

**Building Science
Summit
New Zealand**

Brian Hubbs

Moisture Wins



March 2026

Façade Risk Mitigation

A look to the future based on lessons from the past

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RDH BUILDING
SCIENCE



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Agenda

A bunch of random case studies related to fenestration

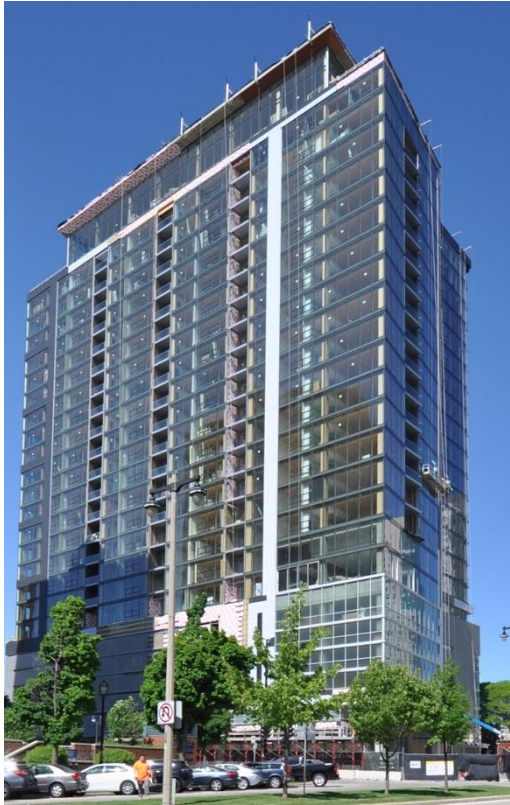


For High-Performance Glazing in Windows and
Curtain Walls

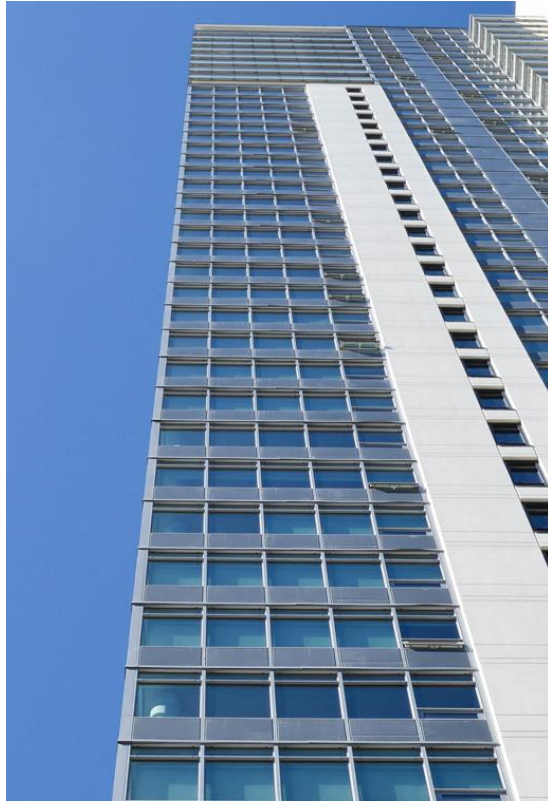
1 Fenestration Fundamentals 101

Interstory Drift Imparts Movement on the Façade

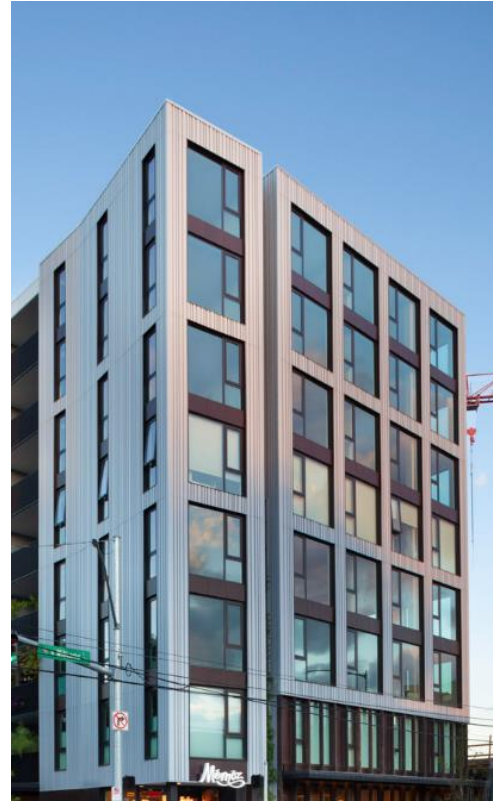
Why do we care? Façades must go along for the ride...



Curtain Wall



Window Wall/
Strip Windows

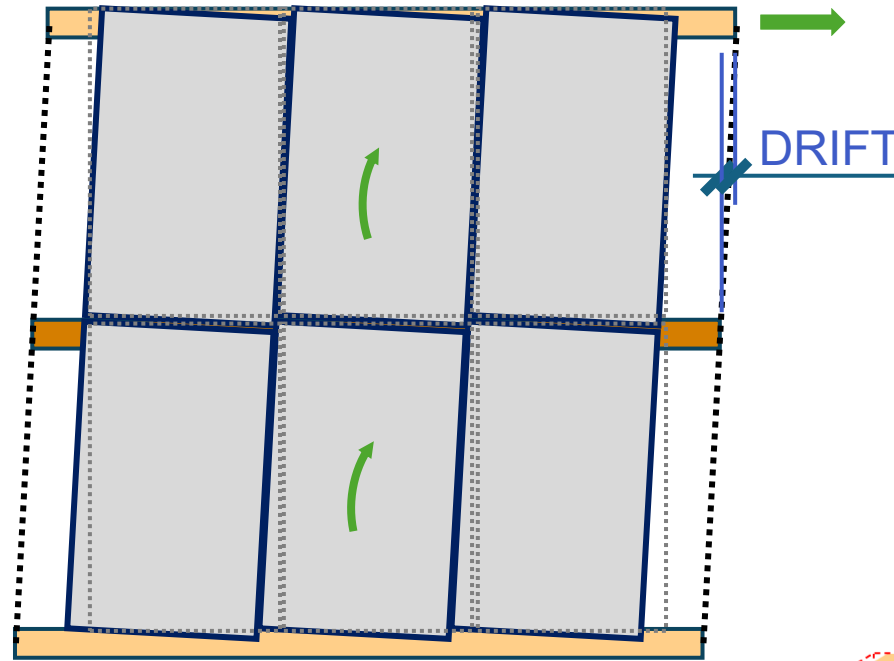
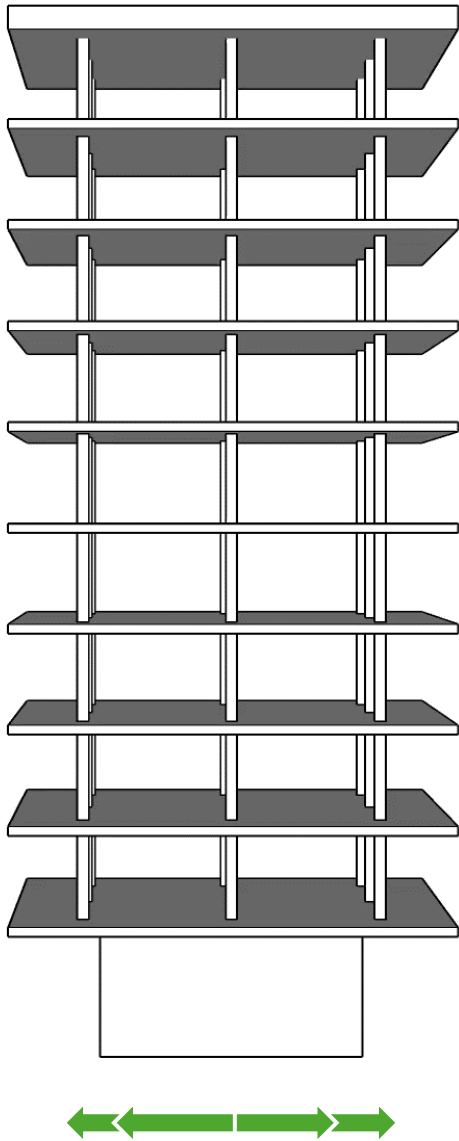


Site Built



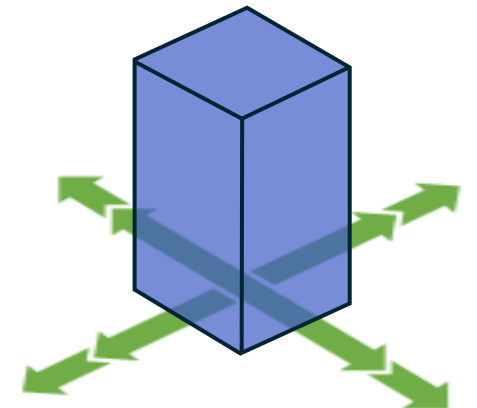
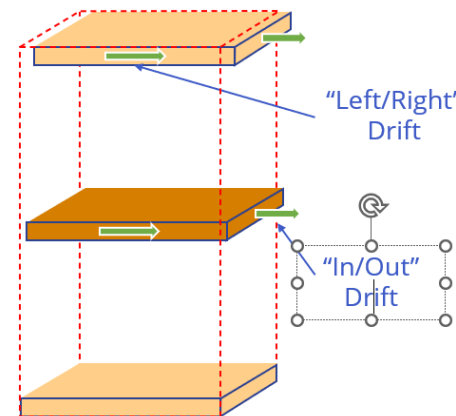
Large Panelized

Building Interstory Drift

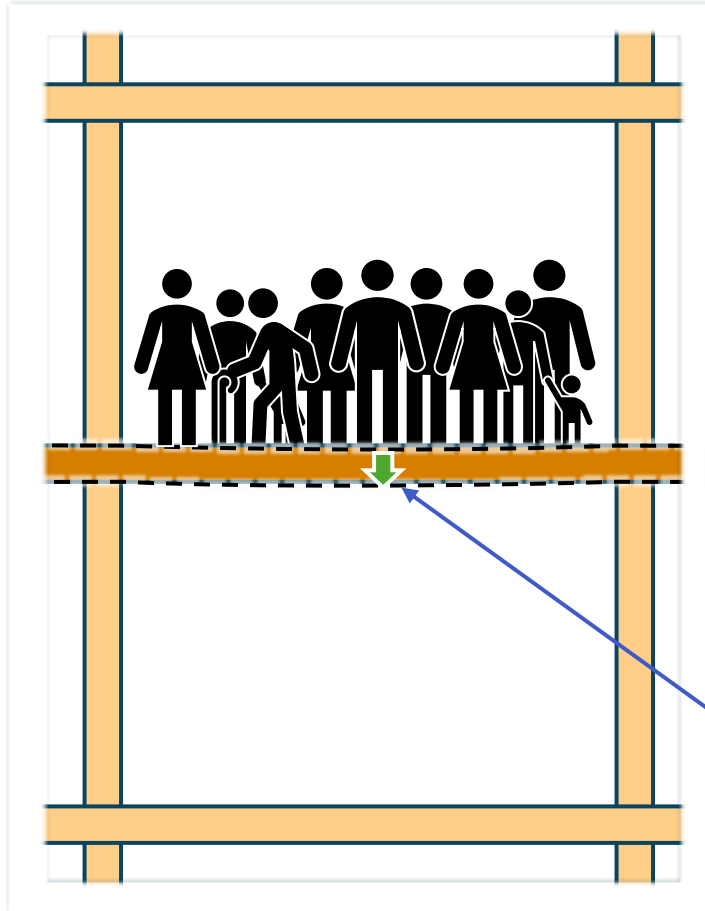


Typically expressed as %
of story height

1. **Elastic/service** interstory drift **10 mm to 25 mm**
2. **Inelastic** interstory seismic drift (The Big One) **50 mm to 75 mm**



Don't Forget About Differential Vertical Movement

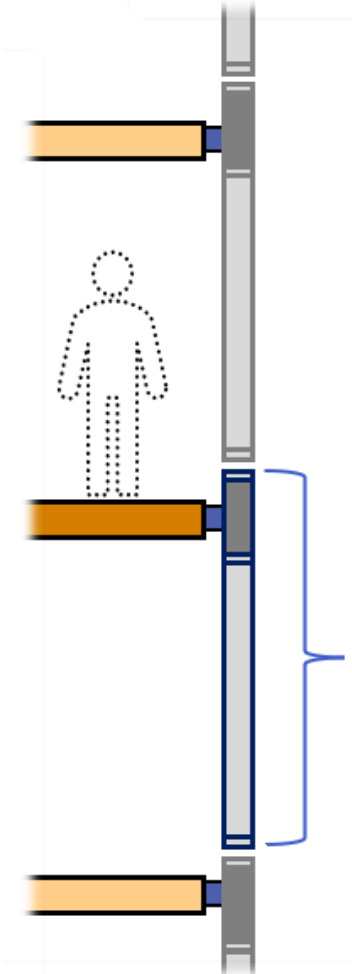


The façade needs to be able to move with its slab, and clearances at each joint.

