the main building structure.

2. Products and Technologies (cont.)
The Critical Load Path

ISSUES TO CONSIDER

The GLASS:
Type, Impact Rating, Size, Thickness, Interlayer, Silicone. location.

The ALUMINUM FRAMES:
Shape, Alloy, Thickness, Internal Reinforcing, Assembly, Welds.

The ANCHORS:
Type, Configuration, Edge Distance, Spacing, Embedment, Prying, Bending.

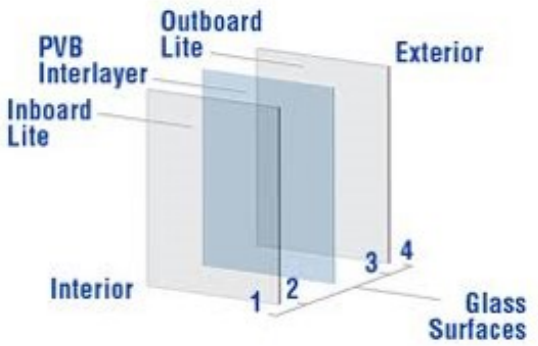
The SUBSTRATE:
Reduced Anchor Capacities, Buckling, Concrete Burst Out, Penetration, Joints, Bracing, Backing.

2. Products and Technologies (cont.)
The Critical Load Path

The glass is also burdened with two important and critical tasks that make a glazing system hurricane resistant.

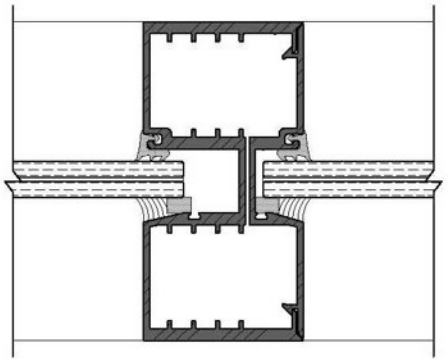
1. The glass must absorb impacts from wind borne debris and still maintain its integrity and protect the building envelope.

This is done via the GLASS INTERLAYER.



2. The glass once shattered by impact must remain secured to the aluminum frames as to not allow wind, water or debris from entering the envelope.

This is done via the STRUCTURAL SILICONE.



2. Products and Technologies (cont.)
The Critical Load Path
The Building Substrate

This is an area much neglected by delegated engineers in shop drawings when they rely on information provided to them by the contractors.

However, it is one of the most critical aspects of ensuring a successful load path transfer has been created.

Substrate conditions to consider can include:

- **Wood Bucks**
- **Metal Studs**
- **Hollow Masonry Block**
- **Filled Masonry Block**
- **Stone or Brick Veneer**
- **Steel Frame**
- **Concrete**
- **Wood Frame**

2. Products and Technologies (cont.)
The Critical Load Path
The Building Substrate

IS THE SUBSTRATE ADEQUATE TO TRANSFER THE LOAD TO THE BUILDING STRUCTURE?

- **WOOD BUCKS: 1x, 2x, full depth, wood values, connection**
- **METAL STUDS: gage, backing, bracing, buckling**
- **HOLLOW MASONRY BLOCK: anchor reductions, tools, joints**
- **FILLED MASONRY BLOCK: anchor location, edge dist., anchor reductions**
- **STONE OR BRICK VENEER: capacity, anchor values**

3. Product Certifications and Testing

MIAMI-DADE COUNTY, FLORIDA
DEPARTMENT OF REGULATORY AND ECONOMIC RESOURCES
PRODUCT CONTROL SECTION

CHECKLIST #0205 FOR THE APPROVAL OF:
CURTAIN WALLS, WINDOW WALLS & STOREFRONTS

- Basic Requirements Checklist.
- One set of the manufacturer's 'approval document'.
- Calculations verifying structural results of the tested structure including:
  a. Aluminum stresses according to the Aluminum Association Specification,
  b. Steel stresses according to the AISC Manual,
  c. Deflection for load carrying members not to exceed L/180, and
  d. Fasteners and connectors.
- One set of manufacturer's design drawings marked and verified by the testing laboratory.
- Letter from adhesive manufacturer certifying the compatibility of glazing components. (See note 2.)

The following current laboratory tests and test reports in compliance with protocol TAS 301.

- Impact test per TAS 201 & 203. (Applicable if product is impact resistant.)
- Air infiltration test, per TAS 202.
- Uniform static air test, per TAS 202.
- Water resistance test per TAS 202.
- Minimum sample of 1% of the glazed system tested. (See note 2.)
- Thermal Transmittance (U-factor) per checklist G.8 (See note 4)
- Solar Heat Gain Coefficient (SHGC) per checklist G.9 (See note 4)

http://www.miamidade.gov/development/products/control-forms.asp#Other

3. Product Certifications and Testing (cont.)

- TAS 201:
  - Large Missile Impact **(Wood 2x4)**
  - Small Missile Impact **(30 Steel Balls)**
- TAS 202: Uniform Load Test, Air and Water Infiltration
- TAS 203: Cyclic Loading: **9000 total cycles**

3. Product Certifications and Testing (cont.)

Product Approvals:

Just because a product has a certification or product approval does not mean it is acceptable for use on all projects

Some limitations include:

- Design load
- Glass areas
- Different levels or reinforcement
- Water Infiltration

4. Shop Drawings

A COMPLETE SET OF SHOP DRAWINGS SHOULD INCLUDE:

1. The Design Criteria
2. General Notes
3. Product Information
4. Building information
5. Product Elevations
6. Product Installation Details

4. Shop Drawings (cont.)

1. The Design Criteria:
    - Applicable Code
    - Referenced Standards
    - Design Criteria used to determine the wind loads
    - Material Properties
    - Deflection Criteria

4. Shop Drawings (cont.)

2 The General Notes:

- Anchors
- Steel and Aluminum Grades and Alloys
- Welding
- Wood Bucks
- Metal Studs
- Maximum Shimming
- Notes to contractor

4. Shop Drawings (cont.)

3 Product Information

- Manufacturer name and series
- Product approval number
- Impact rating
- Glass type and thickness
- Interlayer type and thickness

4. Shop Drawings (cont.)

4. Building Information
    - A well detailed plan
    - Identification of Corner Zones
    - Building Sections
    - Building Elevations

4. Shop Drawings (cont.)

5. Product Plan and Elevations

- Product Approval Number
- Design Wind loads
- Complete Dimensions
- Anchor layout
- Detail callouts

4. Shop Drawings (cont.)

6. Product Installation Details

- Head, Sill, Jamb and Mullion details
- Internal reinforcing if required
- Anchor type, embedment, spacing and edge distance limitations
- Substrate conditions

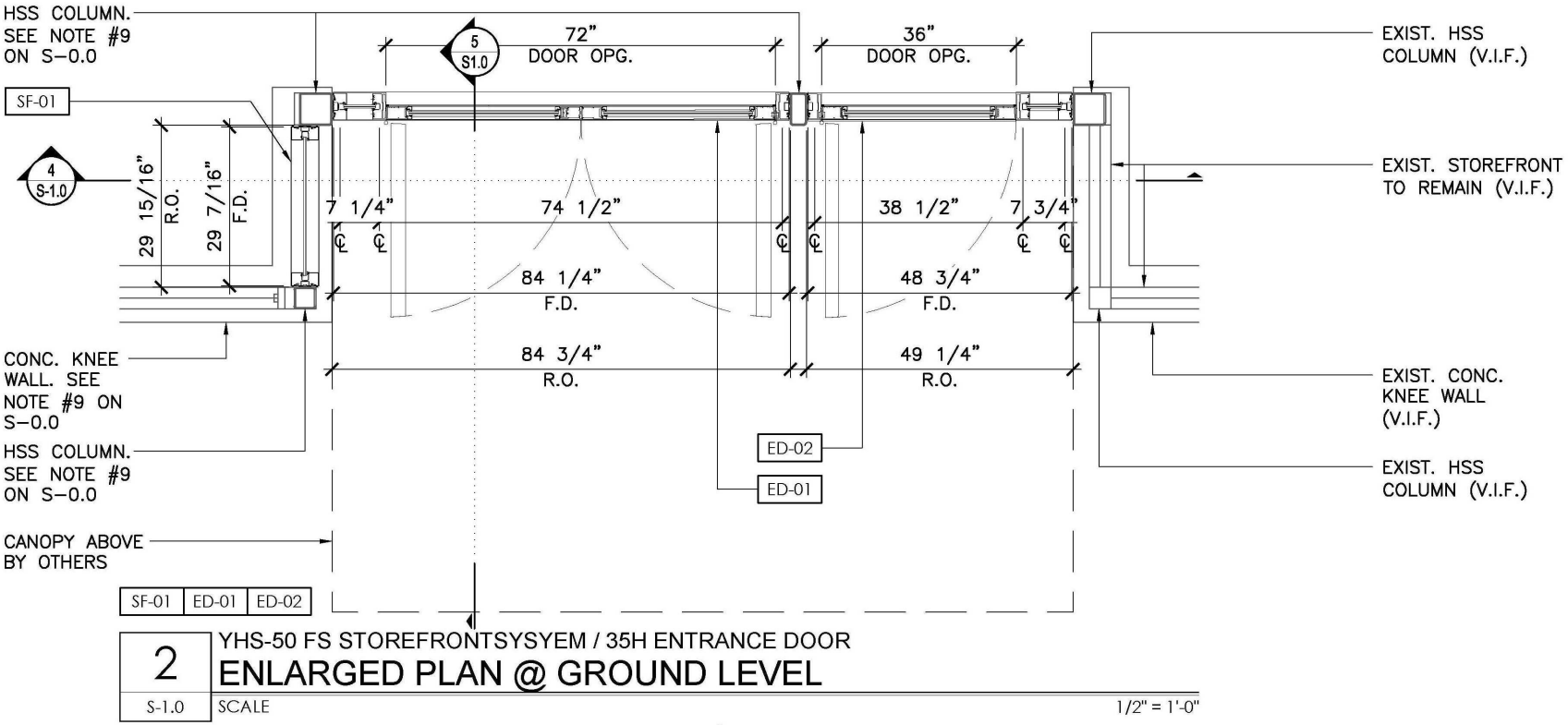
4. Shop Drawings (cont.)