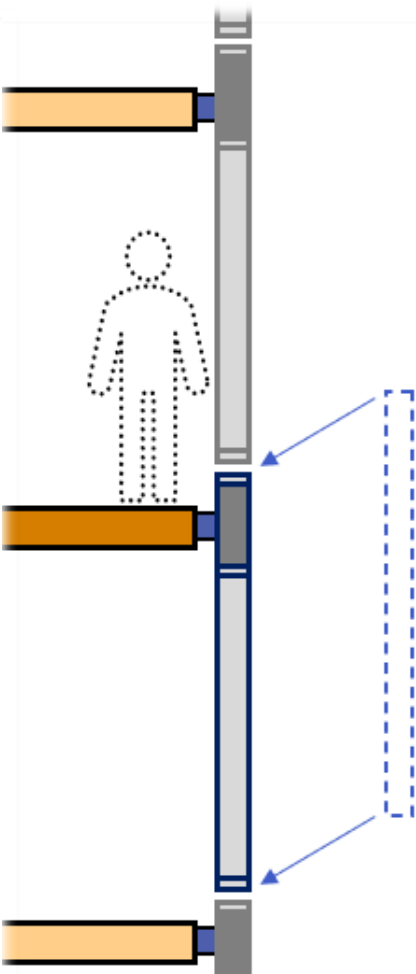


Typically up to 15-30mm

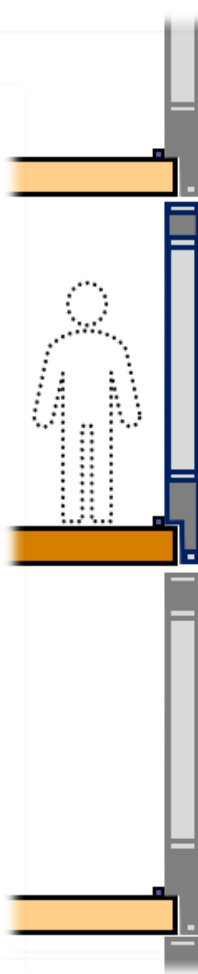
Unitized Curtain Wall vs. Window Wall



Curtain Wall

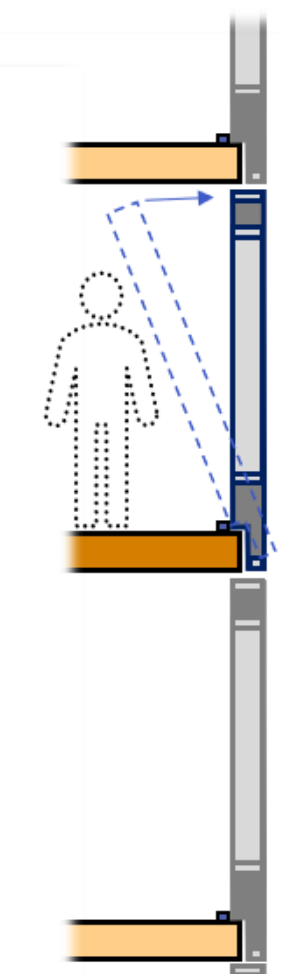


Hung From exterior



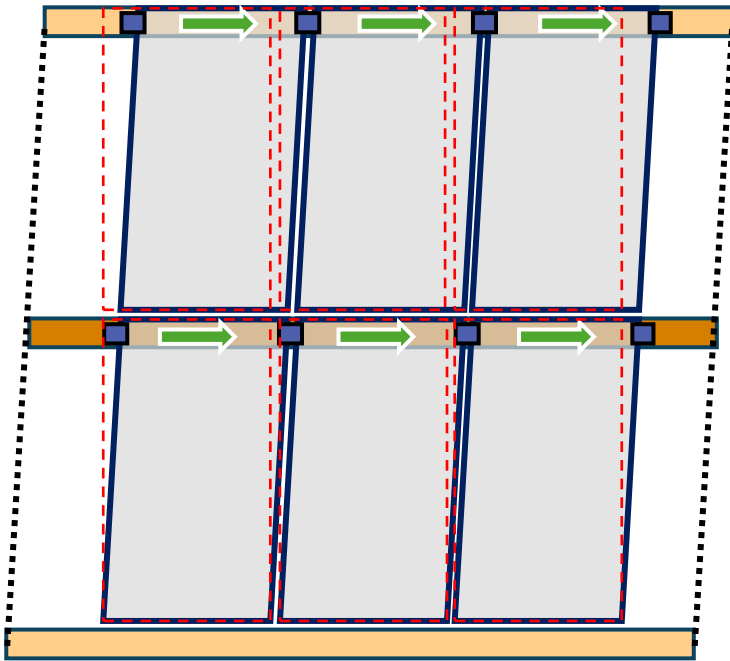
Bottom Bearing Unit

Window Wall

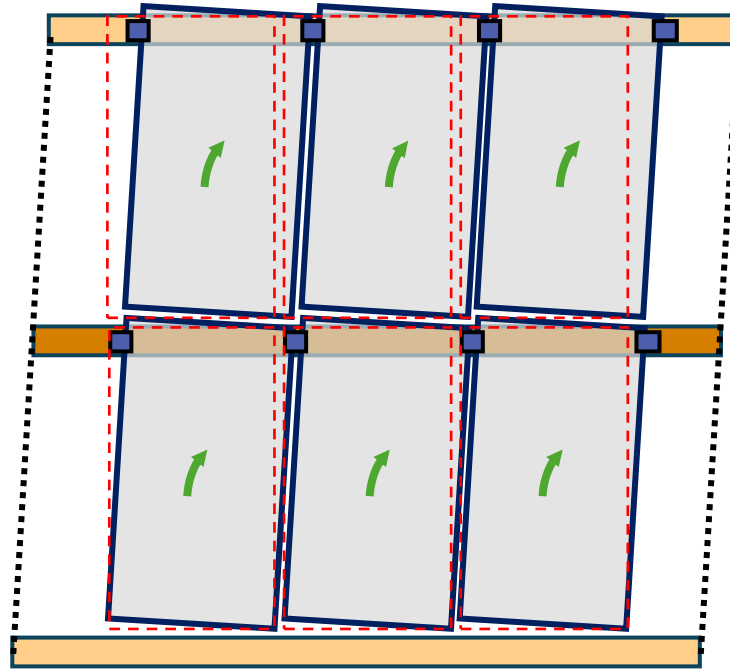


Placed From interior

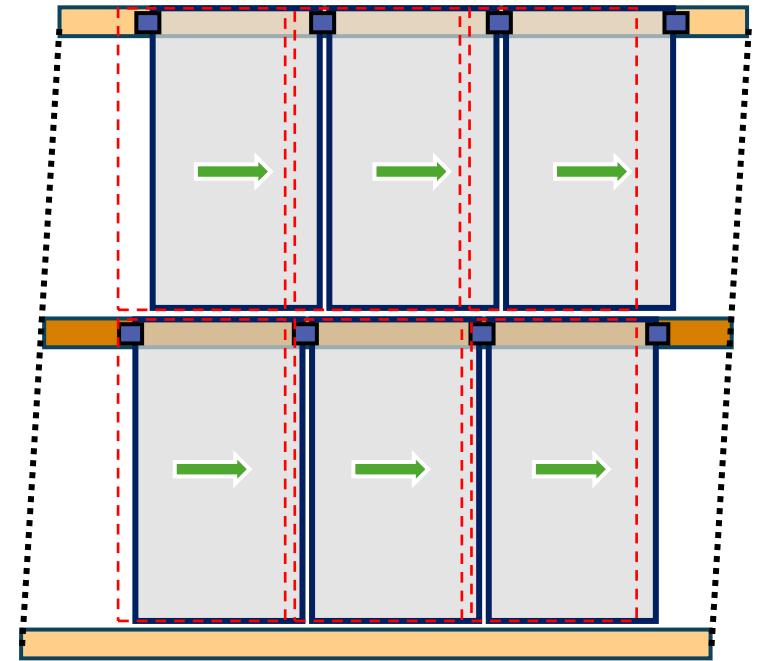
Three Types of Façade Movement



Racking



Rotating

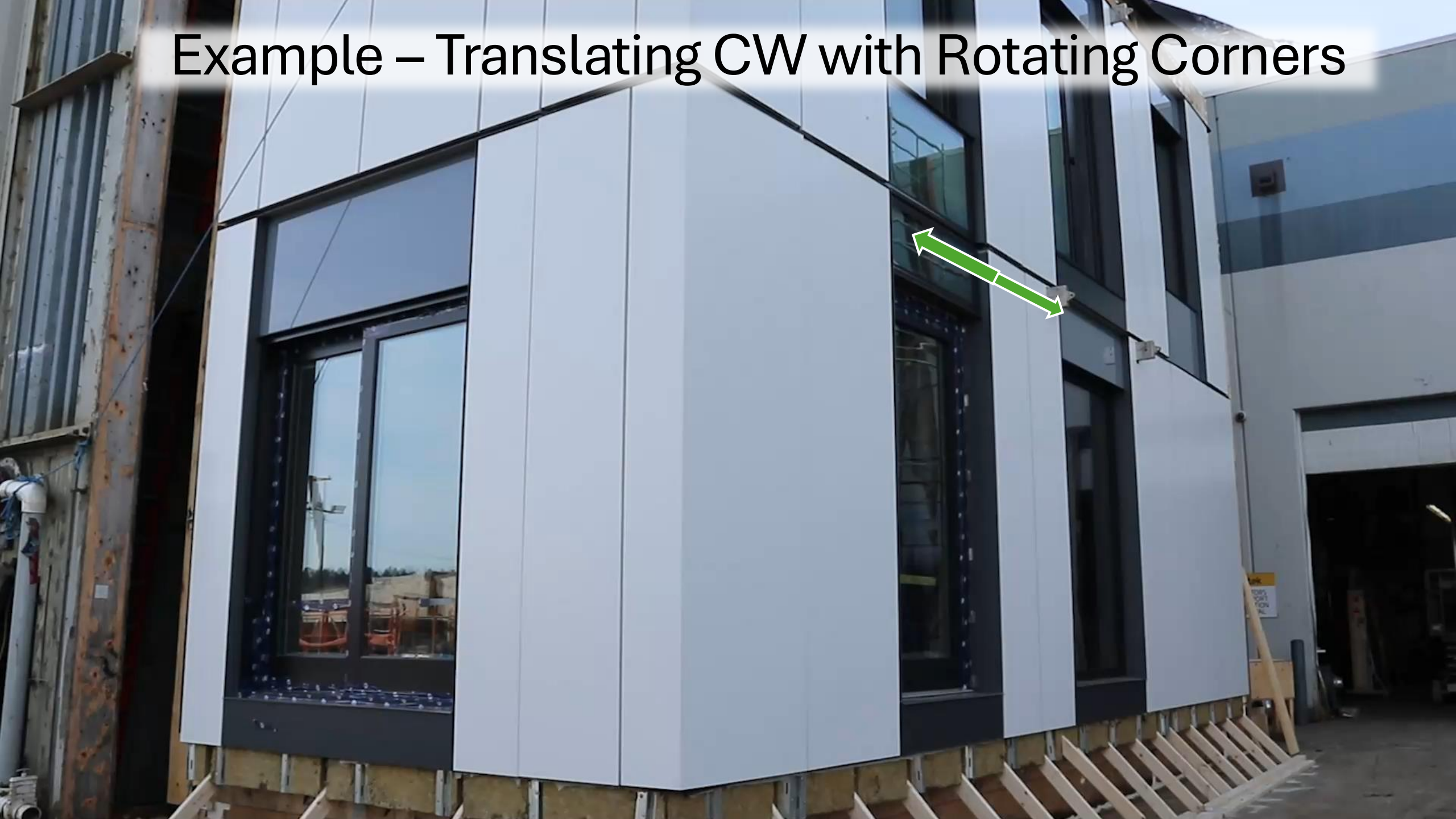


Translating



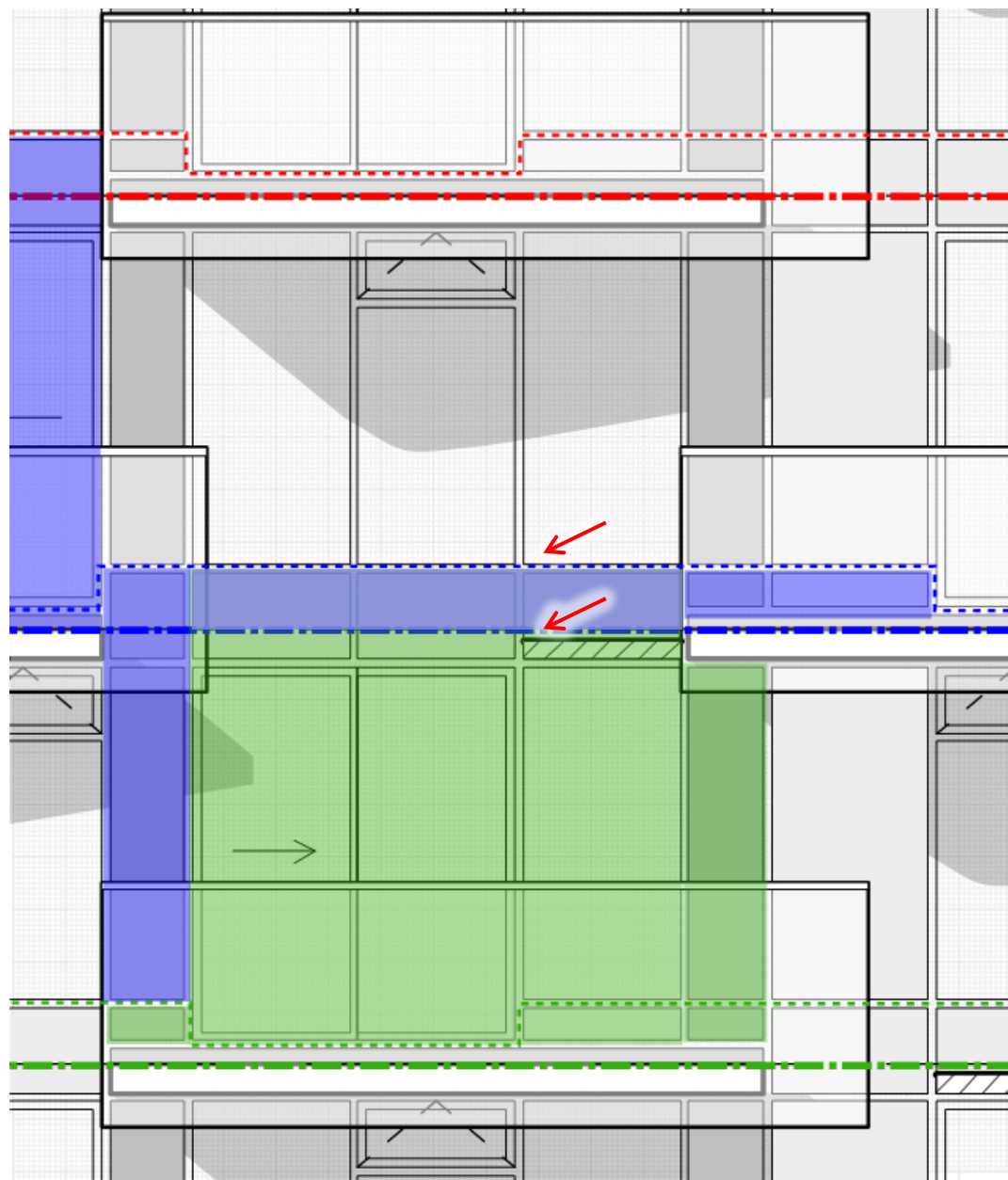
Example – Translating WW with Rotating Corners

Example – Translating CW with Rotating Corners





Example - Rotating CW



Example – Racking, Rotating, Translating CW



PMU Interstory Drift – Pass or Fail?



What IGU Standards/Labels are required by Code ?

→ Standards for Insulating Glass Units

- Can/CGSB-12.8 Insulating Glass Units or ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation

→ Certification for IGU's – Ensures compliance with code requirements

- IGMAC
- IGCC

→ Glass Associations

- GANA

→ Labelling Requirements

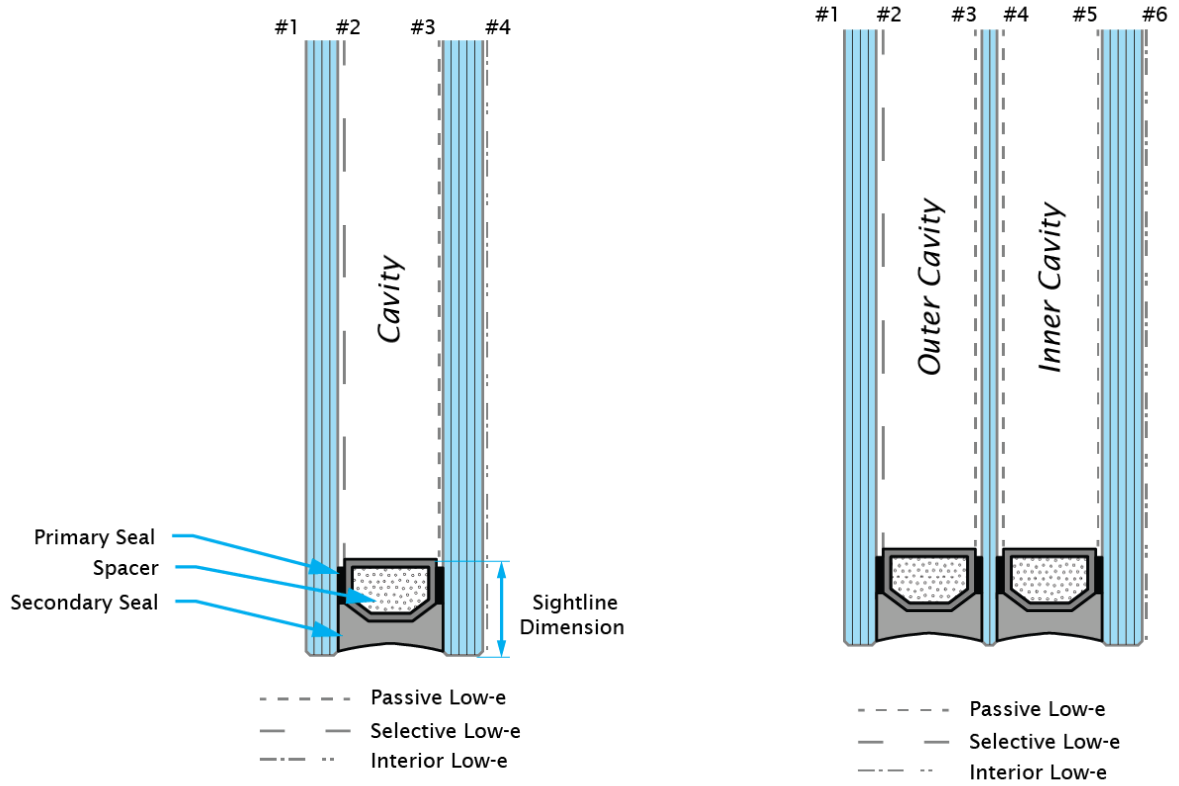
- Code: Manufactures Name and year of Manufacture
- IGCC/IGMAC: Manufactures Name, IGCC®/IGMA®, Date
- Label often means that manufacturer is certified to make IGU's but need to check to see if they are certified to make your specific IGU's

Specification

Glass	Clear	Monolithic	Annealed
	Ultra Clear	Laminated – PVB	Heat Strengthened
	Architectural	Laminated – SGP	Fully Tempered
Cavity Gas	Air		Chem. Tempered
	Argon		
	Krypton		
Spacer	Aluminum		
	Stainless Steel		
	Foam	"Warm Edge Spacer"	
	Thermoplastic & Hybrid		
	FRP		
Coating	Passive low-e	
	Selective low-e	- - - - -	
	Interior low-e	— · · · —	
Position	#2 (Low SHGC)		
	#3 (High SHGC)		
	#2 & #4 (Low SHGC)		
	#3 & #5 (High SHGC)		
	+ #4 or #6 (Interior low-e)		

Double Glazed Unit (DGU)

Triple Glazed Unit (TGU)



> 5,000,000 Combinations

IGMA IGCC IGMAC Certification

- Need to verify label on line
- <https://igcc.org/certified-products.aspx>



LEGEND

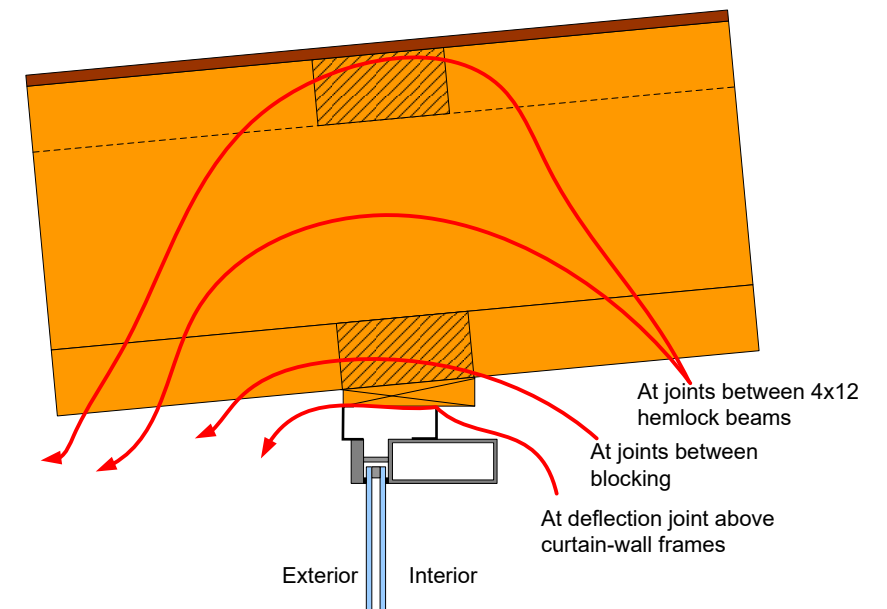
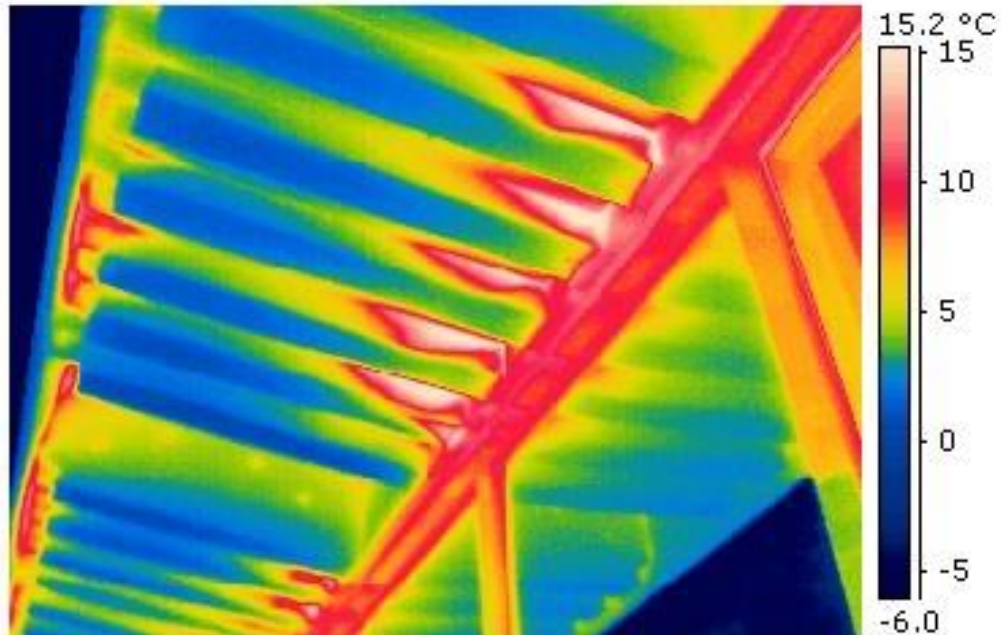
- U** Uncoated
 - C2** Sputter Coated, Edge Deleted (Soft)
 - MA** Mill Finish Aluminum
 - PHSS** Plastic Hybrid Stainless Steel
 - MC4** Mechanical Corners x4
 - LF** Loose-fill Desiccant
 - PIB** Polyisobutylene
 - S2** Two Component Silicone
 - GCIA** Measured initial value $\geq 90\%$, $\geq 80\%$ after weathering
- Yes:**

2 Case Studies

Case Studies: Mass Wood Facades

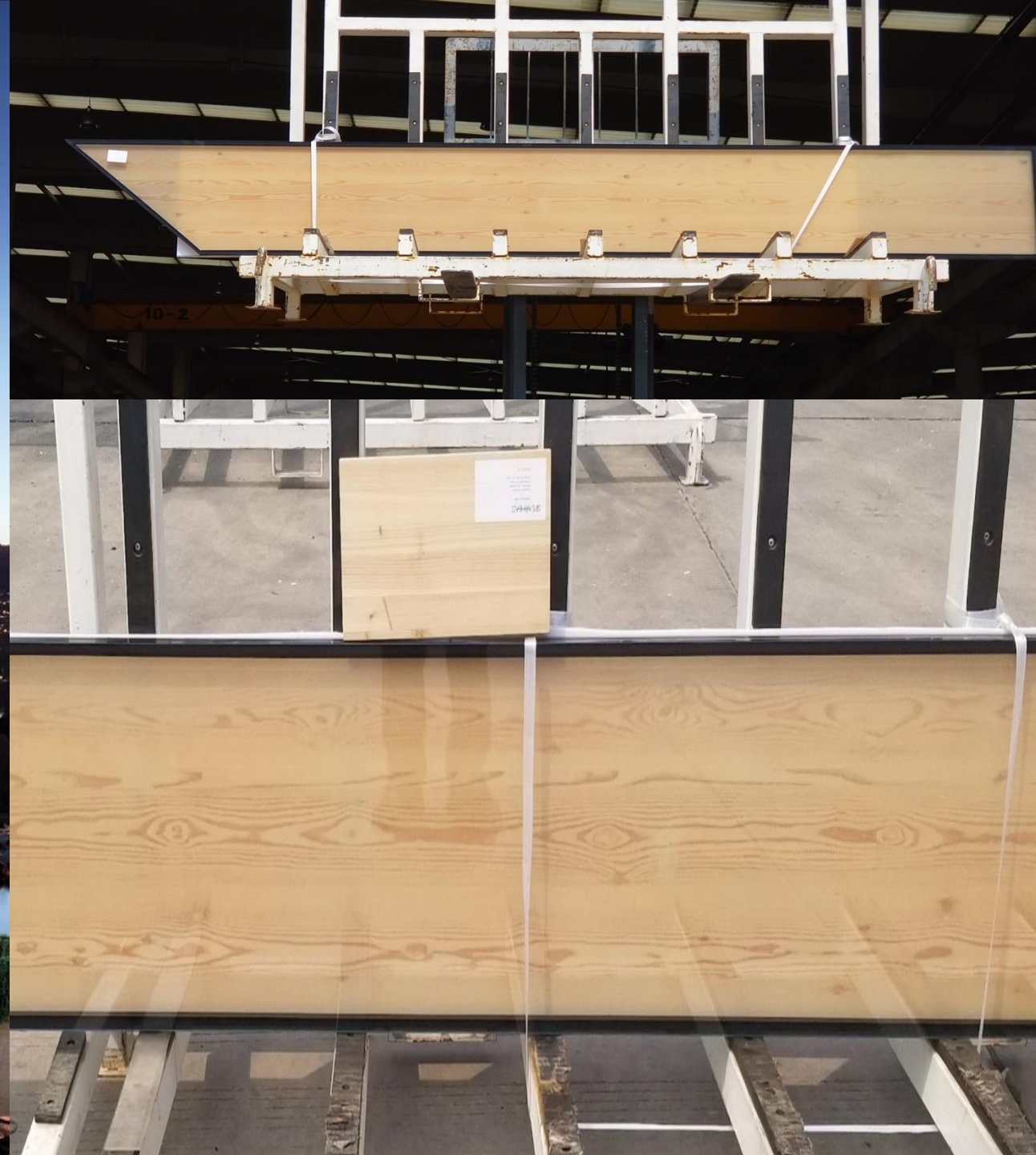
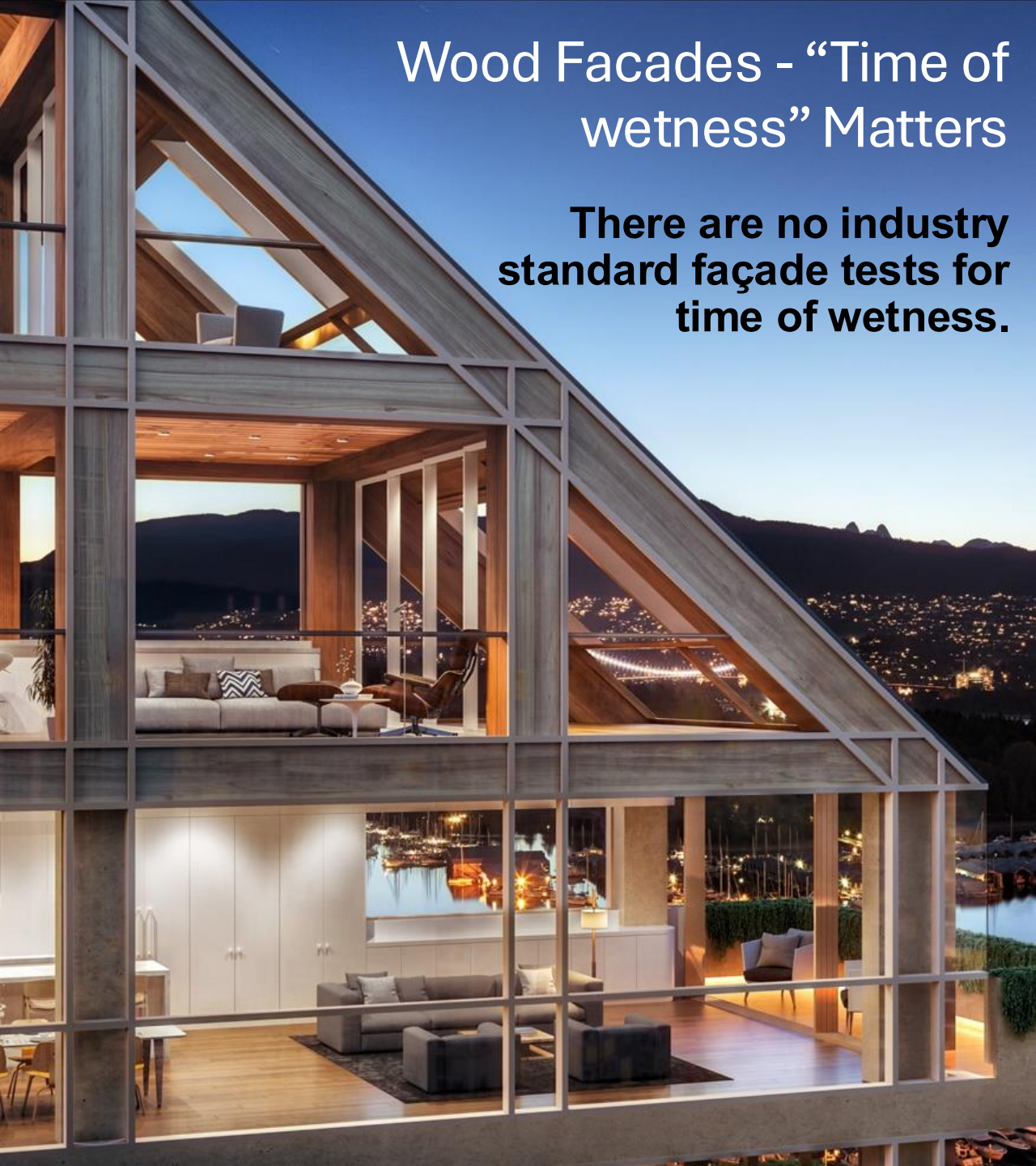


The Biggest Challenge with Exposed Mass Timber,



Wood Facades - “Time of wetness” Matters

There are no industry standard façade tests for time of wetness.