1. Study the shop drawings carefully and methodically in the office
   - Spend enough time so that you understand full scope of the inspections

2. Do not ignore the non-detail or non-drawing oriented information
   - General Notes
   - Product Information
   - Building Information

3. Go from large to small details
   - Plan
   - Elevation
   - Details

4. Shop Drawings (cont.)

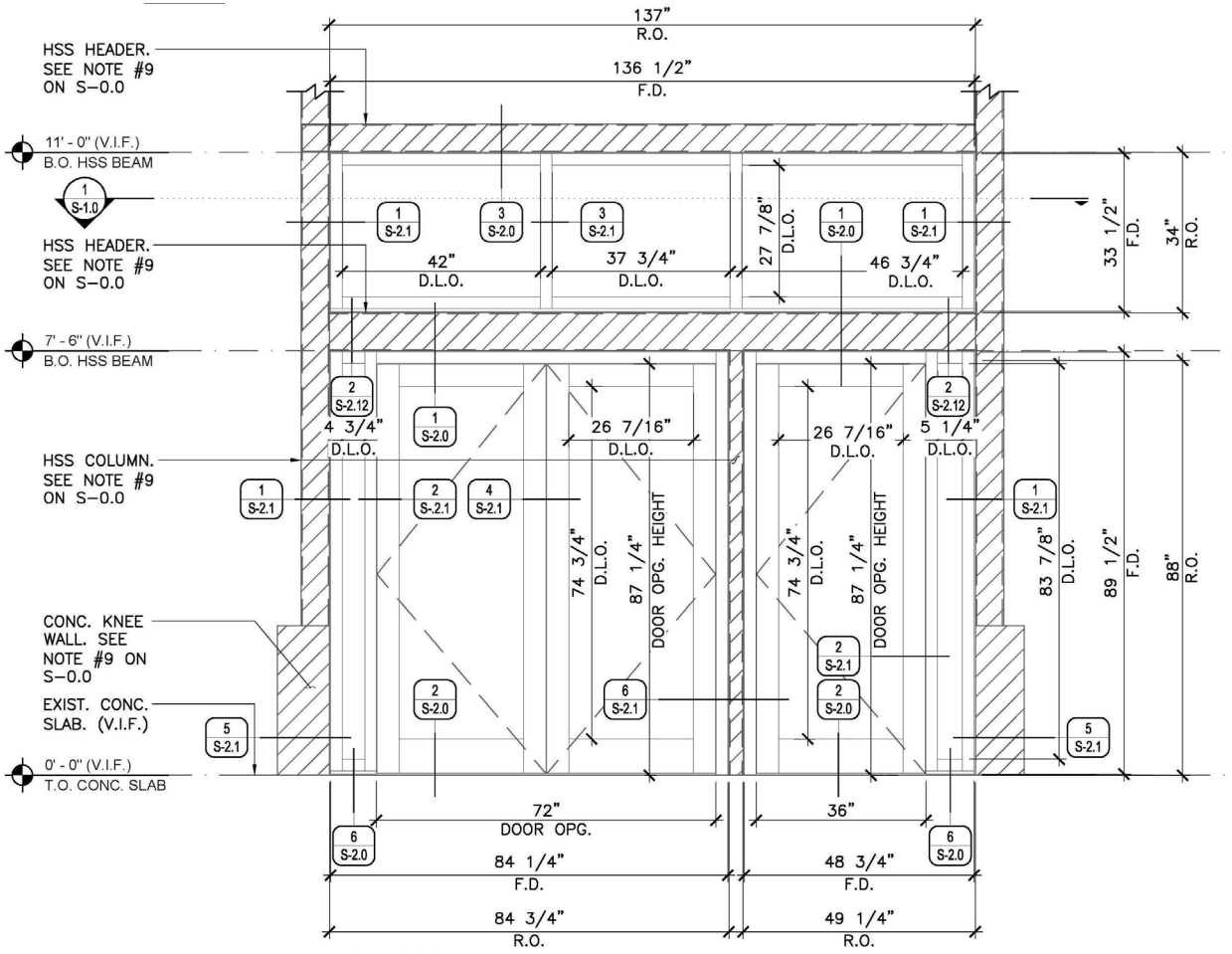


4. Shop Drawings (cont.)

Important things to look for within the plans:

1. Horizontal Layout
2. Product types
3. Interaction between varying product types and substrates
4. Elevation call outs
5. Section call outs
6. Rough opening and frame dimensions

4. Shop Drawings (cont.)

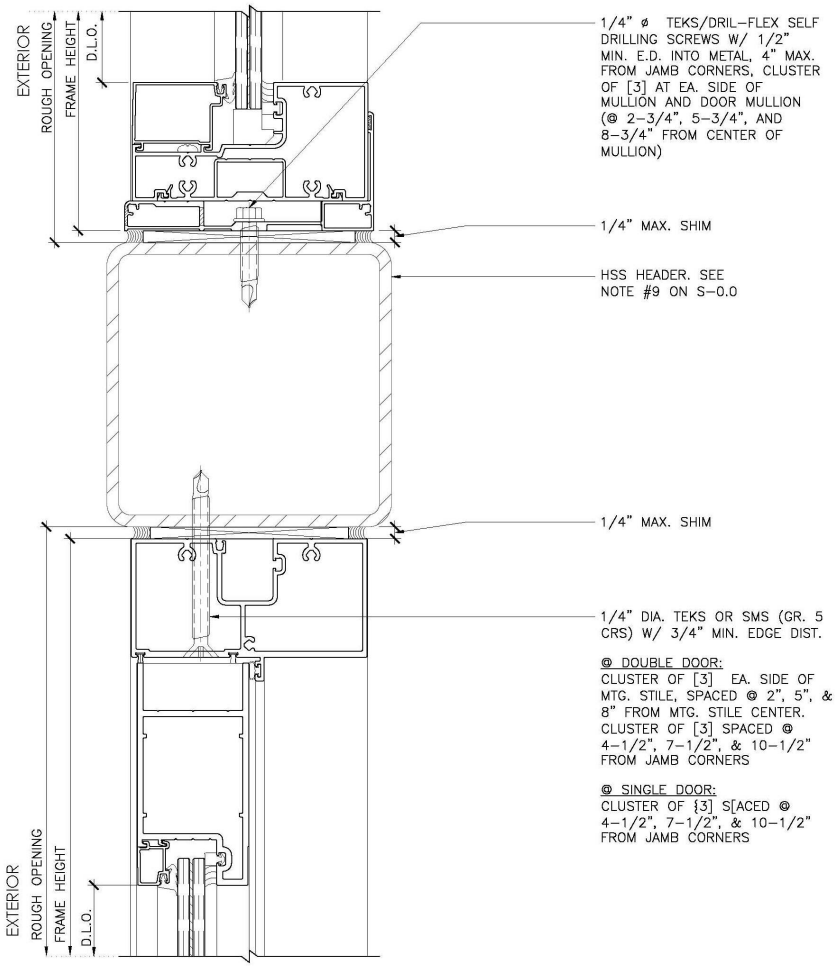


4. Shop Drawings (cont.)

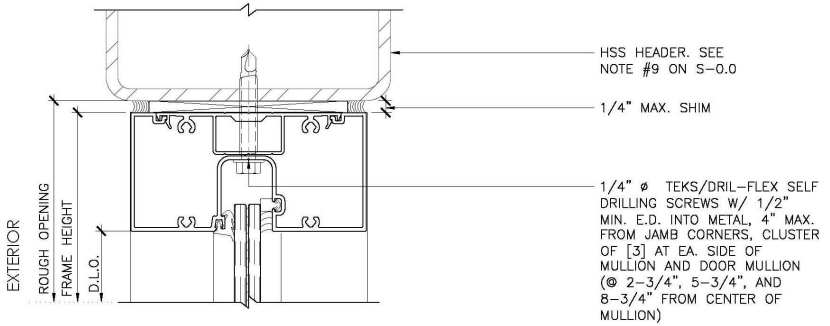
Important things to look for within the elevations

1. Vertical Layout
2. Product types including approval numbers
3. Project design loads specific to the products
4. Zone locations
5. Interaction between varying product types and substrates
6. Detail call outs
7. Rough opening and frame dimensions

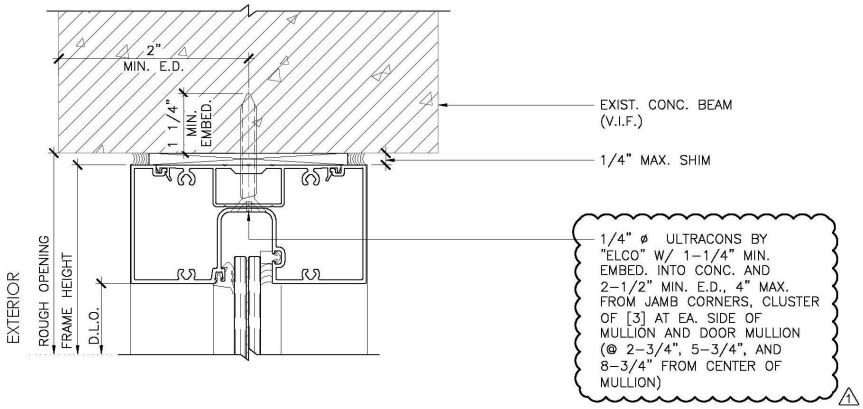
4. Shop Drawings (cont.)



1 S-2.0 — YHS-50 FS STOREFRONT / YKK 35 H OUTSWING ENTRANCE DOOR
HEAD / SILL DETAIL
SCALE 6" = 1'-0"



3 S-2.0 — YHS-50 FS STOREFRONT
HEAD DETAIL
SCALE 6" = 1'-0"



4 S-2.0 — YHS-50 FS STOREFRONT
HEAD DETAIL
SCALE 6" = 1'-0"

4. Shop Drawings (cont.)

Important things to look for within the installation details

1. Extrusion shapes
2. Substrate conditions
3. Connection details
    - Anchor types
    - Embedment
    - Spacing
    - Edge Distance
    - Quantity
4. Allowable shim space
5. Glass byte
6. Silicone type
7. Weep holes
8. Interior vs Exterior orientation

5. Responsibilities and Limitations of Inspectors
RESPONSIBILITIES

- **To become intimately familiar with the approved shop drawings**
- **To ensure the installation conforms to the approved plans**
- **To ensure that deviations from the approved plans are addressed by the delegated engineer**
- **To ensure that corrections are made to bring the deviations into compliance with the design intent as directed by the delegated engineer.**
- **To adequately perform your inspections to ensure that the installation complies with the product design capabilities.**

5. Responsibilities and Limitations of Inspectors
LIMITATIONS

WHAT SHOULD YOU DO WHEN YOU RUN ACROSS A DEVIATION FROM THE APPROVED SHOP DRAWINGS?