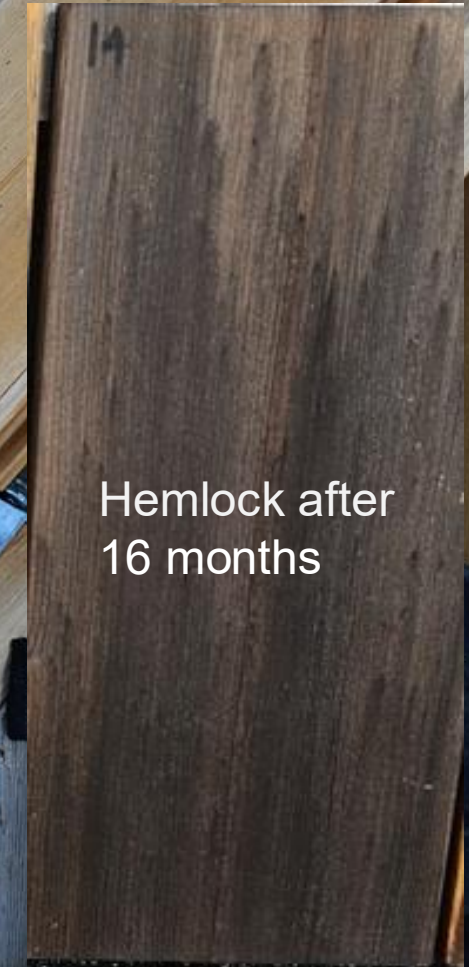
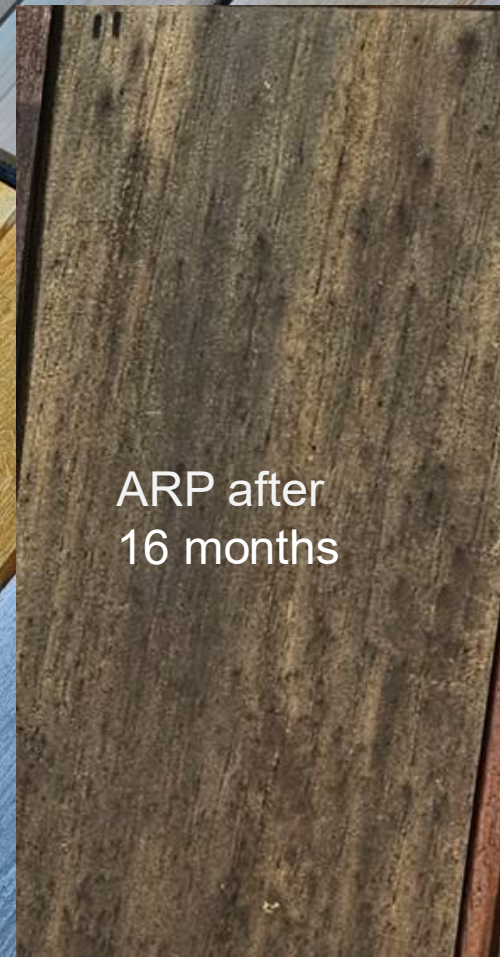
Preservative Treatments ? Acetylated Radiata Pine (ARP) RDH Wood Cladding Weathering Study Observations

INTERNAL USE

FEBRUARY 5TH , 2024 UPDATE

Graham Finch, Dipl.T., M.A.Sc., P.Eng.
Principal, Senior Building Science Specialist

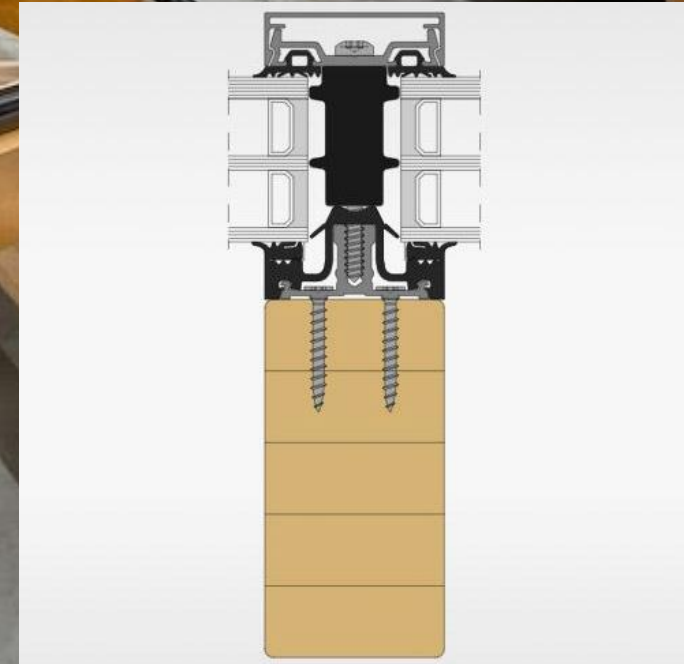
Marc Imrich, B.A.Sc., EIT
Building Science Engineer (EIT)



Mass Wood is NOT Curtain Wall



Mass Wood can be an Integral part of a Fenestration System



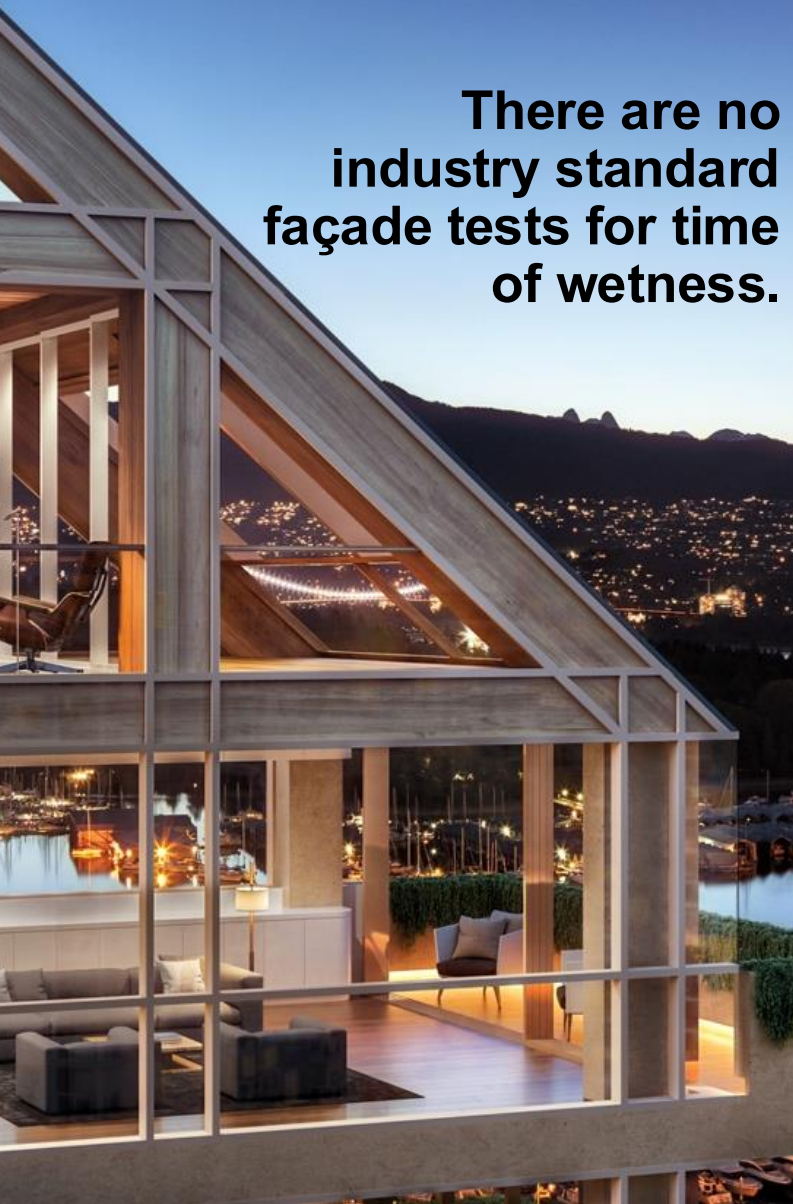


Mass Wood Exposure Nomograph



Wood Facades “Time of wetness” Matters

**There are no
industry standard
façade tests for time
of wetness.**



Case Study: Spontaneous Glass Breakage



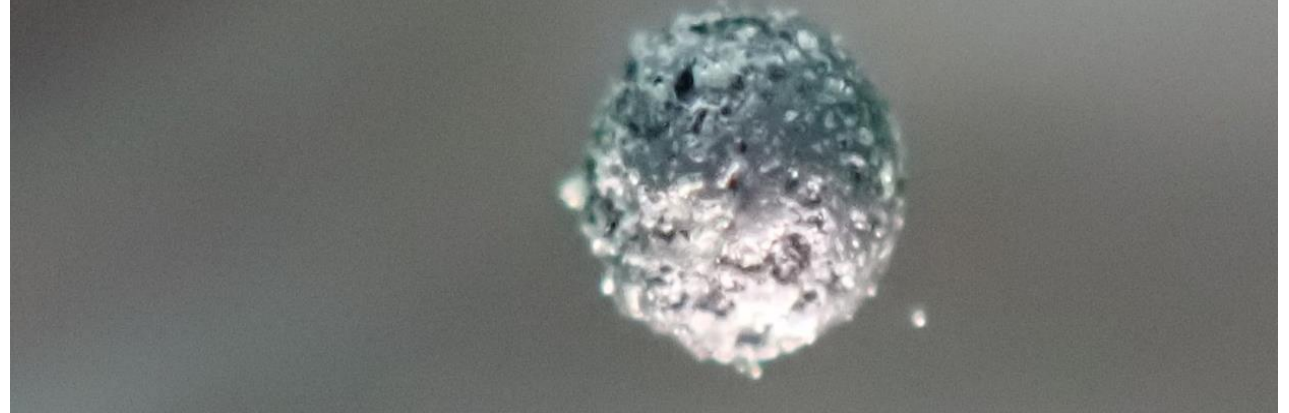
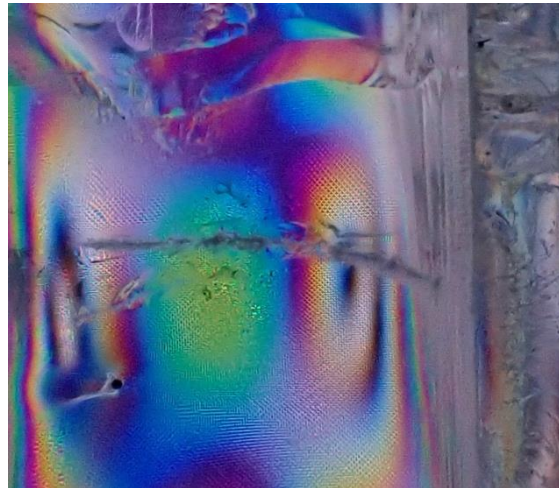
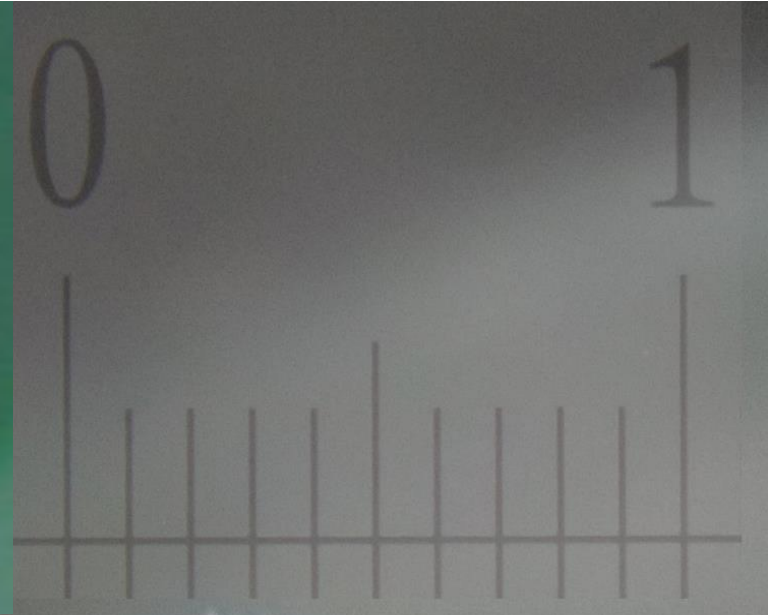
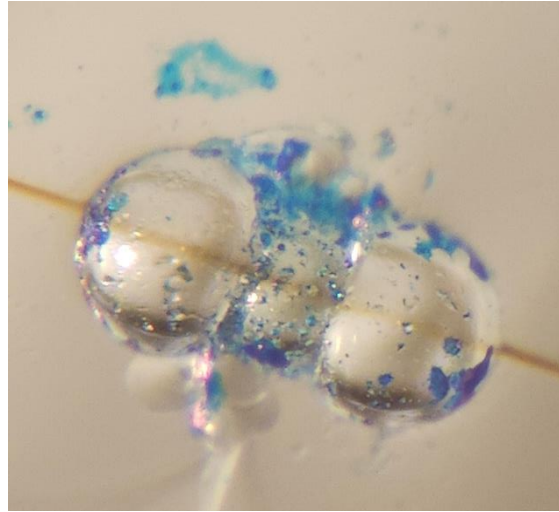
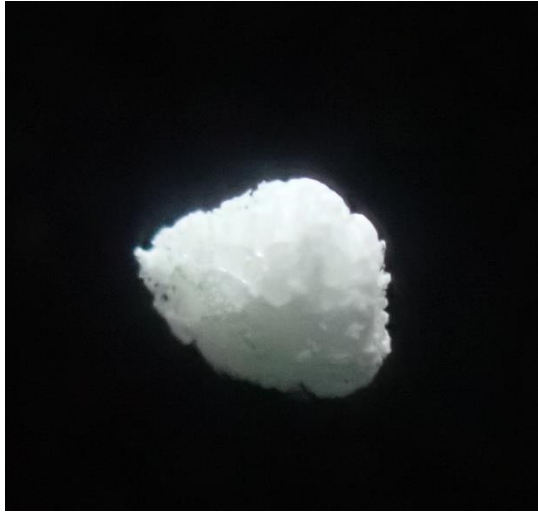
Case Study – Spontaneous Glass Breakage

- Several high-rise residential buildings between 2 and 8 years old.
- Higher buildings with larger tempered glass.
- Between 4 and 40 glazing units on each building have spontaneously broken to date.
- In one case, the occupant was showered with broken glass while he was sleeping. In other cases, broken glass has fallen out of the building onto the street below.
- Mitigation measures deployed (Varies):
 - Hoarding of public spaces below
 - Daily visual inspections of all glazing and rapid replacement program
 - Replacement of high risk glazing above public spaces.

Case Study – Spontaneous Glass Breakage



Case Study – Spontaneous Glass Breakage



NIS Myths

- Under 8 breaks in 1000 is OK – No it is not
- Tempered Low-Iron Glass is similar risk to Tempered Heat Soak Tested glass – Not in my experience..
- Glass etched as heat soak tested has been – Not Always
- 2hr soak time is enough for all sources of glass – Not Always
- Offshore glass has more inclusions ?
- Glass with high % recycled content tends to have more inclusions ?

Heat Soak Testing of Tempered Glass

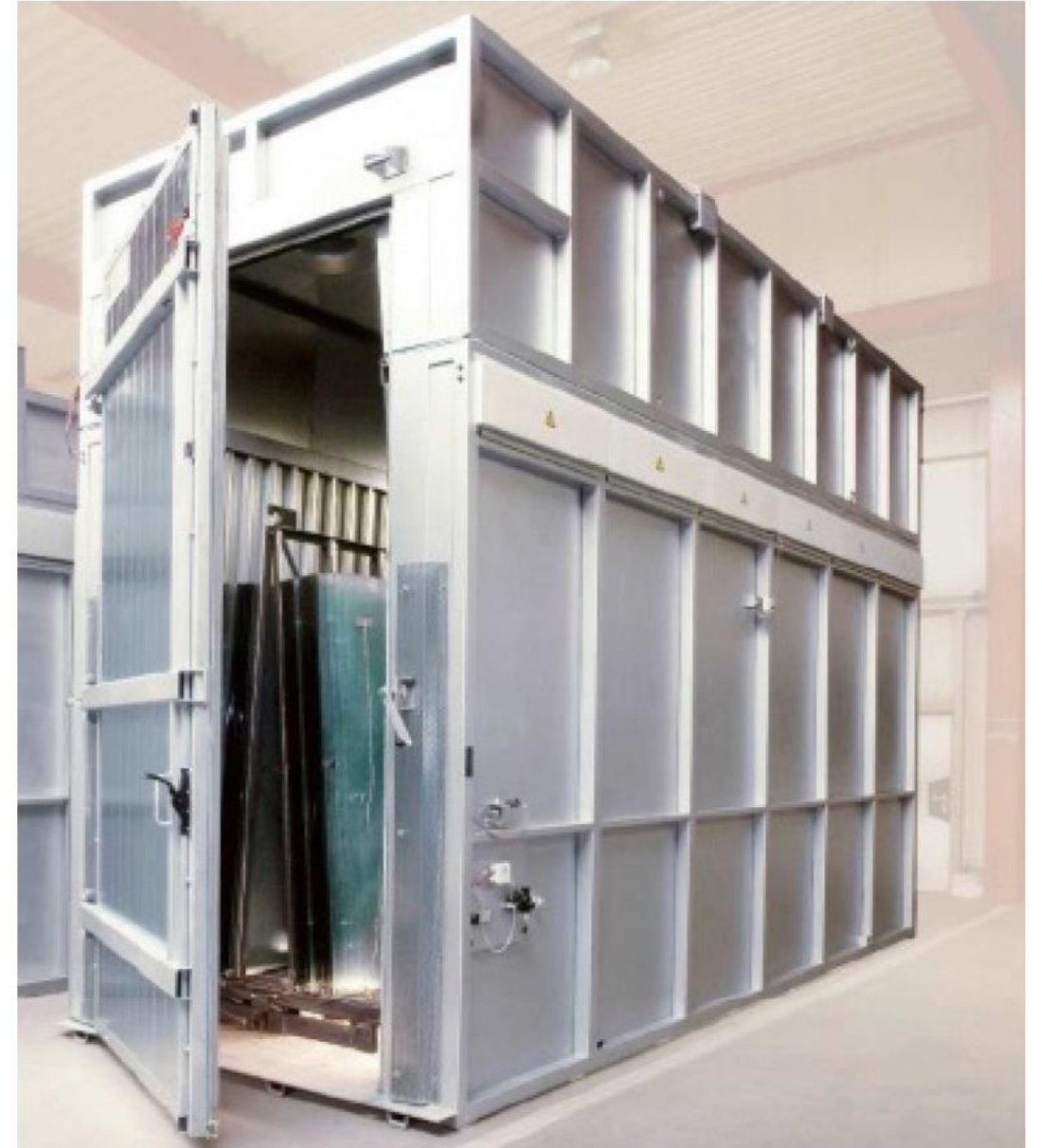
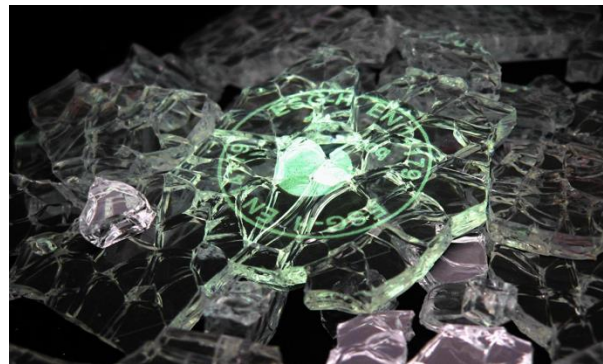
Suggested for larger quantities of glass, high risk glass, structural glass.

European Norm EN 14179 2h.

Eliminates 99% of critical inclusions

Without Heat Soaking: Risk of NiS breakage 1/10 tons (or 5,000 ft² of 5/16")

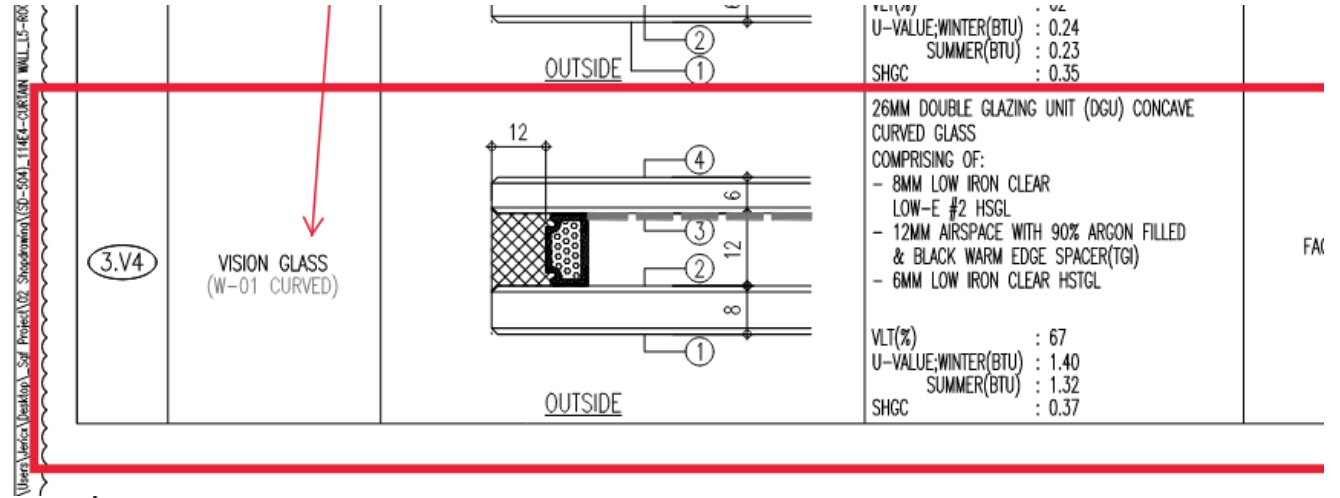
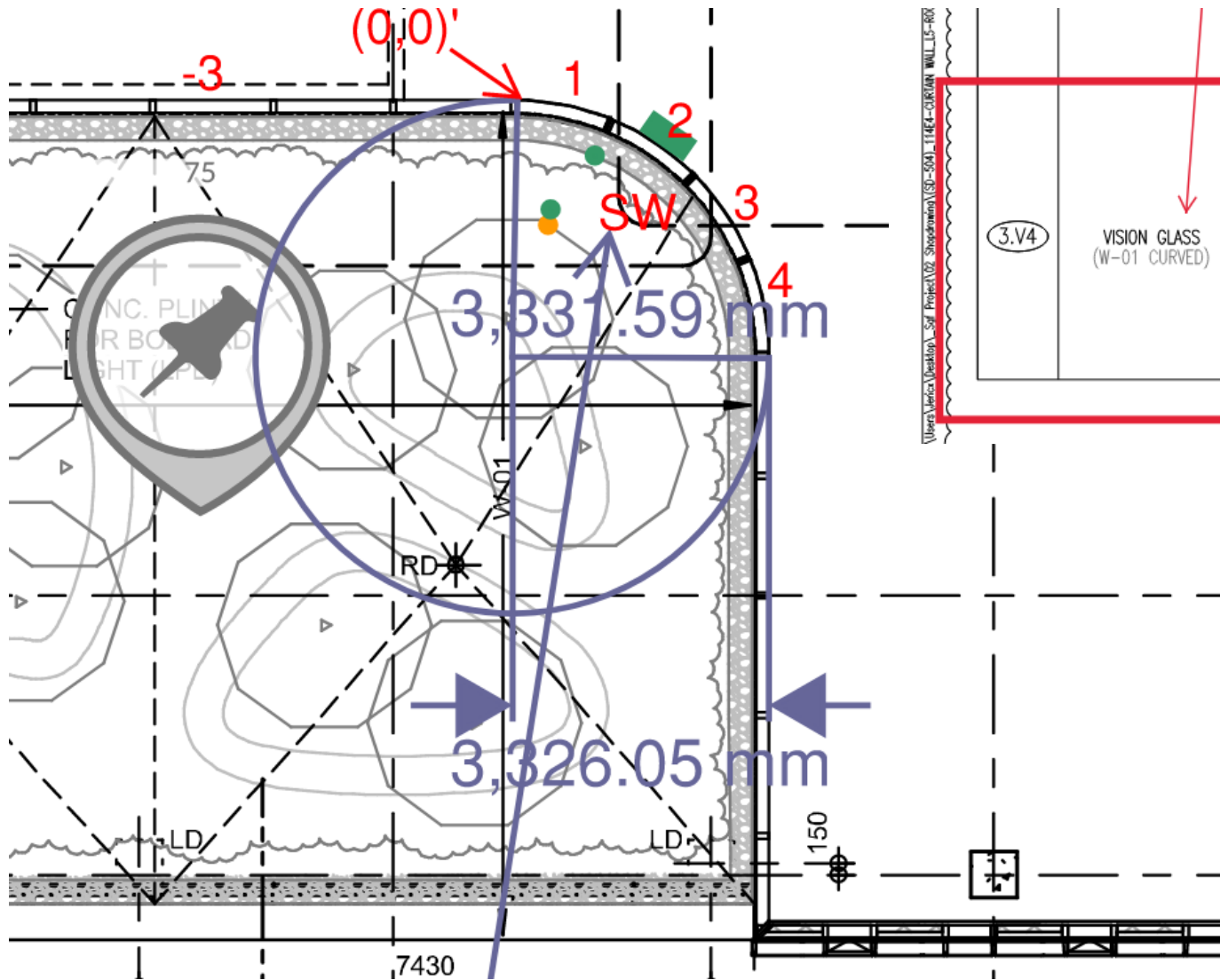
With Heat Soaking: Risk of NiS breakage 1/1400 tons (or 200,000 ft² of 5/16")



An aerial photograph of a modern, multi-story building with a prominent glass facade and a rooftop garden. The building features a central glass-enclosed atrium and several rooftop terraces with various plants and structures. The text "Case Study: Solar Oven" is overlaid in large white font across the center of the image. The surrounding area includes a parking lot with several cars and a street with more buildings in the background.