- **Take initiative and resolve the issue on your own by instructing the contractor in remedial work.**
- **Approve the deviation if you feel qualified to do so.**
- **Leave it up to the contractor to come up with and implement a solution**
- **NOTE THE DEVIATION IN YOUR INSPECTIONS REPORT AND REQUEST THAT THE DELEGATED ENGINEER ADDRESS THE DEVIATION.**

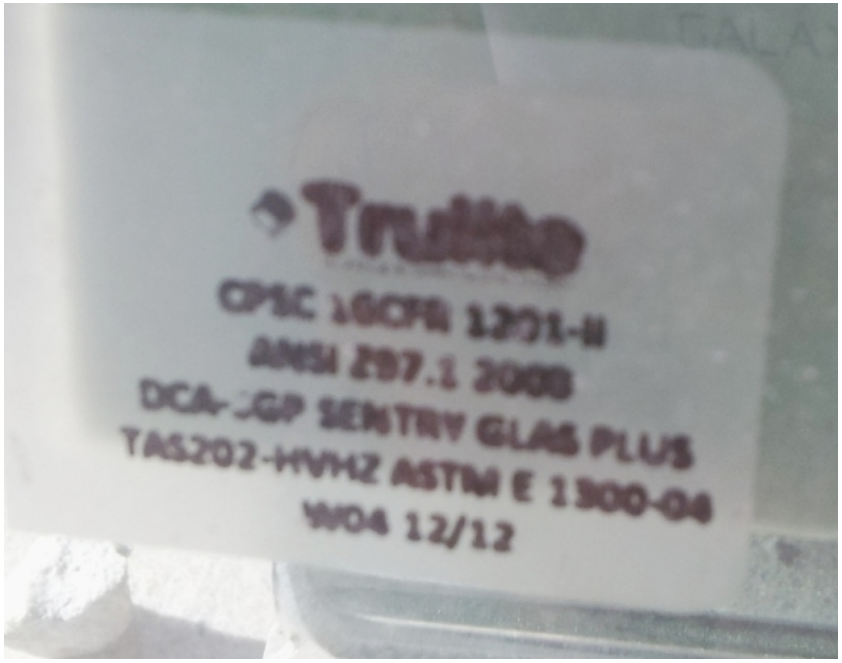
6. Identifying Deficient Installations
Inspection Requirements

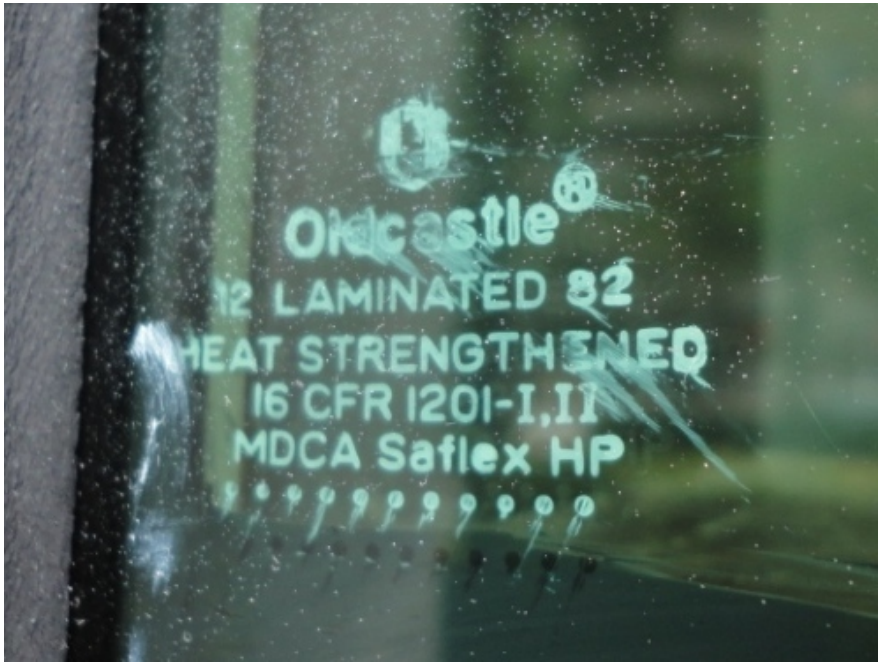
- Verify and review city **Approved** Shop Drawings
- Verify Products Manufacturer and Sizes
- Verify Substrates are as shown on the approved shop drawings.
- Confirm Internal Reinforcement, if Required
- Confirm Glass Type, Thickness and Interlayer
- Check Wood Buck and Mullion Connections
- Confirm Anchor Type, Spacing, Embedment, Edge Distance
- Make Sure Shims are not Excessive
- Confirm Silicone for Missile Products

6. Identifying Deficient Installations (cont.)
Inspection Requirements

There is only one sure way to know
If internal mullion steel reinforcement
Is present in the required amount…
BY PERFORMING VISUAL
OBSERVATION
PRIOR TO FRAME INSTALLATION

6. Identifying Deficient Installations (cont.)
Inspection Requirements





Interlayer type and thickness is critical to the performance of hurricane resistant Impact rated glass.

Locating and identifying the glass bugs or markings are one way to determine if the right interlayer was used

7. Preparing Inspection Reports

1. Be precise and concise
2. Include the pertinent information such as date, time, who was present, project permit number, address, project name.
3. Always takes lot of photos and include the most relevant in the reports.
4. Stay away from long paragraphs and instead use bulleted details.
5. Be cautious when rejecting installations and ask for clarification from the delegated engineer.
6. Identify follow up actions and who needs to follow up and by when.
7. Use reference to the shop drawing detail numbers.

7. Preparing Inspection Reports (cont.)

October 30, 2013 Page **1** of **1**

City of Coral Gables
405 Biltmore Way
Coral Gables, FL 33134

INSPECTION REPORT #1

REFERENCE:	**Village of Merrick Park: Tenant Space #**
DLGE PROJECT #:	**13-XXX**
PERMIT NUMBER:	**BL-13-08-XXX**
INSPECTOR:	**SC/JC**
CONTACT ON SITE:	**Contact (Company)**

On **10/30/2013**, our office visited the above project to observe the installation of the storefront's supporting steel framing installation including connections and welding as per DLGE drawings XXX dated 08/07/2013. **The following was noted:**

1. Observed installation of storefront's supporting steel framing including connections and welding. Installation was deemed satisfactory.

If you have any questions, please feel free to contact us.

7. Preparing Inspection Reports (cont.)

December 03, 2013 Page **1** of **1**

City of Coral Gables
405 Biltmore Way
Coral Gables, FL 33134

STATEMENT OF INSPECTION

REFERENCE:	**Village of Merrick Park: Tenant Space #**
PERMIT NUMBER:	**BL-13-08-XXX**
DLGE PROJECT #:	**13-035-XXX**

With this letter, we certify that we have observed the installation of the storefront's supporting steel framing including connections and welding and the storefront framing, as per DLGE drawings XXX dated 8/07/2013. We attest that to the best of our knowledge, belief, and professional judgment, the installation of the above mentioned item(s) are in substantial accordance with the approved drawings as per attached Inspection Reports #1-6.

FBC 110.3.7.4.1:

To the best of my knowledge and belief, the above described construction of all structural load-bearing components complies with the permitted documents.

8. Examples of Deficient Installations

- **Excessive shimming of framing**
- Inadequate embedment, spacing or edge distance of anchors:
- Improperly attached wood bucks:
- Inadequately designed metal stud framing:
- Improper substitution of glass type

8. Examples of Deficient Installations (cont.)

Excessive Shimming Of Framing:

Imposes Bending Forces On Anchors

8. Examples of Deficient Installations (cont.)

Inadequate Embedment, Spacing Or Edge Distance Of Anchors:

When anchors are spaced too close it causes their interaction cones to overlap and necessitates the use of a capacity reduction factor.

Causes Anchor Strength Reduction

8. Examples of Deficient Installations (cont.)

Improperly Attached Wood Bucks

Places Undue Burden On Anchors - May Not Be Adequate To Transfer Loads

8. Examples of Deficient Installations (cont.)

Inadequately Designed Metal Stud Framing:

May Not Transfer Loads To The Main Building Structure

8. Examples of Deficient Installations (cont.)

Improper Substitution Of Glass Type
Safety Glazing Designation

Trulite Glass & Aluminum Solutions ; Pittsburgh, PA

1784	COMPOSITE	1/8	3.0 TTG	U	A
1785	COMPOSITE	3/16	5.0 TTG	U	A
1786	COMPOSITE	1/4	6.0 TTG	U	A
3495	COMPOSITE	5/16	8.0 TTG	U	A
1787	COMPOSITE	3/8	10.0 TTG	U	A
1788	COMPOSITE	1/2	12.0 TTG	U	A
4134	COMPOSITE	5/8	16.0 TTG	U	A
4135	COMPOSITE	3/4	19.0 TTG	U	A
4452	COMPOSITE	1/8	3.0 TPG (s)	U	A
1790	COMPOSITE	3/16	5.0 TPG (s)	U	A
4453	COMPOSITE	3/8	10.0 TPG (s)	U	A

Label Content.
The label shall contain the following information:

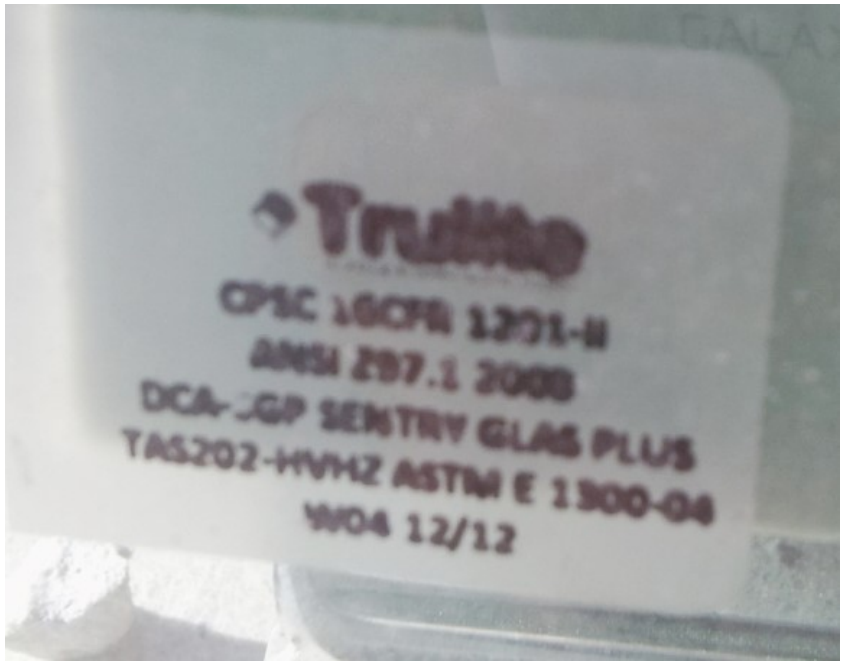
1) Supplier's name, distinctive mark or designation.
2) The words "American National Standard Z97.1-2009" or the characters "ANSI Z97.1-2009."
3) Classification of test size (L or U) and drop height class (A, B or C). Plastic glazing does not require drop height.
4) Place of fabrication (if fabricator has more than one location fabricating the product).