Case Study: Solar Oven

Microclimates



U-VALUE; WINTER (BTU)	: 0.24
U-VALUE; SUMMER (BTU)	: 0.23
SHGC	: 0.35
26MM DOUBLE GLAZING UNIT (DGU) CONCAVE CURVED GLASS	
COMPRISING OF:	
- 8MM LOW IRON CLEAR LOW-E #2 HSGL	
- 12MM AIRSPACE WITH 90% ARGON FILLED & BLACK WARM EDGE SPACER (TGI)	
- 6MM LOW IRON CLEAR HSGL	
VLT (%)	: 67
U-VALUE; WINTER (BTU)	: 1.40
U-VALUE; SUMMER (BTU)	: 1.32
SHGC	: 0.37

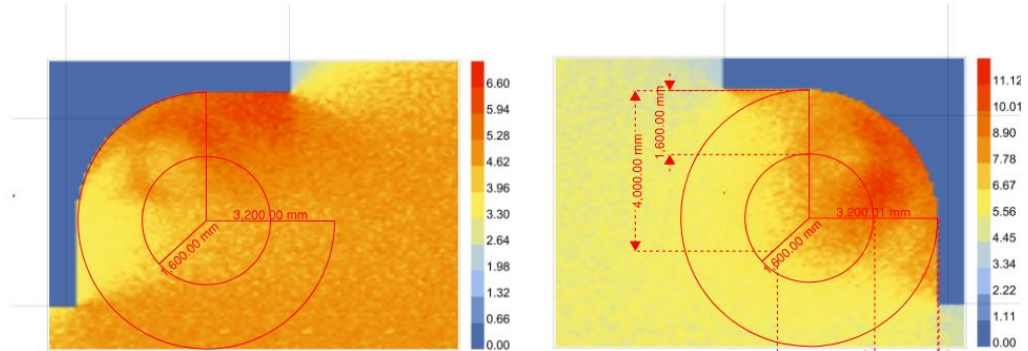
Dirt Burns



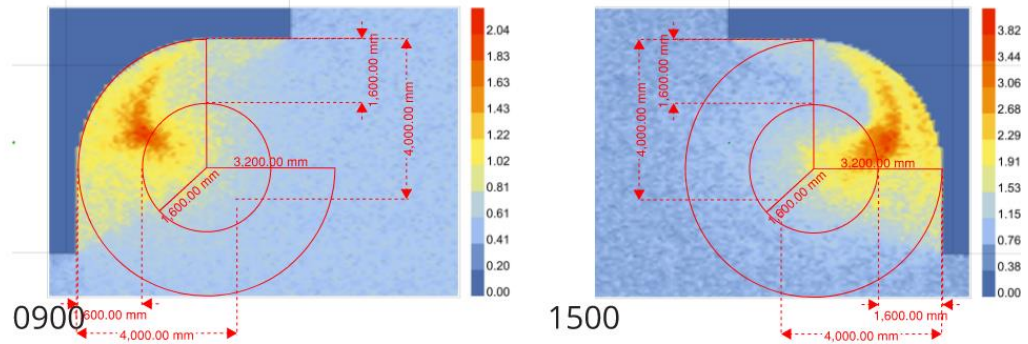
Repaired?



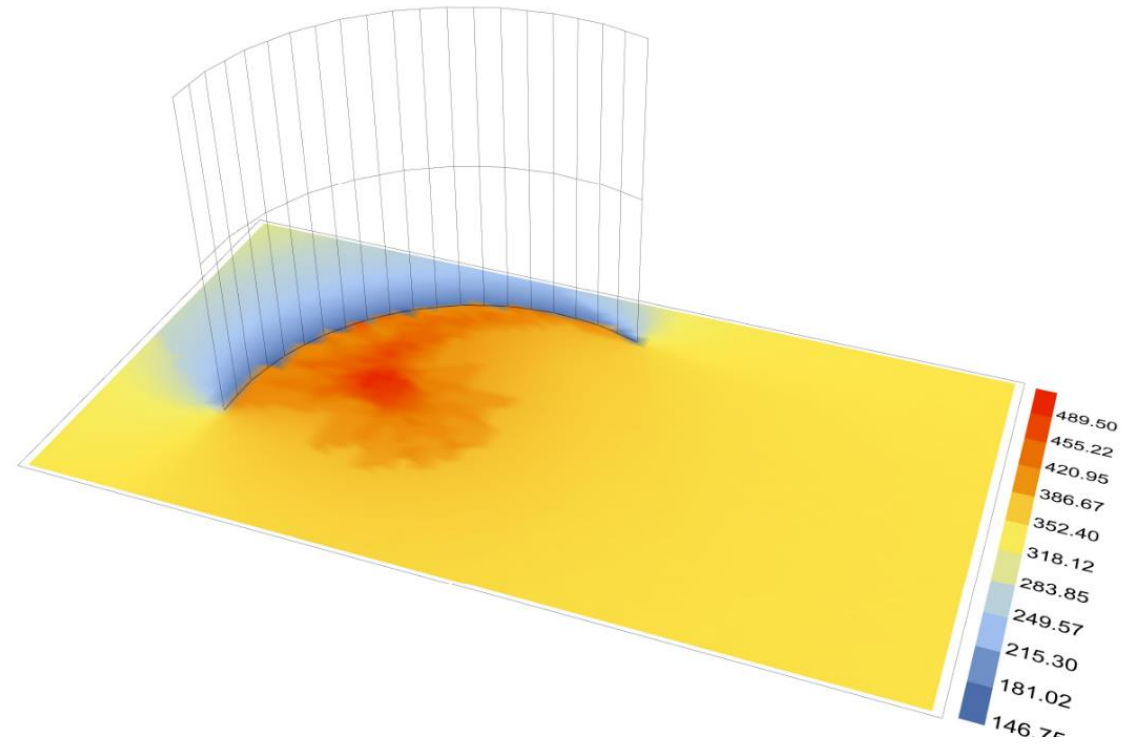
Finite Element Modelling



0600-1800



1500



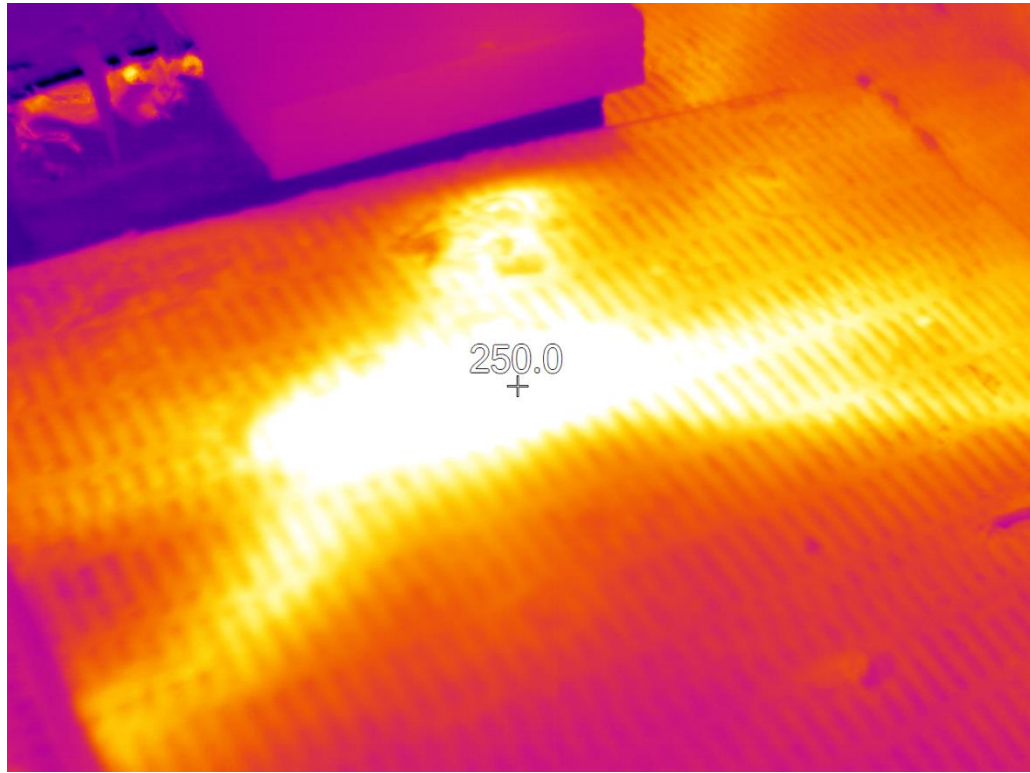
Sensor Installation



As-Built



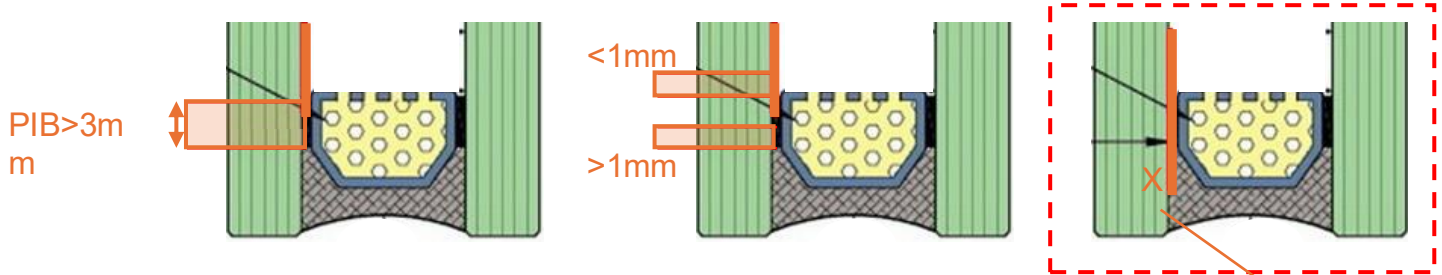
Diffusion Film



A cityscape featuring a prominent blue glass skyscraper in the center. The building has a curved facade and is surrounded by other buildings of various architectural styles, including a brick building to the left and a grey building to the right. The sky is clear and blue. The text "Case Studies: IGU Failures" is overlaid in white on the central part of the image.

Case Studies: IGU Failures

Edge Seal



- Metallic Low-E coatings sensitive to corrosion if not protected from high humidity
- Primary seal (PIB) is the vapor/humidity seal and needs to protect the edge of the coating
- Silicone (secondary seal) very water vapor permeable

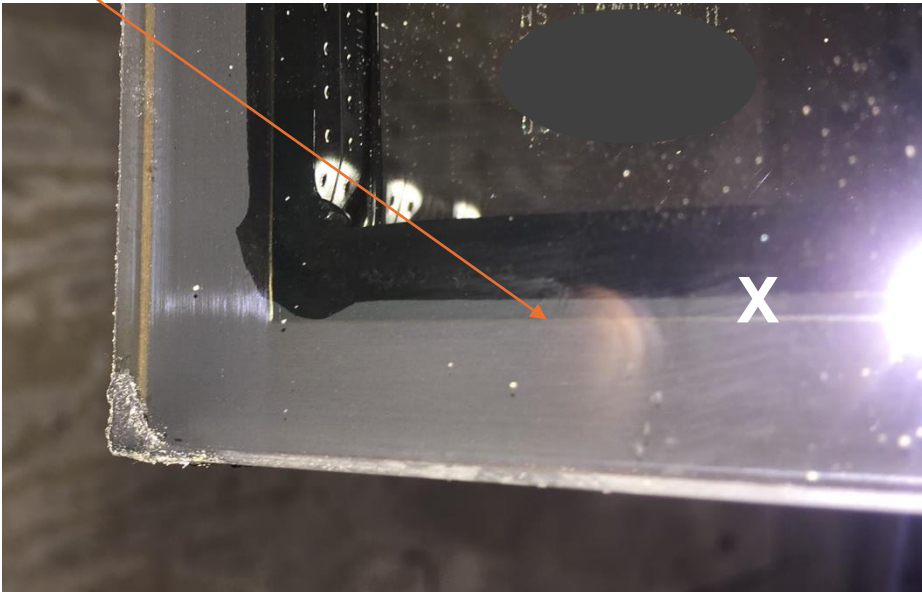
Recommended:

Primary Seal (PIB): Minimum width 1/8" (3mm)

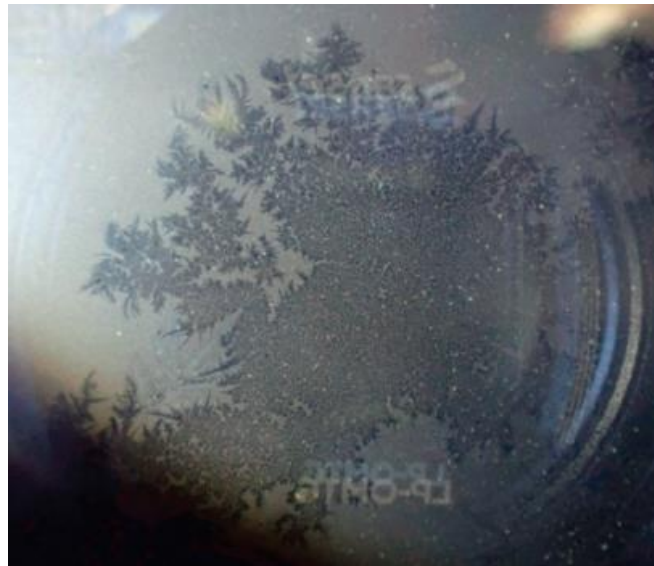
Edge Deletion: (1mm) Straightness of edge deletion ±3/64 inch

Butyl-Glass Contact: Minimum Coating Free Glass Contact: 3/64" (1mm) Maximum

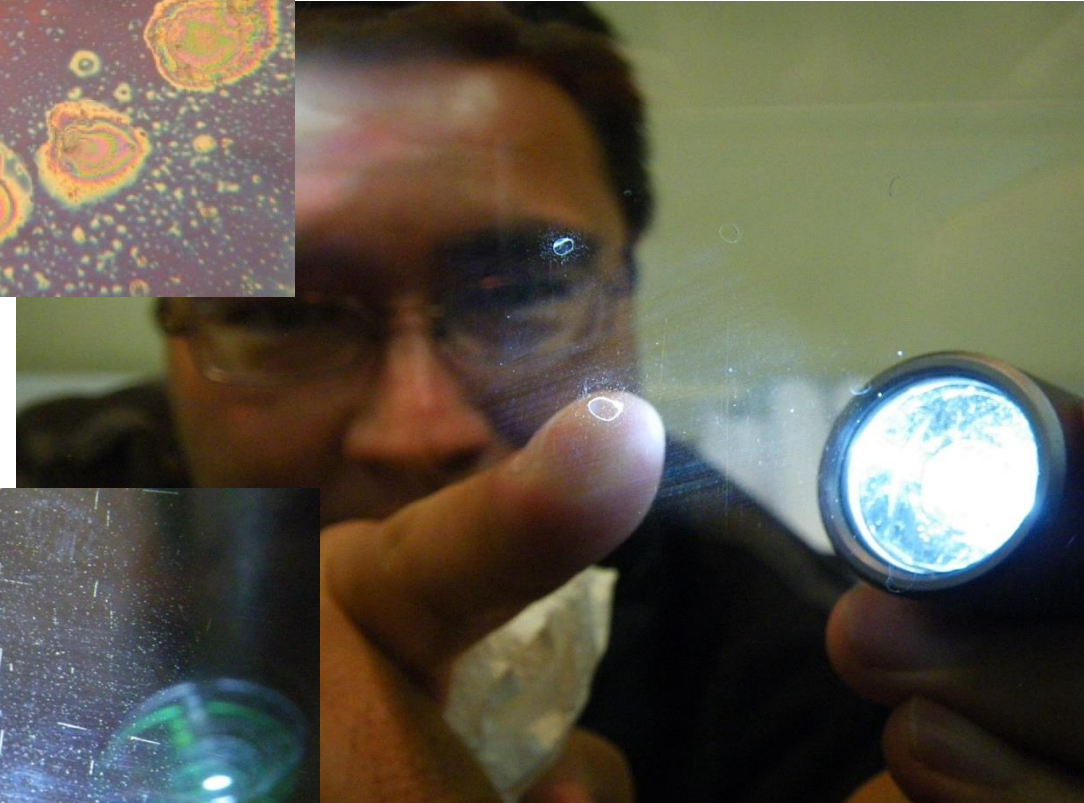
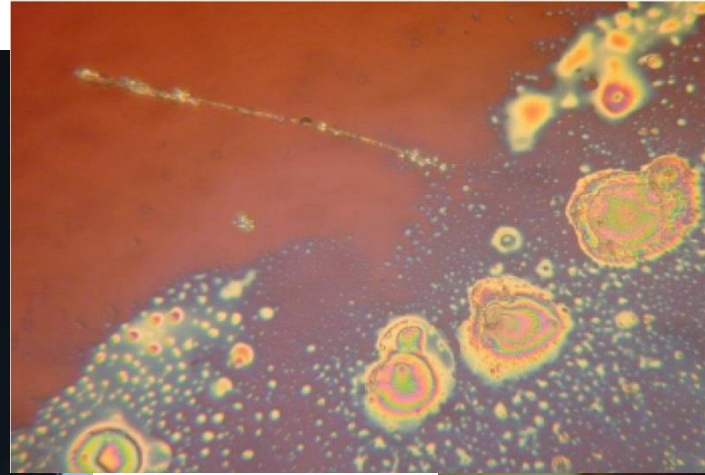
Clear Line: 3/64" (1mm)