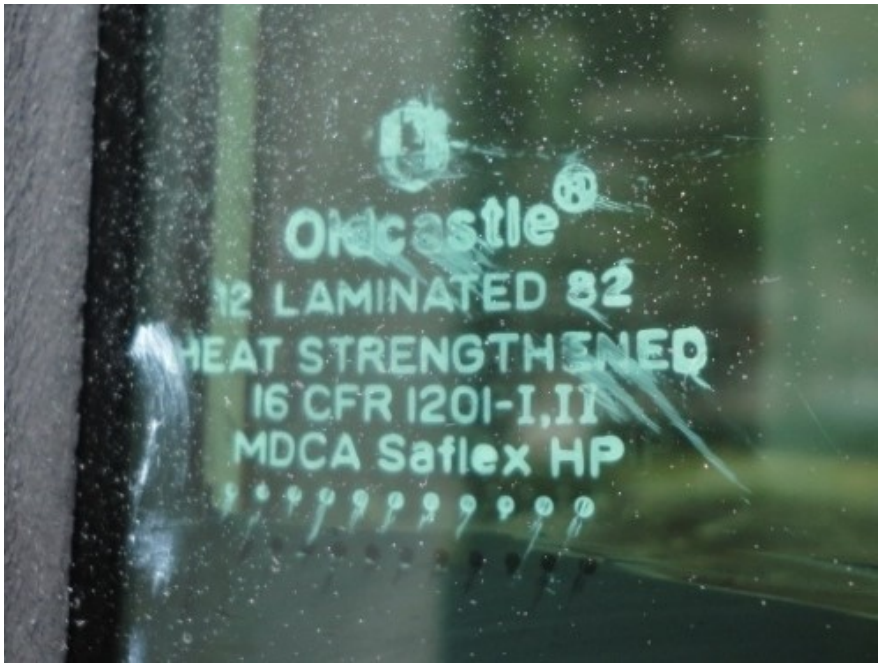
NOTE: Additional details and information, such as thickness and date of manufacture, are permitted.
Quoted from ANSI Z97.1. (Revised 1/1/11)

Do Not Get Confused Between Safety Glazing Designations And Hurricane Resistant Glass Designations.

8. Examples of Deficient Installations (cont.)

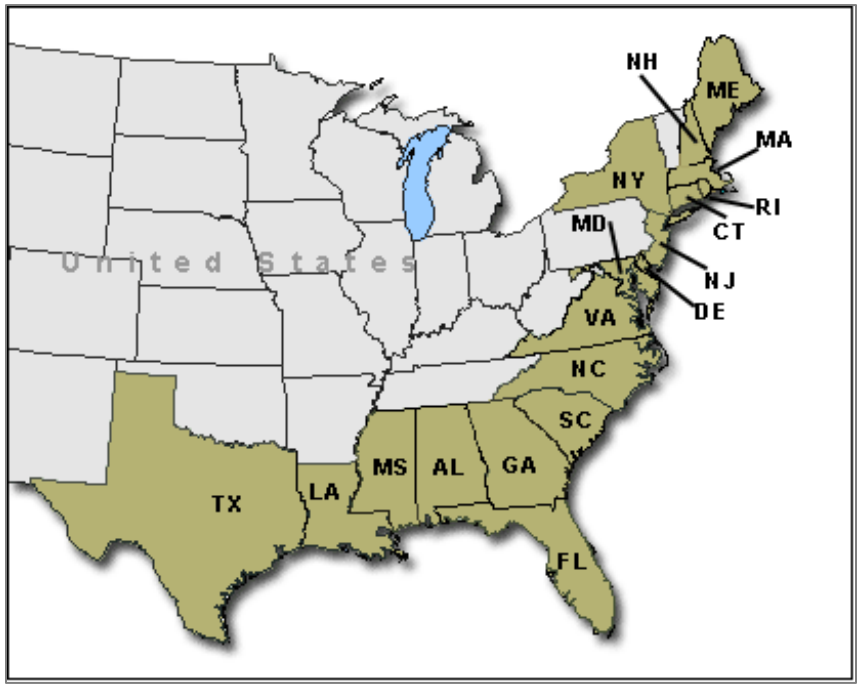
Improper Substitution Of Glass Type
Hurricane Resistant Glass Designation

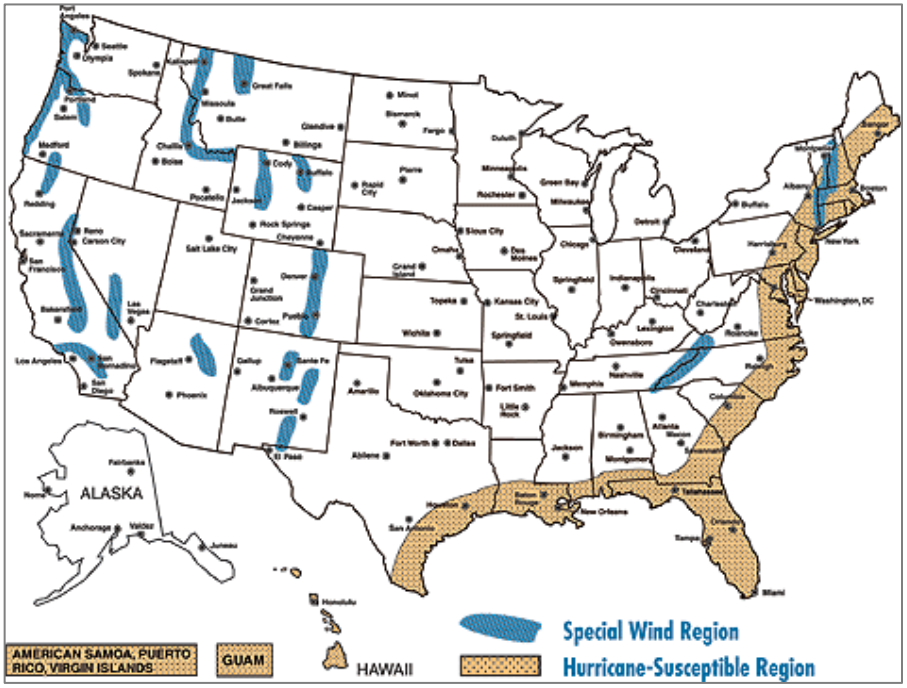




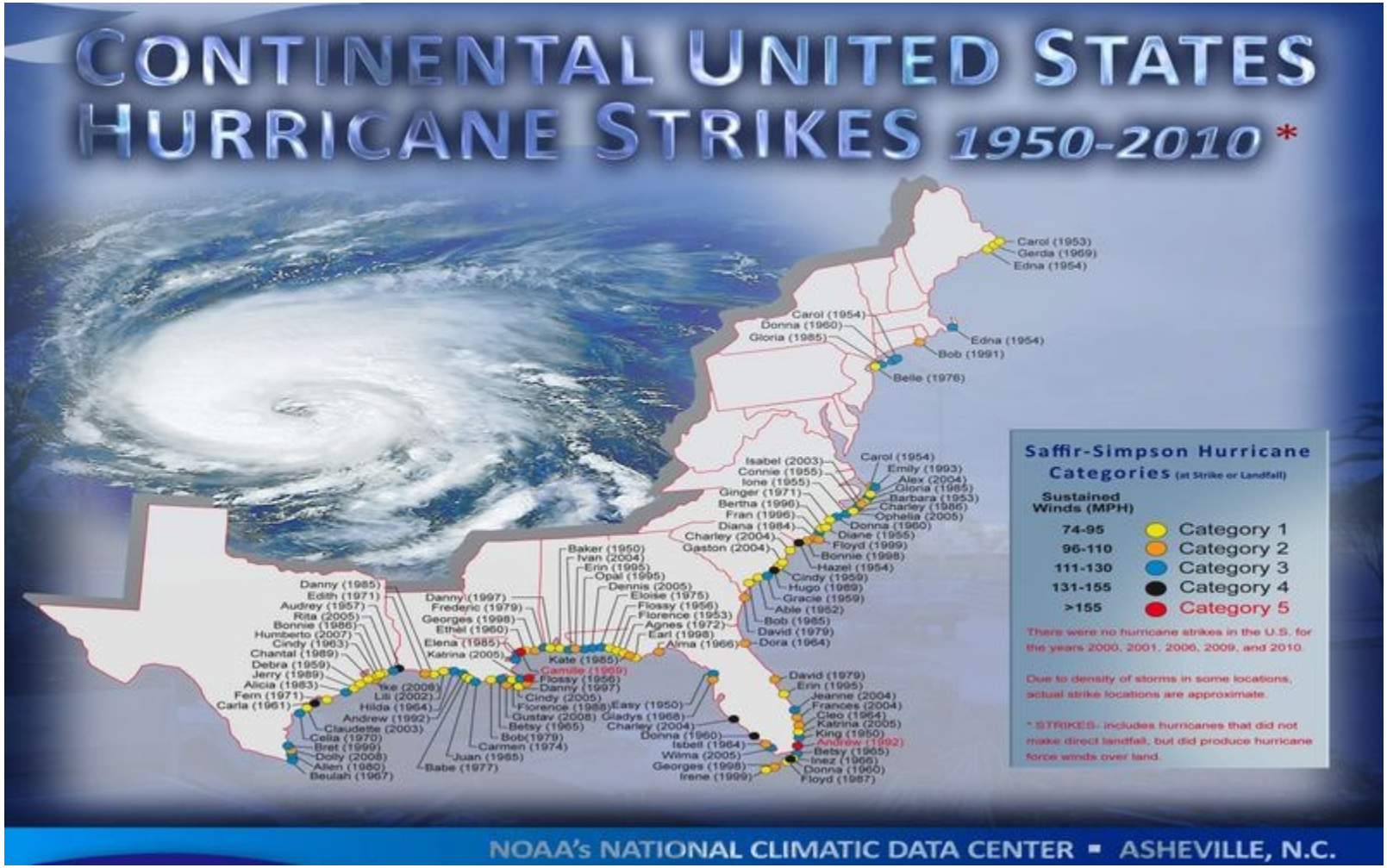
Look For:
Glass makeup (Glass type and Interlayer combination)
If the shop drawings do not show it, ask the delegated engineer to provide glass specifications based on the product approval.

Hurricane Prone States and Regions





Historical Data



http://news.discovery.com/earth/early-hurricane-forecasts-what-are-they-worth-110407.htm

IN SUMMARY

- Inspectors must be intimately familiar with the products they are inspecting prior to performing their inspections.
- Inspectors must know how to properly read a glazing shop drawing and identify any critical missing information in order to perform an adequate inspection.
- Inspectors are not responsible for making decisions when deviations occur and must insist on clear direction from the delegated engineer
- Performing a proper inspection of a hurricane resistant glazing system involves making sure that the entire critical path remains unbroken.

QUESTIONS?