Signs and Symptoms – Failed IGU Seals



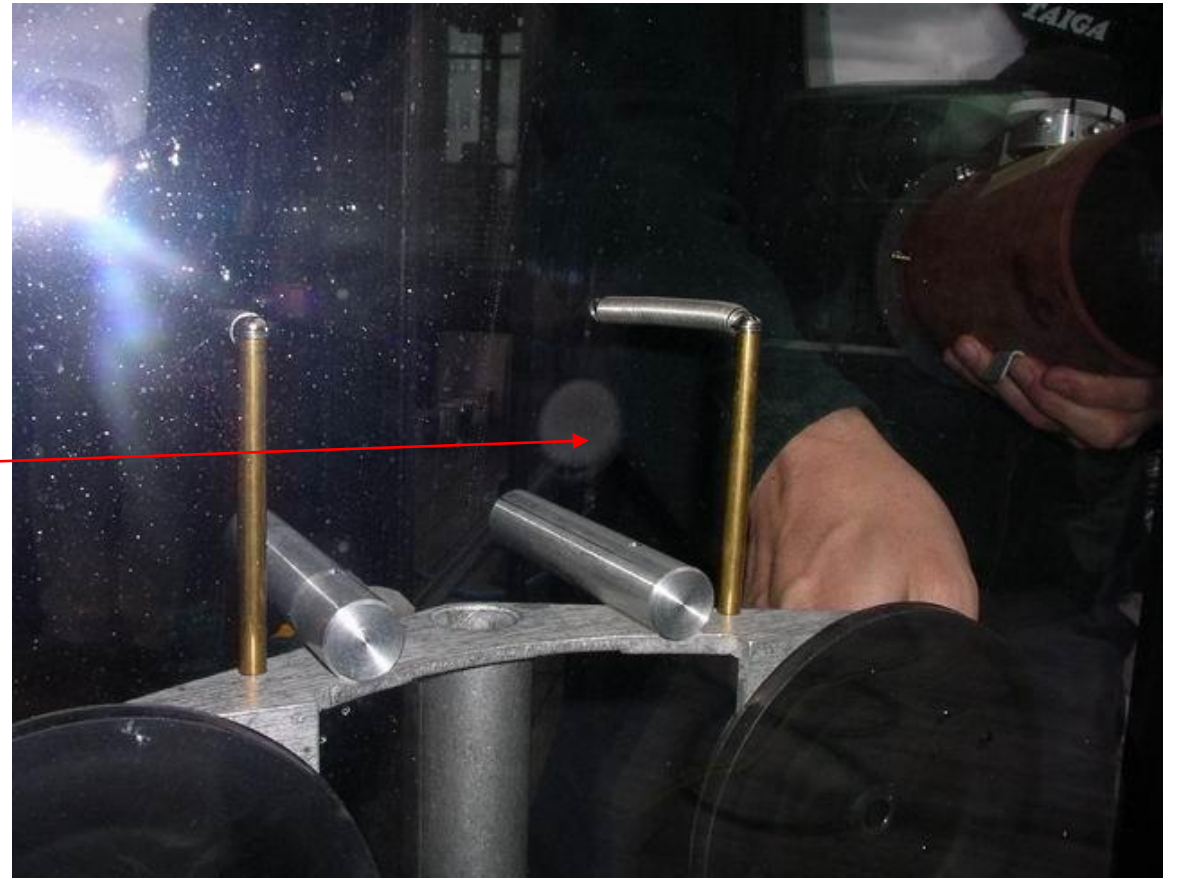
Signs and Symptoms – Failed IGU Seals



IGU Fabrication QA/QC



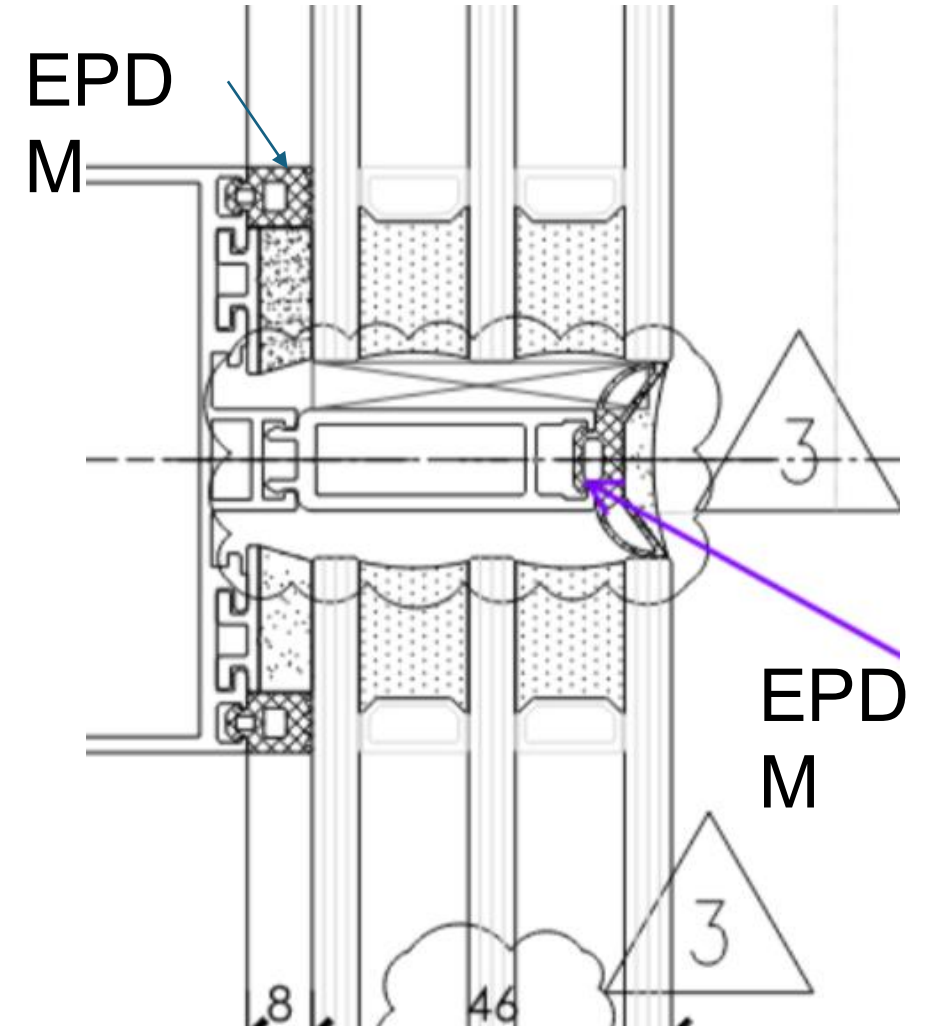
Frost Point Testing



IGU Fabrication QA/QC – Toggle Adapter Installed Manually



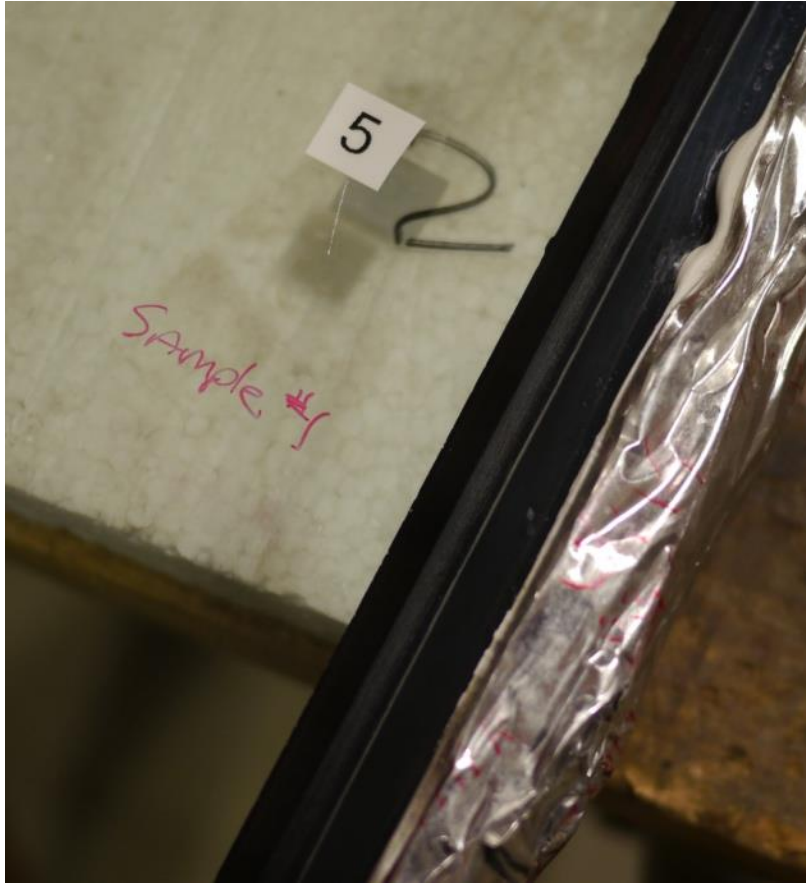
Low-E Corrosion & Delamination



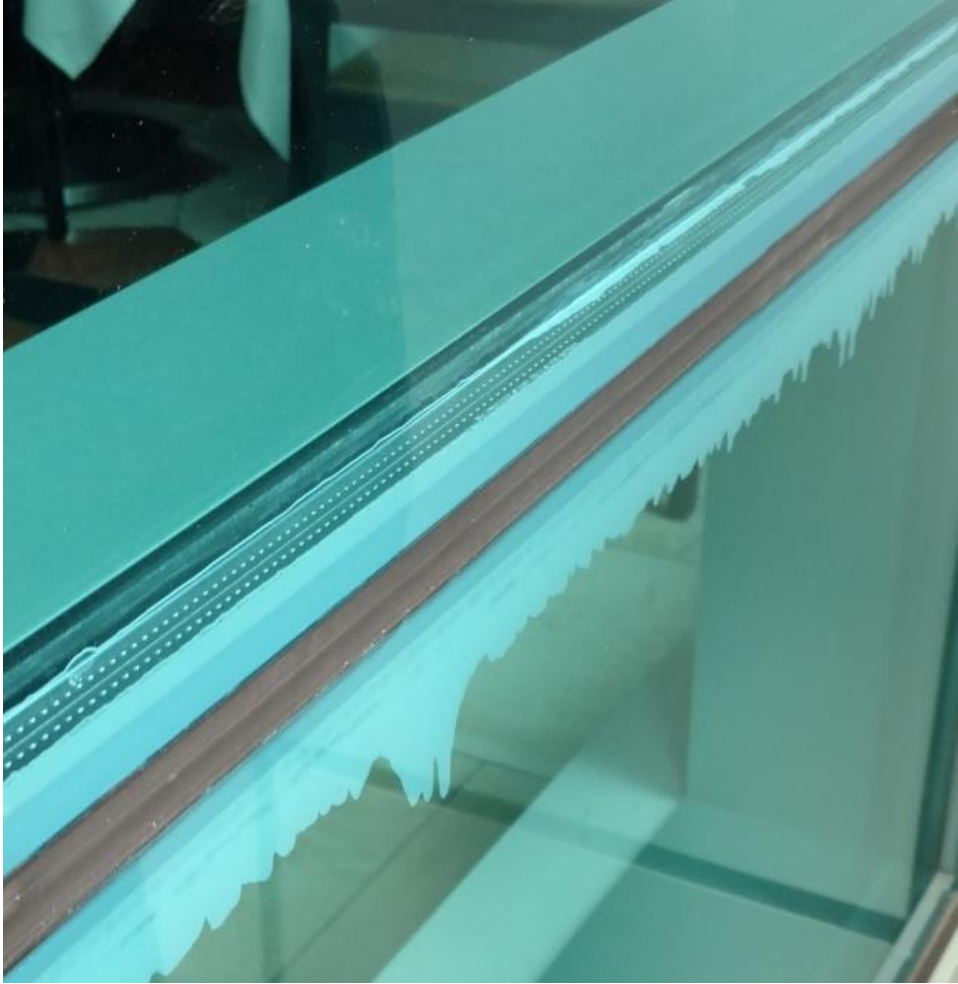
Sealant/Gasket/Setting Block Incompatibility



Compatibility Testing

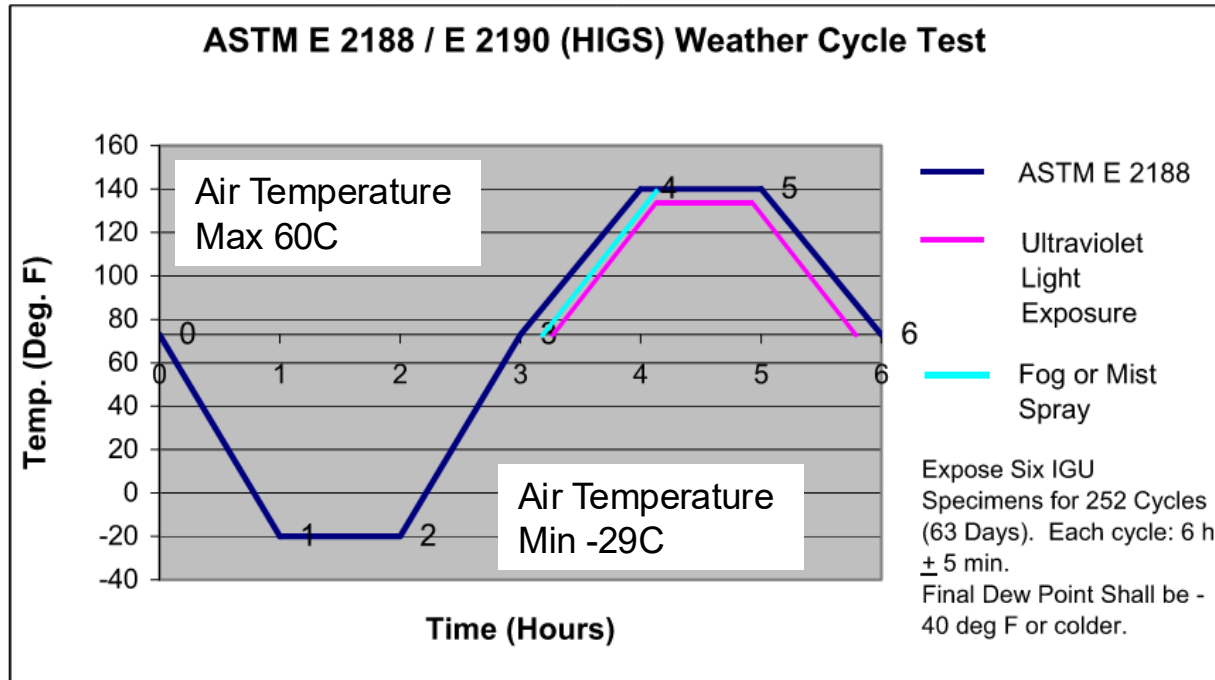


PIB Migration



Spandrel Panel and Shadow Box Performance and Durability

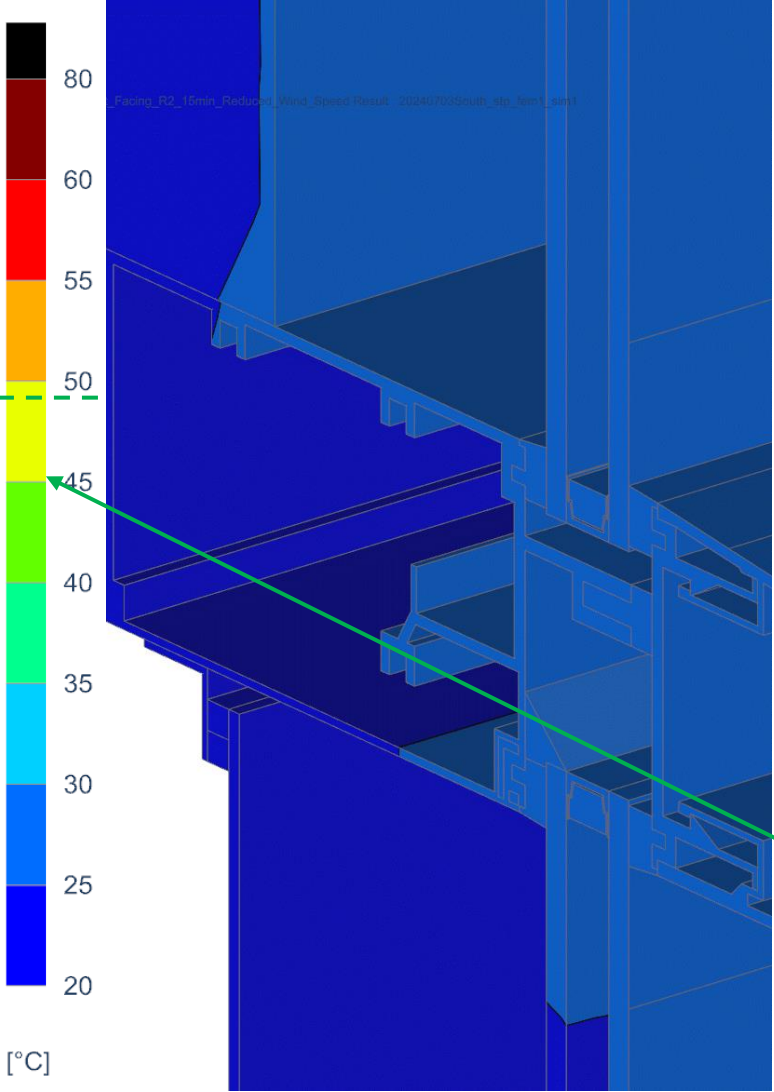
ASTM 2190 – Standard IGU Durability Test (Vision)



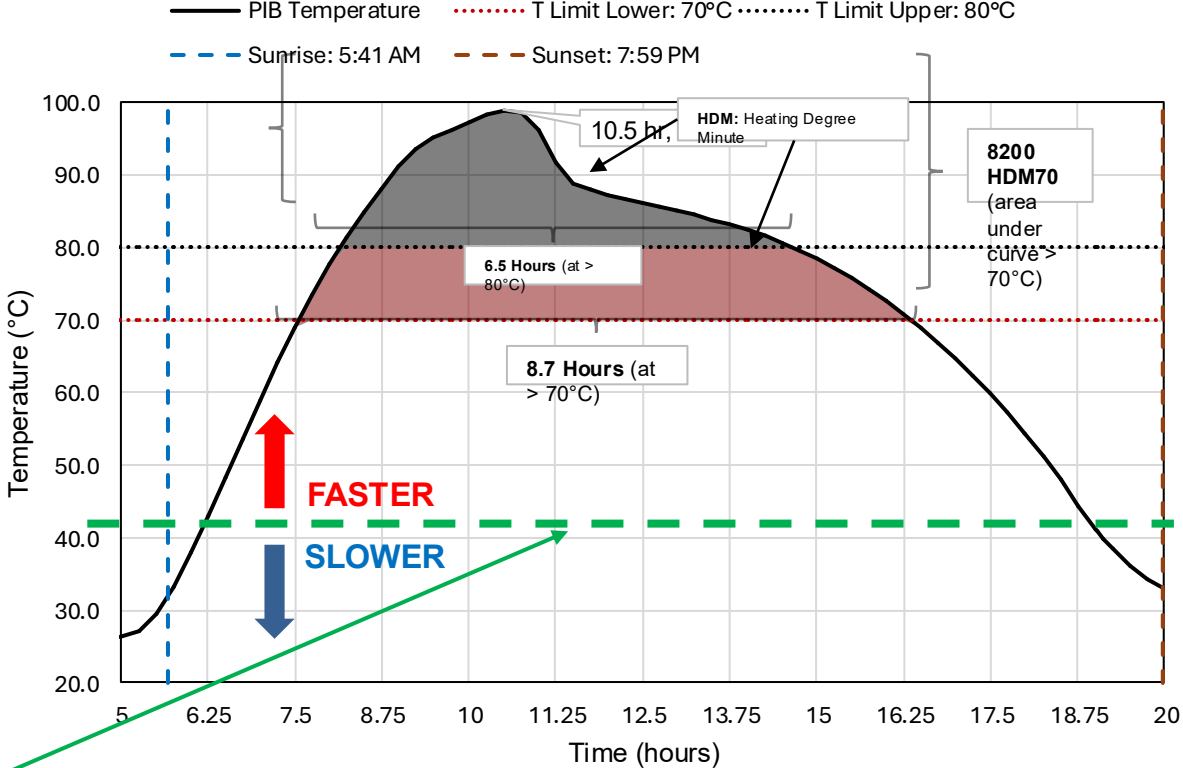
- It is suggested that ASTM E2190 applies in the order of 10 years of weathering to the test samples ? In reality, every building is different.

Spandrel Panel and Shadow Box Performance and Durability

THERMAL PERFORMANCE OF SPANDREL ASSEMBLIES IN GLAZING SYSTEMS RESEARCH (Charles Pankow Foundation)

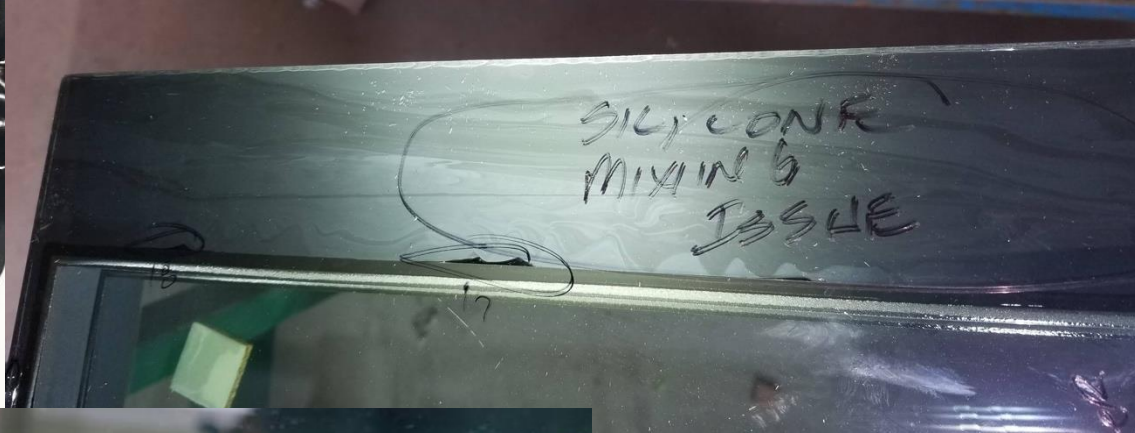
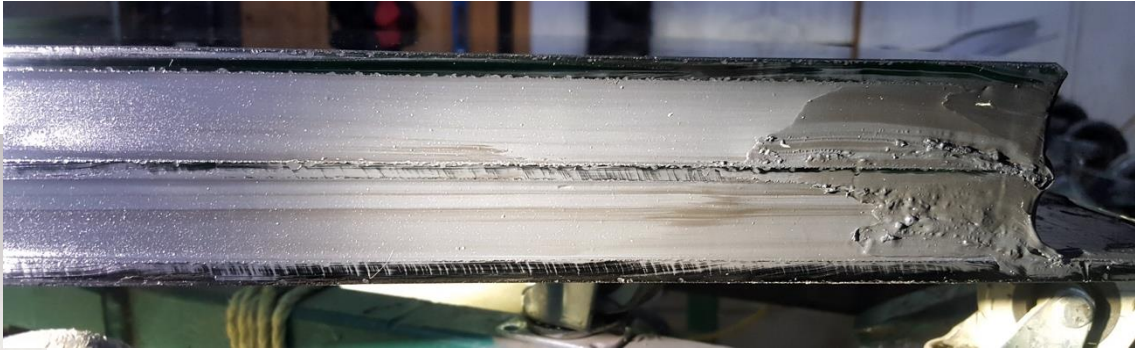


Hermetic Seal Temperature @ Spandrel

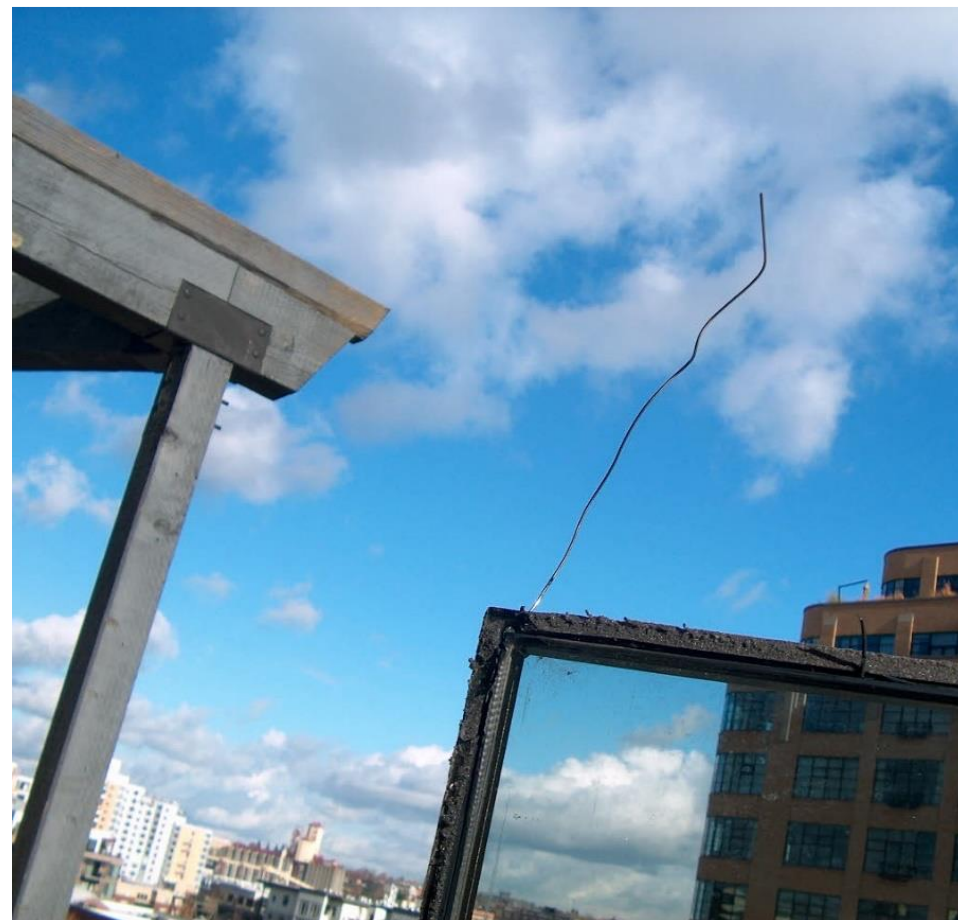


Maximum Temperature predicted for Hermetic Seal in ASTM E2190

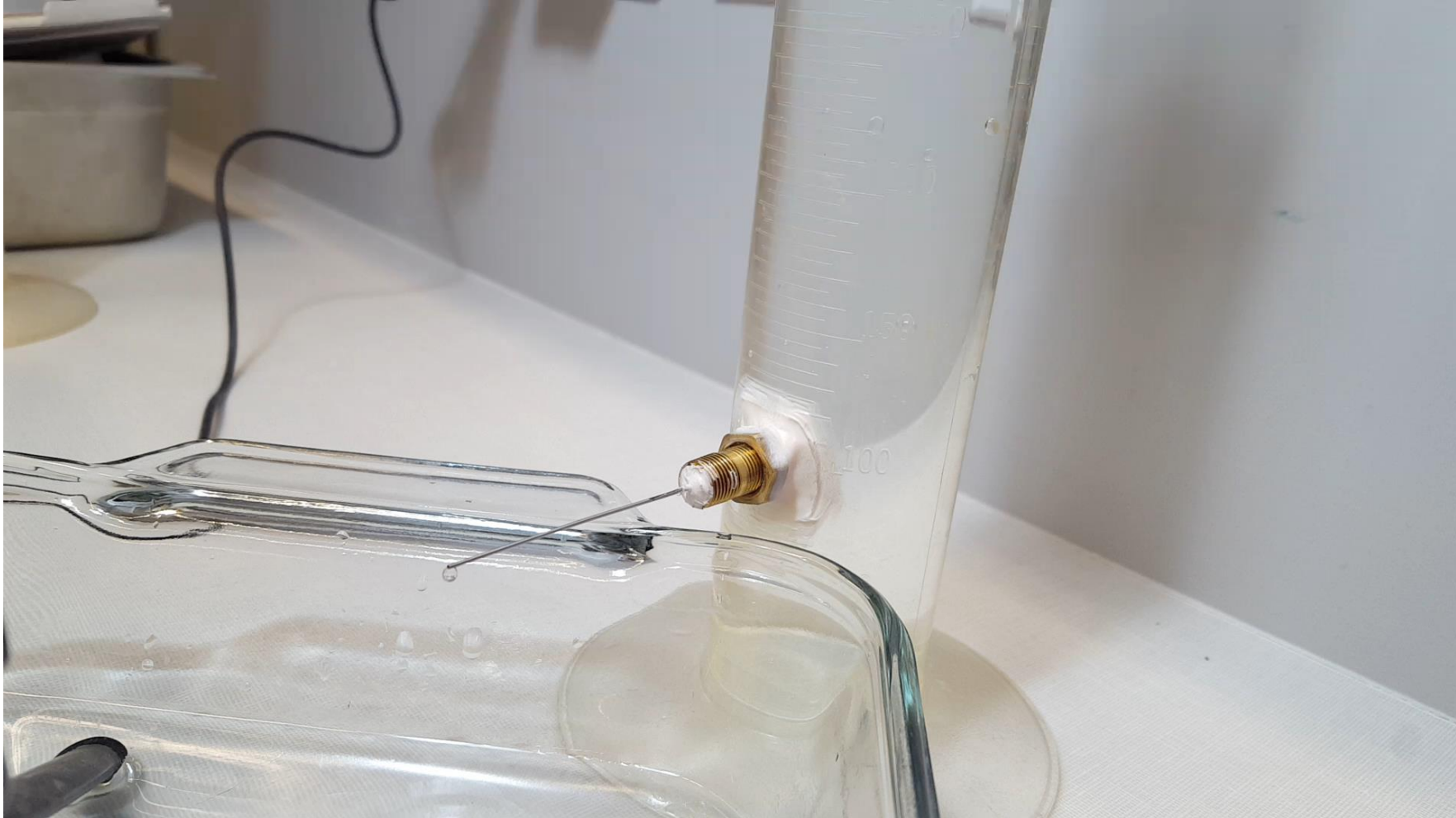
IGU Fabrication QA/QC



Unsealed/Poorly Sealed/Mangled Capillary Tubes

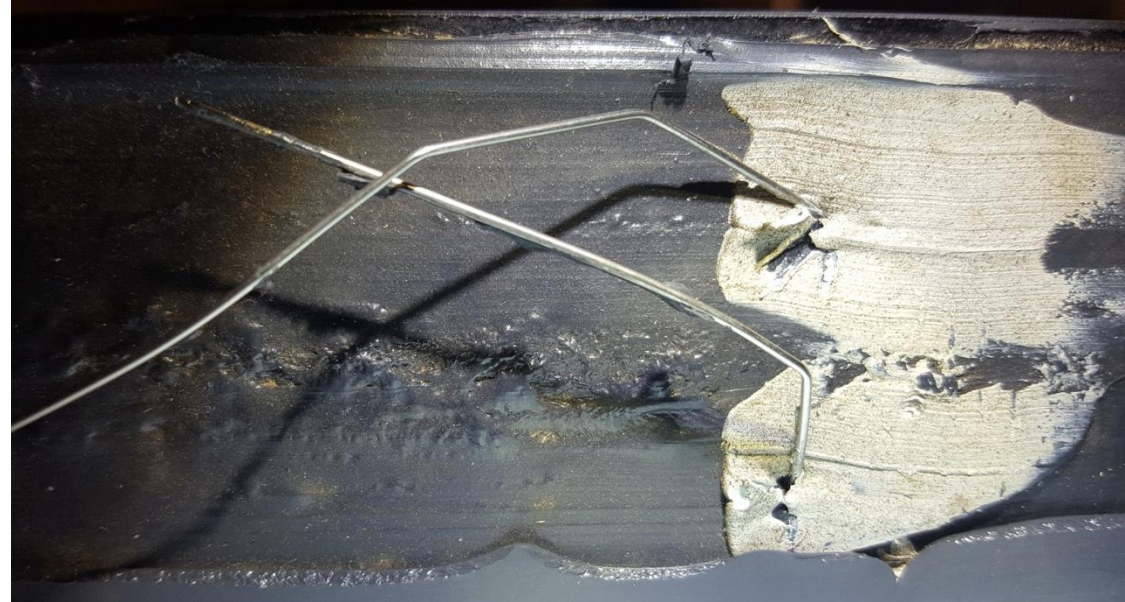


Case Study – Do You Need To Seal Capillary Tubes? YES!



Unsealed/Poorly Sealed/Mangled Capillary Tubes

- Avoid using capillary or breather tubes whenever possible.
- If you must use them, make sure all vent tubes and capillary tubes are sealed.
- Make sure manufacturer is certified for and has tested IGU's to ASTM2190 with breather tubes and proposed sealing method.

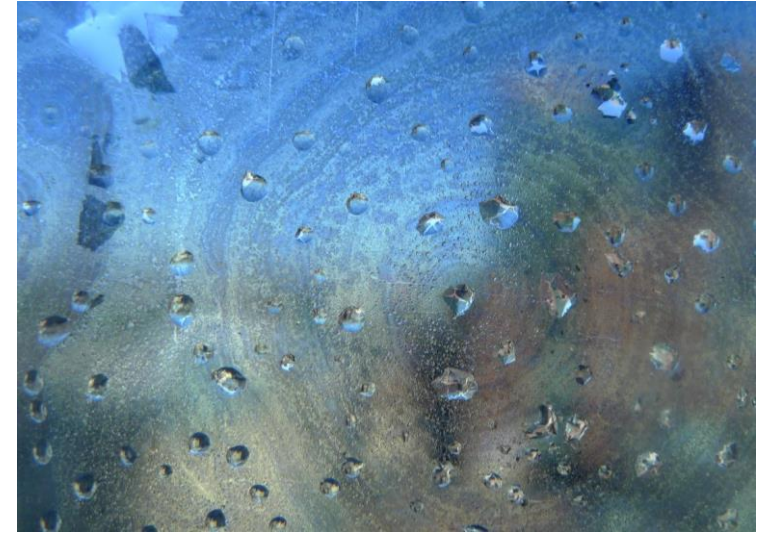


Systemic Highrise IGU Glazing Failure

- Glazed Aluminum Unitized CW
- 10-yr old – Due Diligence Inspection
- Low-e failure | Multiple / Progressing Failures
- No Reported Water Intrusion



Case Study: Corrosion of Low-E



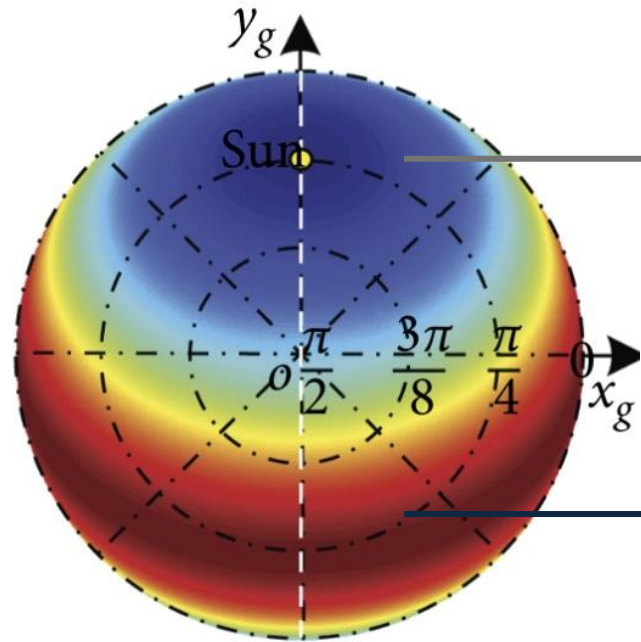




Case Study: Anisotropy Optical Distortion and Haze

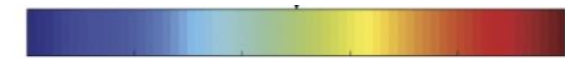
Anisotropy - Visibility

Rayleigh Sky Model



Low Sky polarization

High Sky polarization

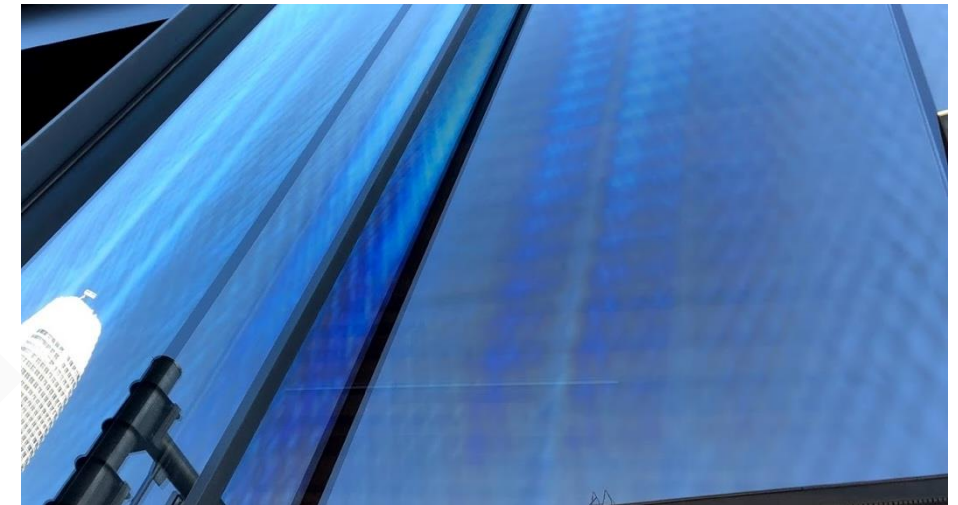
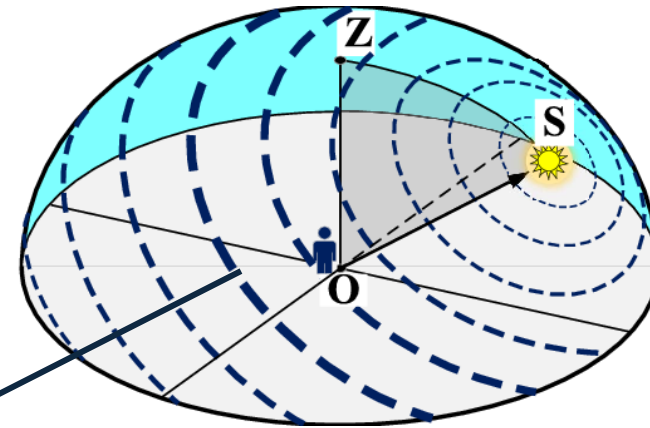


0 0.2 0.4 0.6 0.8 1.0

Degree of Polarization (DOP)

Highest Potential for Visibility of Anisotropy on building elevations facing highly polarized portions of the Sky Dome

Direction of Sky Polarization



What we see...



What we do not want to see...

Regular patterning is inevitable.

Stripes,

Blotches,

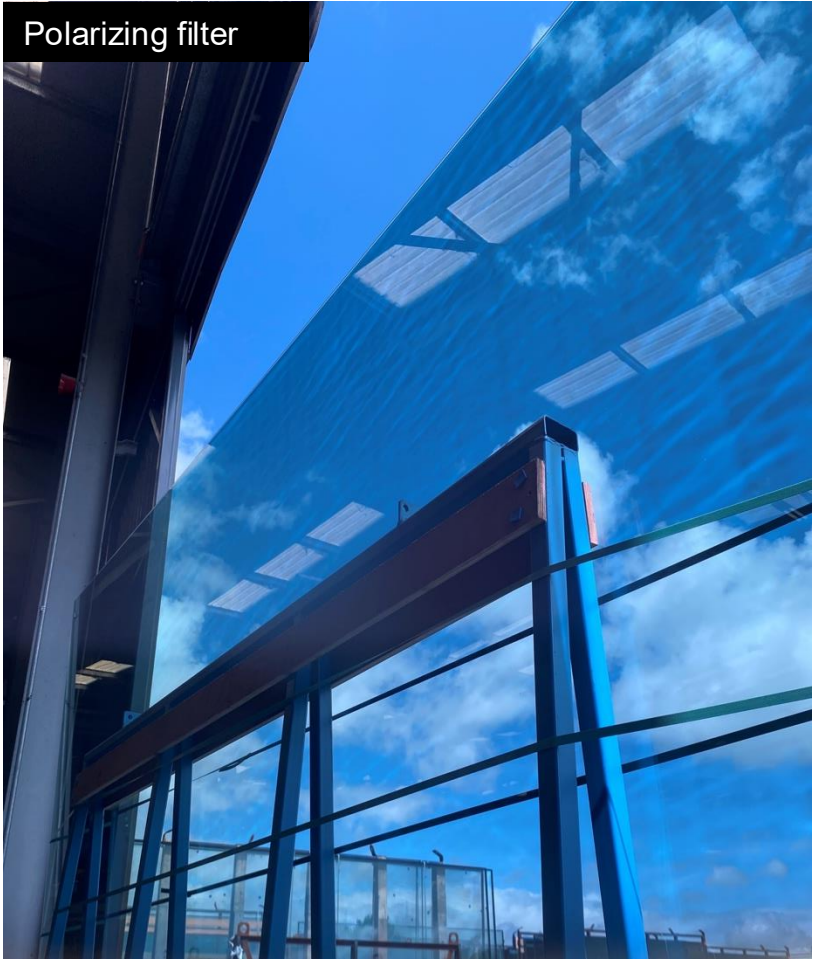
Change of Direction,

excessive Retardation

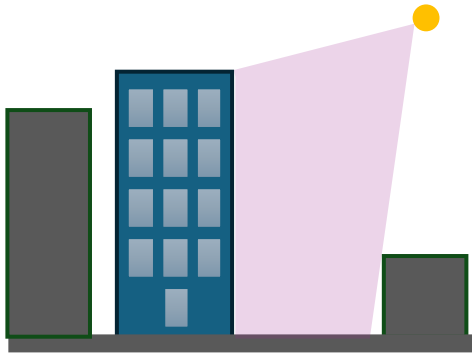
..should be avoided.



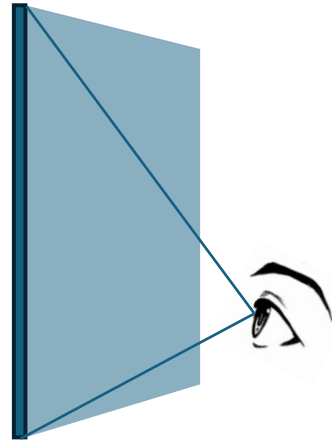
Supplier X Sheet Review



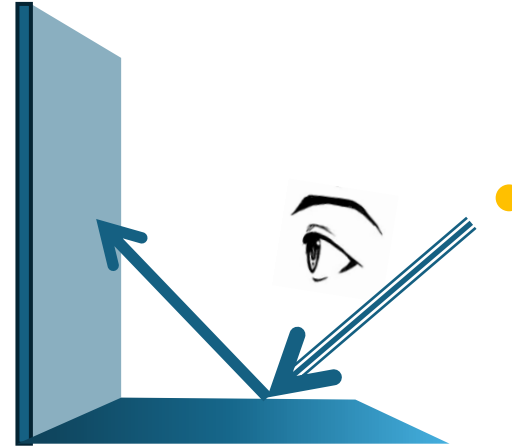
Influencing Factors



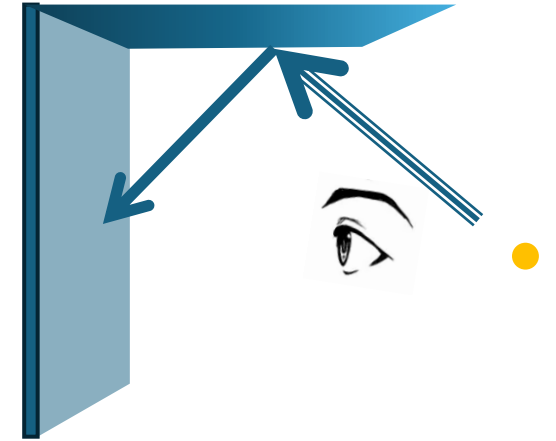
Wide angle of sun exposure



Shallow viewing angle



Reflective surfaces

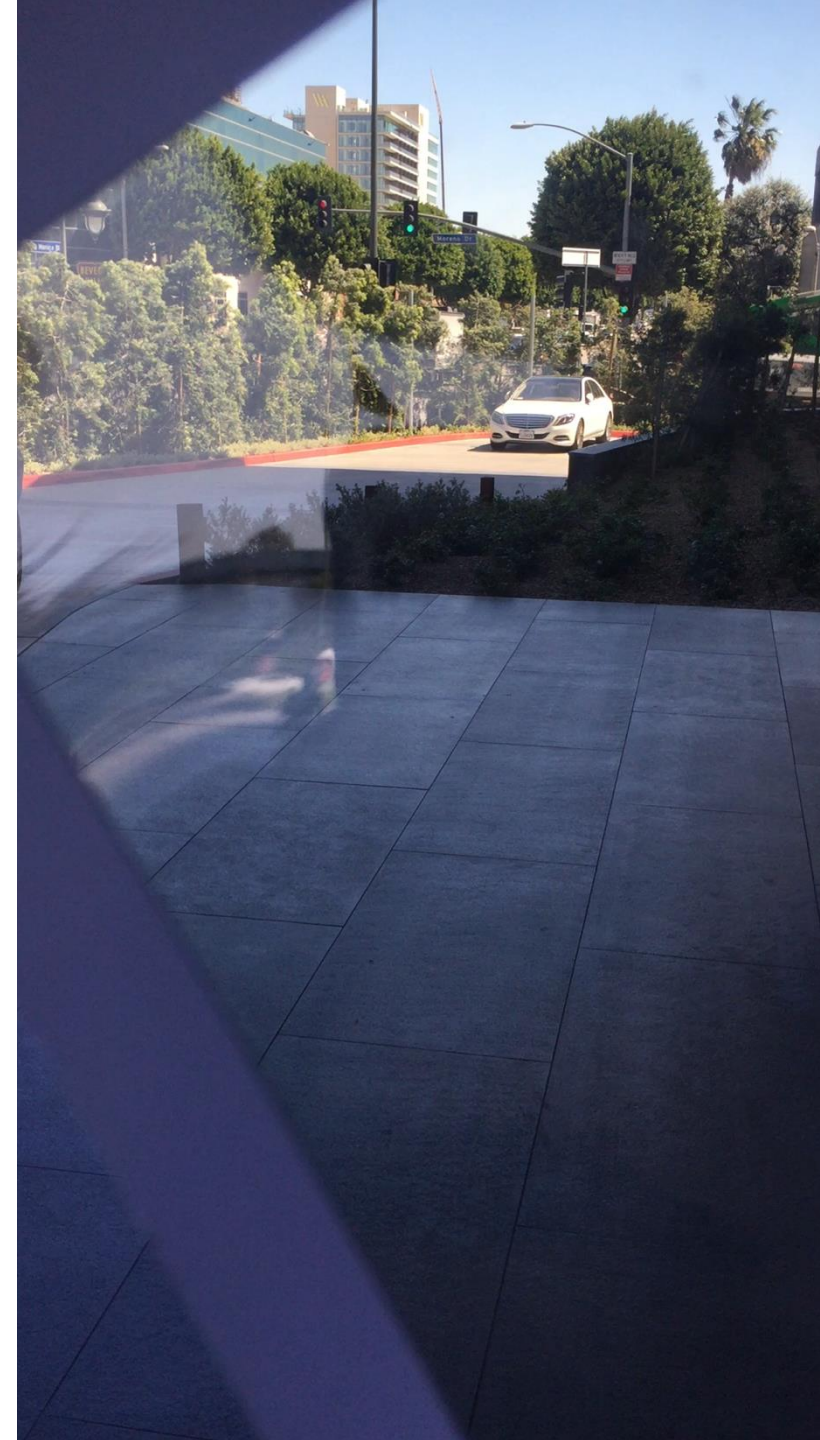


Specular surface materials

+ thick glass substrates, multiple glass layers, coating selection, complex shapes, larger glass

Example

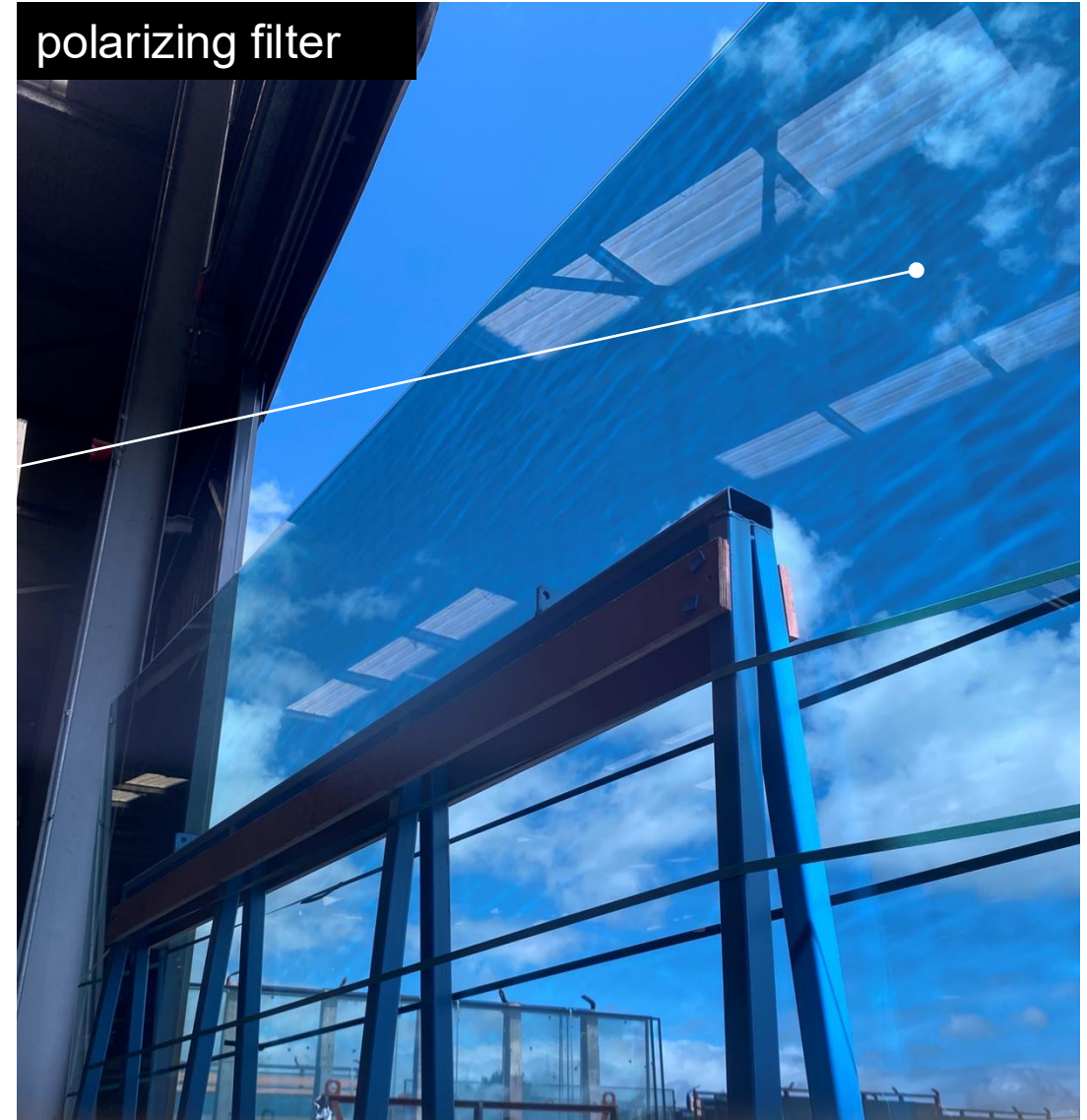
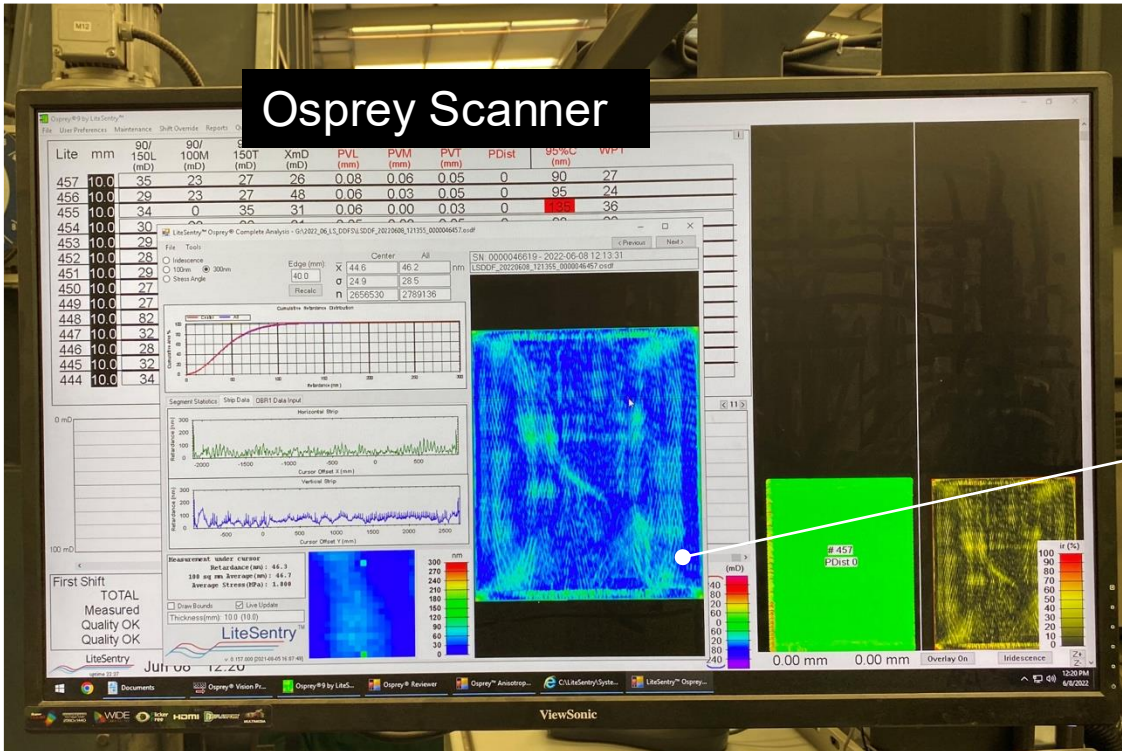
Polarization Through Reflection



Haze

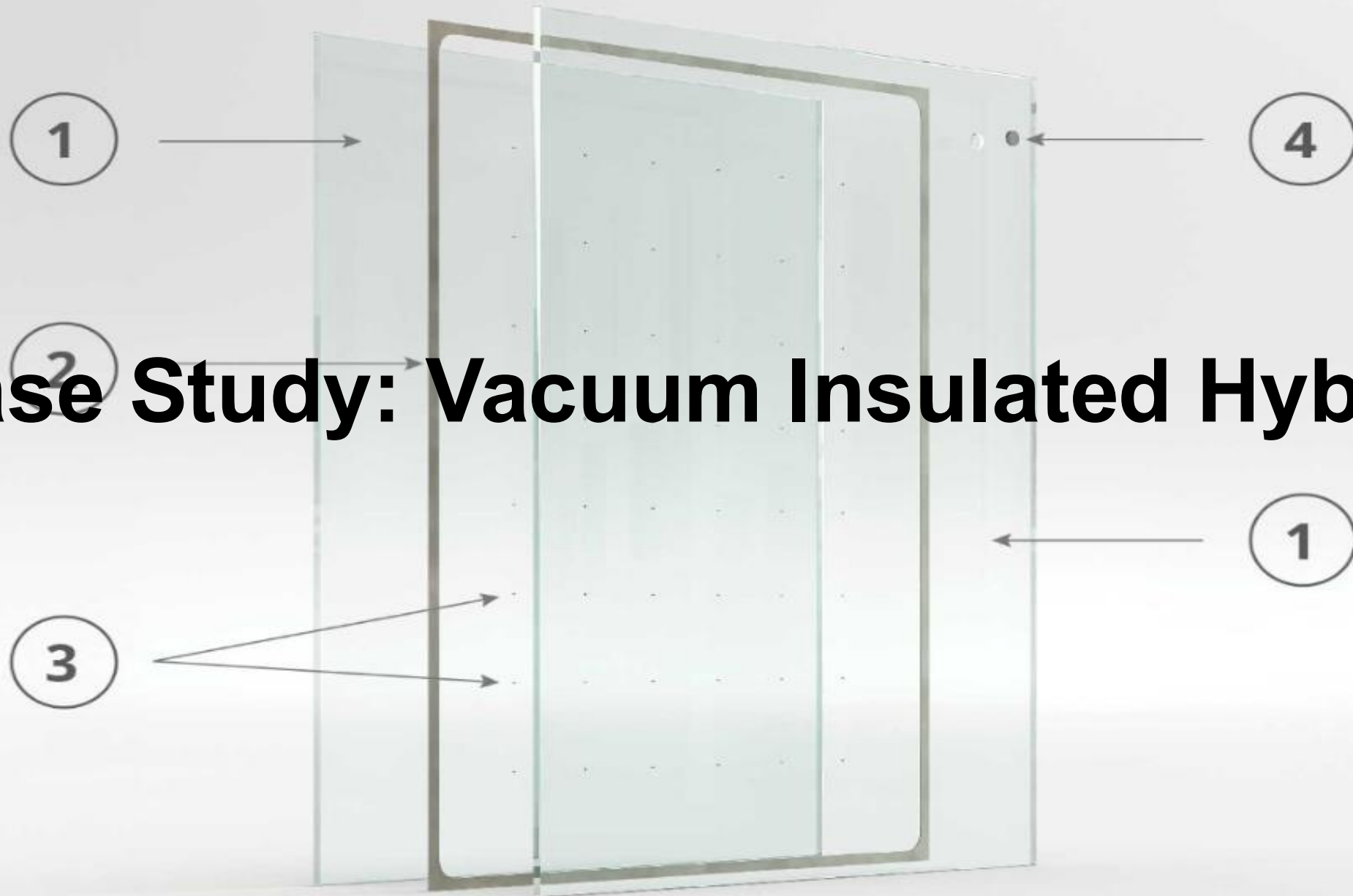


Anisotropy – Control

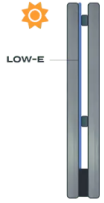


Glass Thickness	Not Noticeable (Sedak)	DIN SPEC 18198			ASTM C1901
		Class A	Class B	Class C	
6mm	40	70	70-95	>95	120
8mm	50	80	80-120	>120	
10mm	60	95	95-140	>140	250
12mm	80	115	115-165	>165	

Case Study: Vacuum Insulated Hybrids



VIG Hybrids

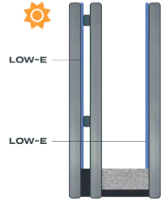


R-18
Enthermal™

0.056 COG U-Factor (BTU/h ft² F)
8-mm Thickness
Ideal for Single Pane Retrofits

LOW-E

DOWNLOAD ENTHERMAL DATA SHEET



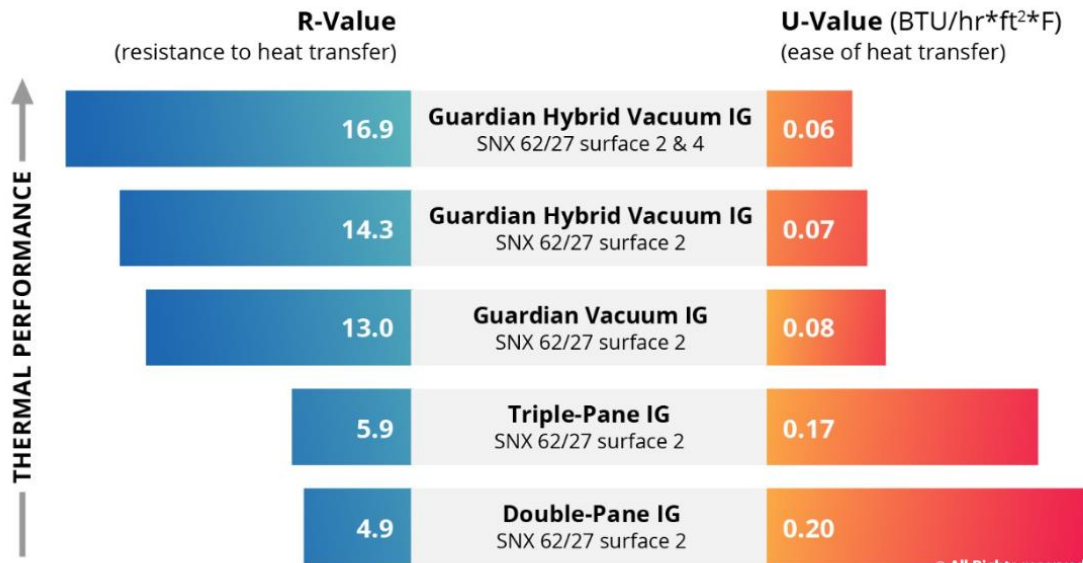
R-21
Enthermal Plus™

0.05 COG U-Factor (BTU/h ft² F)
25-mm Thickness
Ideal for Double Pane Unit Retrofits

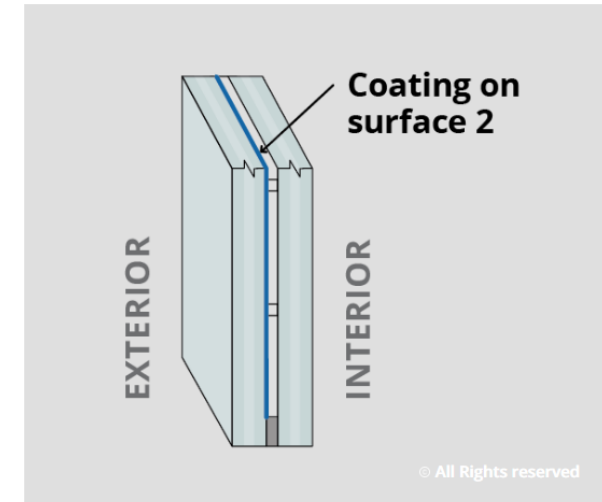
LOW-E

DOWNLOAD ENTHERMAL+ DATA SHEET

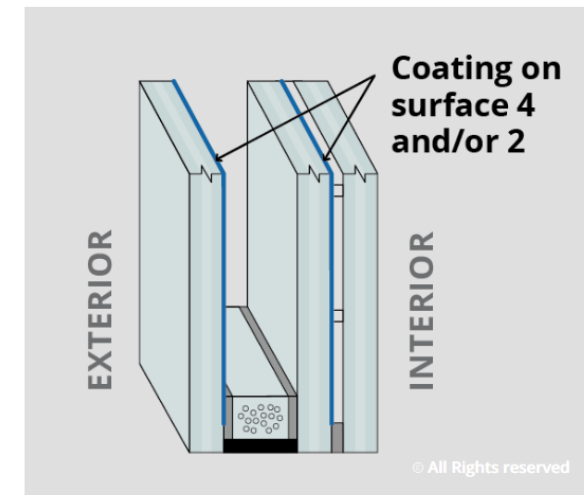
<https://www.luxwall.com/>



<https://www.guardianglass.com/us/en/our-glass/glass-types/vacuum-insulated-glass>



Standard vacuum insulated glass



Hybrid vacuum insulated glass

Before



Before – Single Glazed



After



After – Triple Hybrid VIG in



After – Triple Glazed

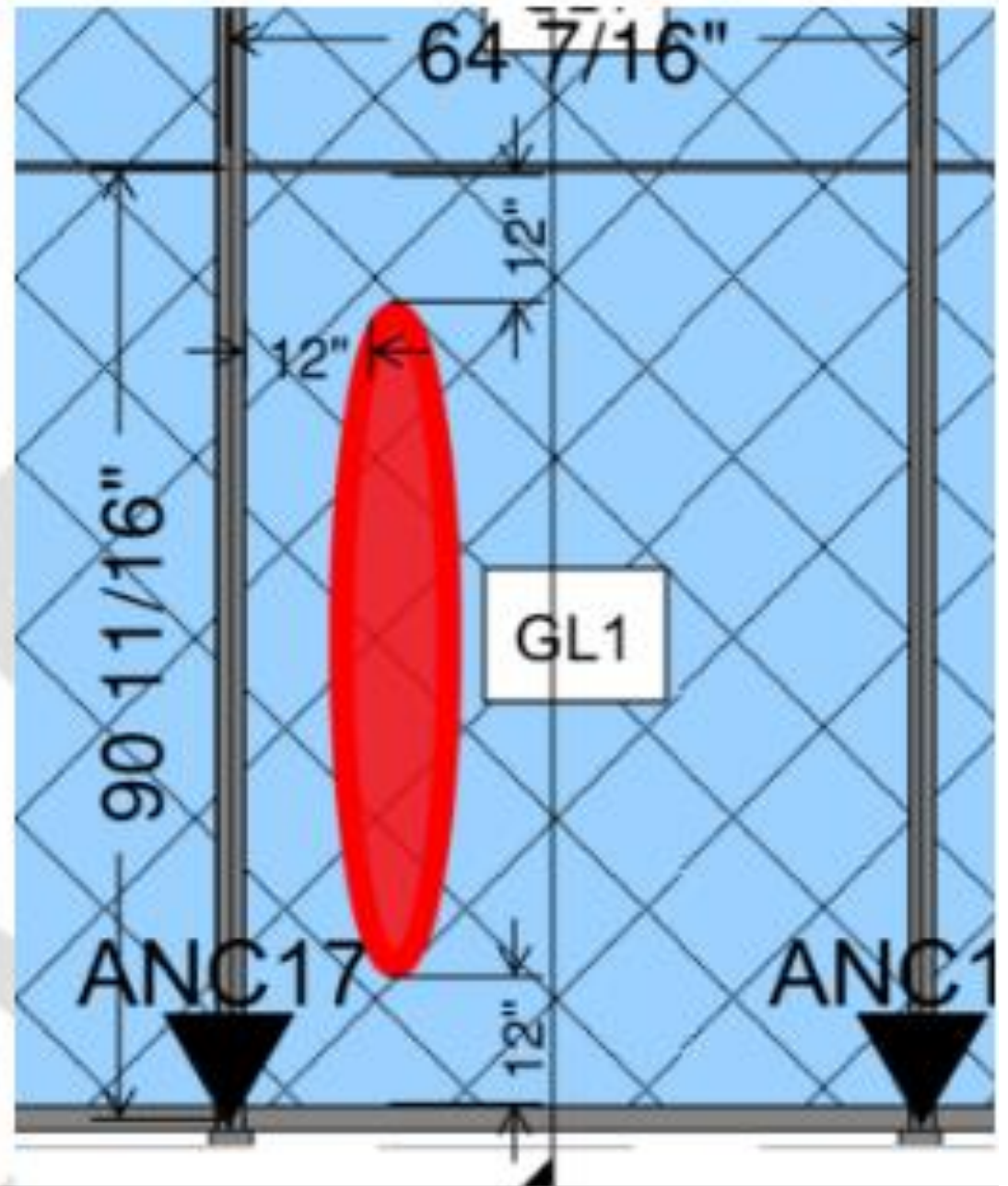


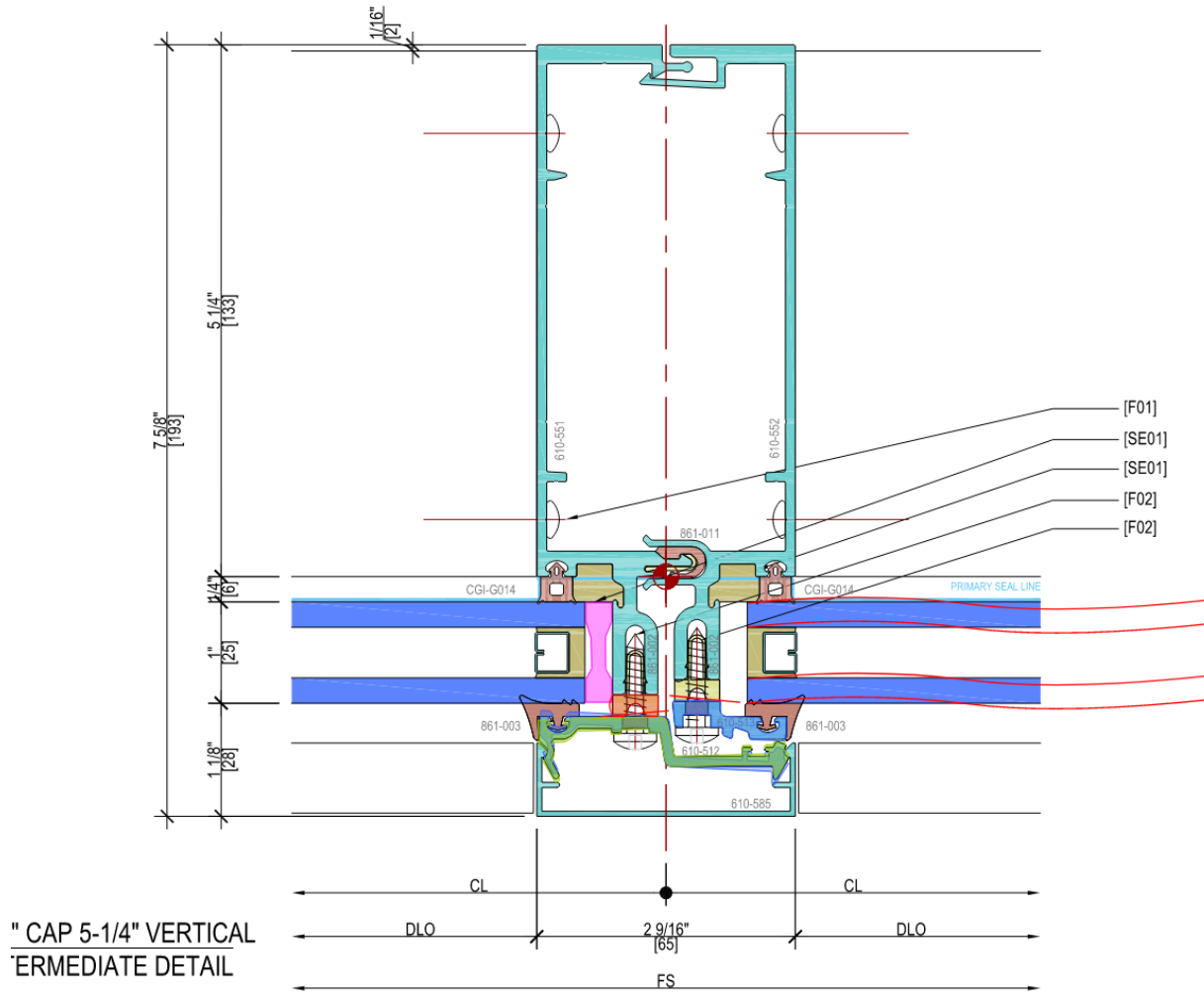
After – Triple Hybrid VIG out

An aerial photograph of a dense urban skyline, likely New York City, featuring a prominent blue skyscraper in the center. The image is overlaid with a semi-transparent blue filter. The text "Case Study: Optical Distortion" is centered in white, bold font.

Case Study: Optical Distortion







"CAP 5-1/4" VERTICAL
 ERMEDIATE DETAIL

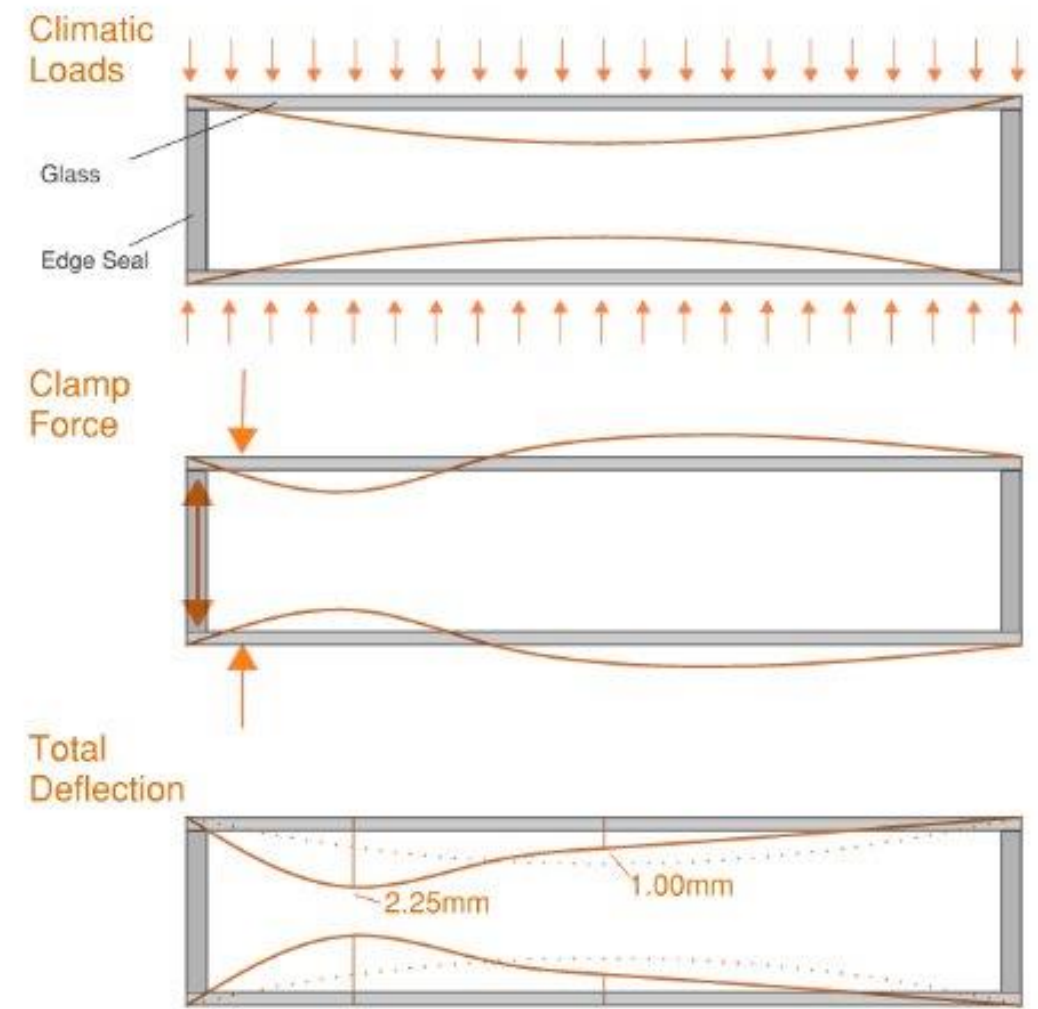


Table 3: Airspace Cavity Thickness Measurements with Glass-Chek ELITE 3200 - IGU Measured In-Situ Vertically Installed in Curtain Wall, dimension 65 7/16" x 90 11/16"

Distance (inches/mm) from left vertical mullion	3" (76mm)	12-16" (305-406mm)	32" (813mm)	63" (1600mm)
Location	Immediately adjacent to left vertical mullion	Location of optical distortion	Center of IGU	Immediately adjacent to right vertical mullion
Airspace thickness measured (mm)	12.6mm	9.5mm	11.8mm	14.2mm

Total Deflection

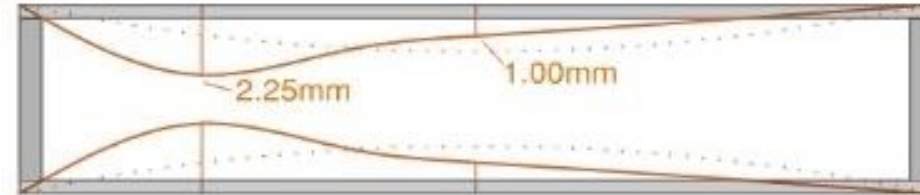
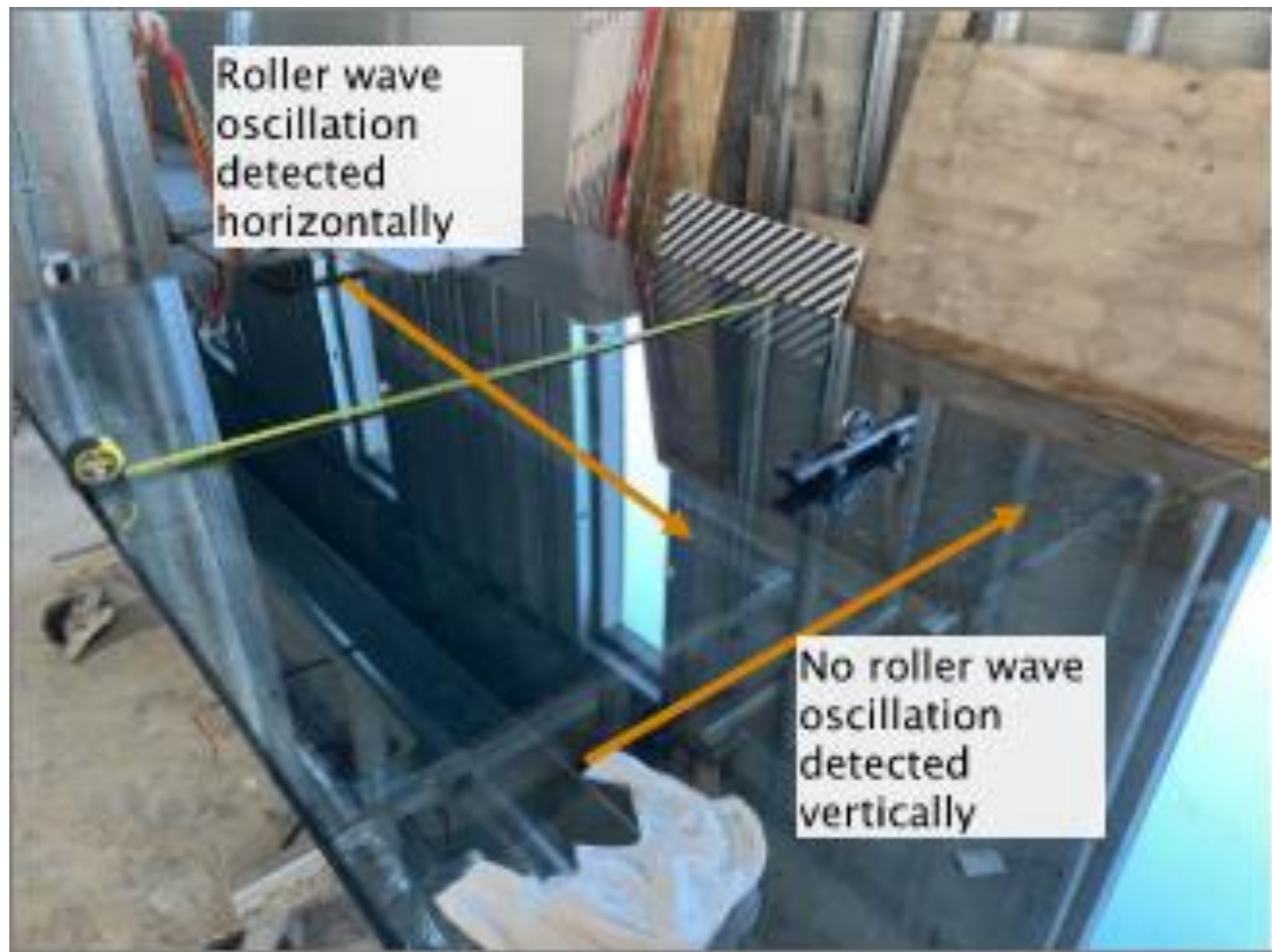


Table 4: Airspace Cavity Thickness Measurements with Glass-Chek ELITE 3200 - IGU Measured horizontally after de-glaze, dimension 65 7/16" x 90 11/16"

Distance (inches) from left vertical mullion	3" (76mm)	12-16" (305-406mm)	32" (813mm)	63" (1600mm)
Location	Immediately adjacent to left vertical mullion	Location of optical distortion	Center of IGU	Immediately adjacent to right vertical mullion
Airspace thickness (mm)	13.4mm	11.1mm	14.2mm	14.2mm



Roller wave
oscillation
detected
horizontally

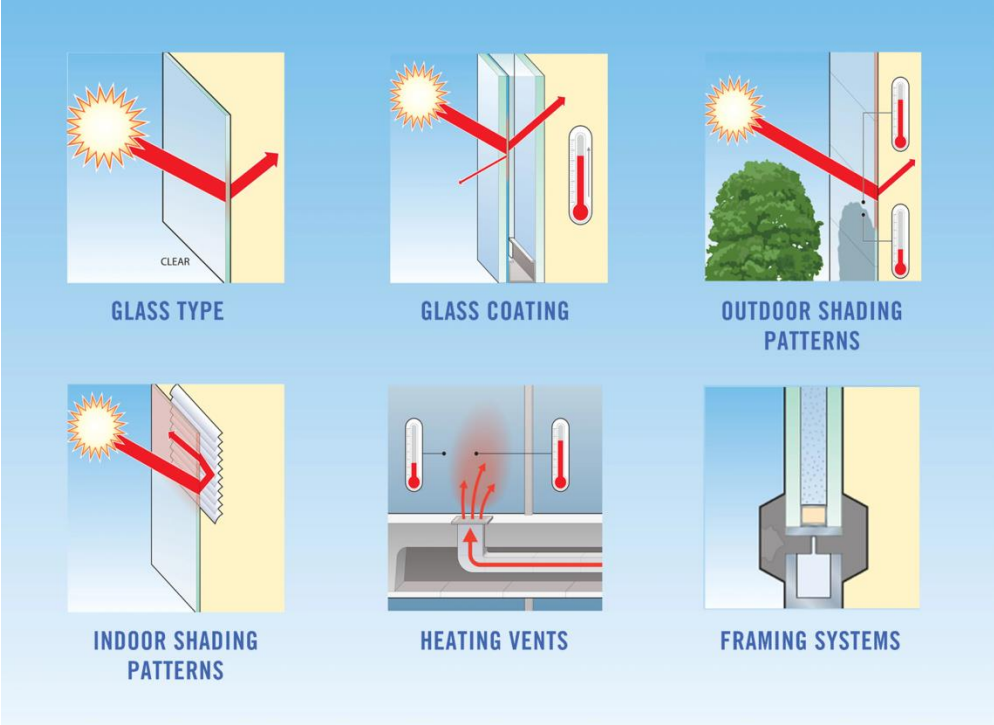
No roller wave
oscillation
detected
vertically

Case Study : Thermal Stress Breakage

Case Study – Sunny Day Breaks



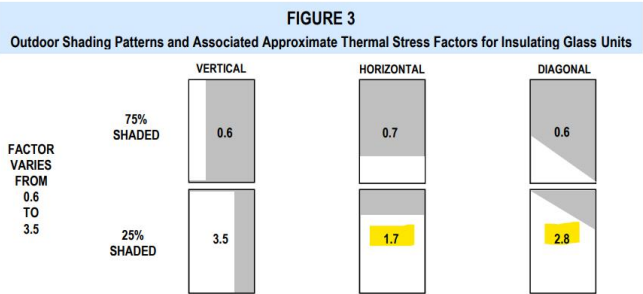
Case Study – Thermal Stress Breakage



<https://www.vitroglazings.com/>



Thermal Stress Update



Case Study – Thermal Stress Breakage

- Breakage always occurred on sunny days on elevations with solar shades.
- Annealed glass was specified and installed.
- Breaks always intersect at 90 degrees to edge.
- Installation of glazing units conformed to IGMA guidelines.
- Conclusion: Thermal stress breakage
- A 28 Degree Celsius difference in glass temperature is often sufficient to cause breakage of annealed glass. Solar shading allows part of the glass to be exposed to the sun while shading other parts of the same lite causing a significant temperature difference. Reflective coatings and solar selective low-e coating compound this effect.
- **Heat strengthened glass should always be used on projects with solar shading devices or when using reflective or heat absorbing glass products.**

Case Study

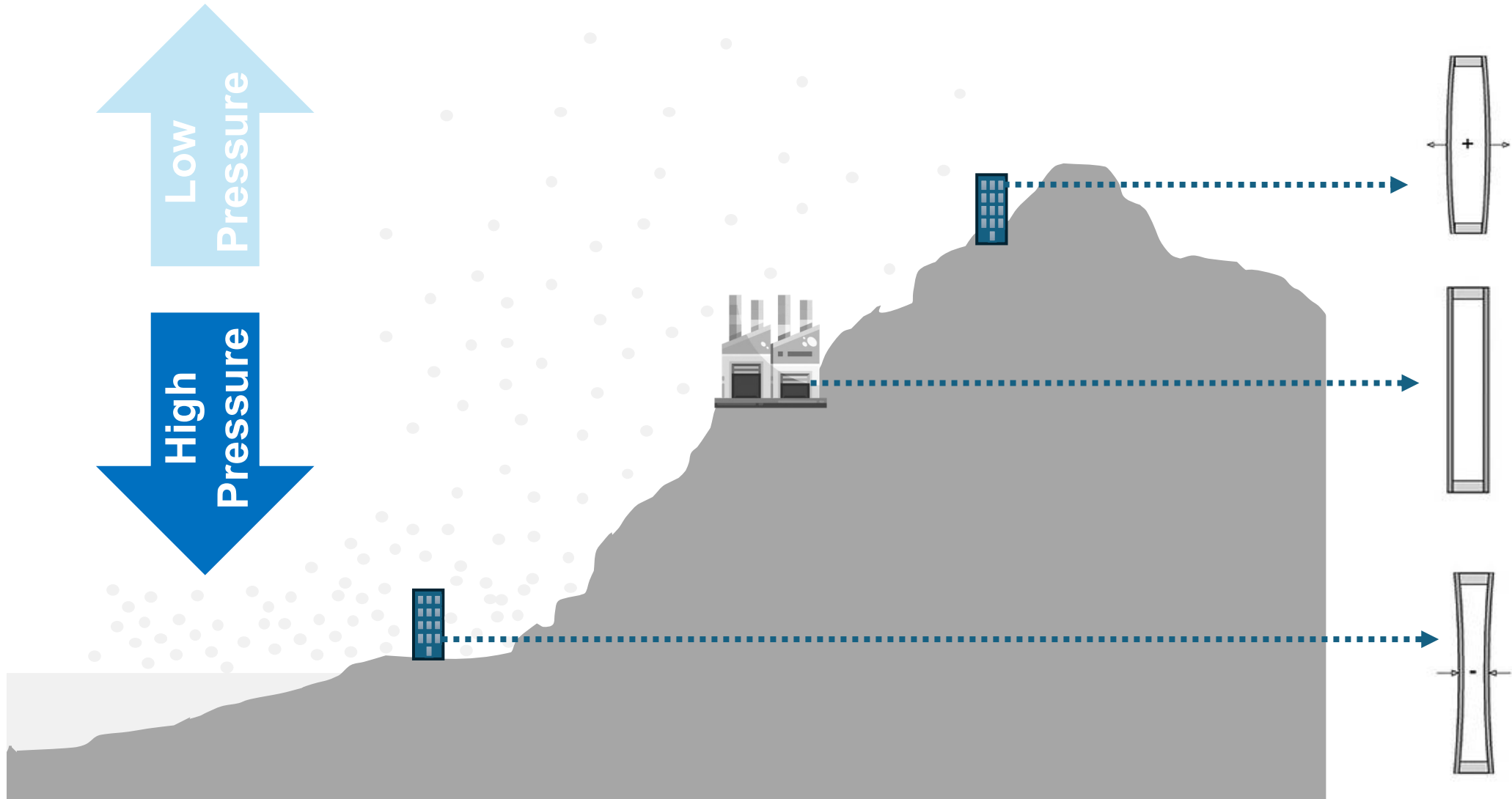
Climatic Load Deflection



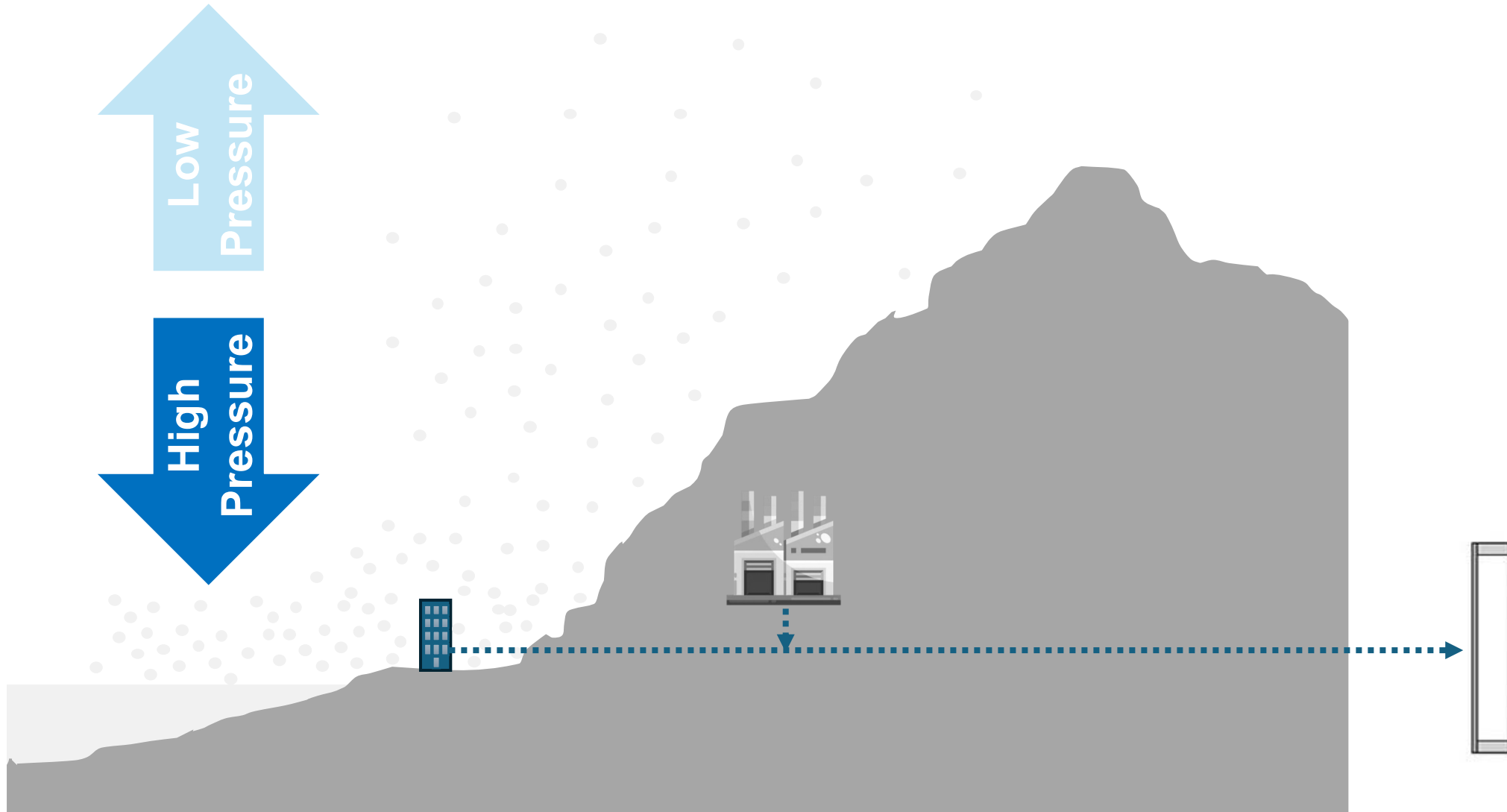
Climatic Load Deflection



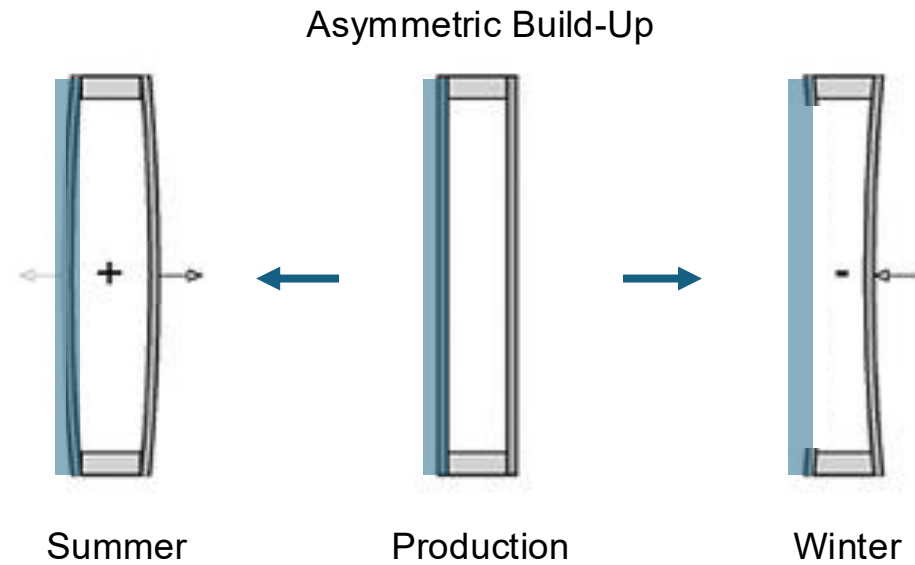
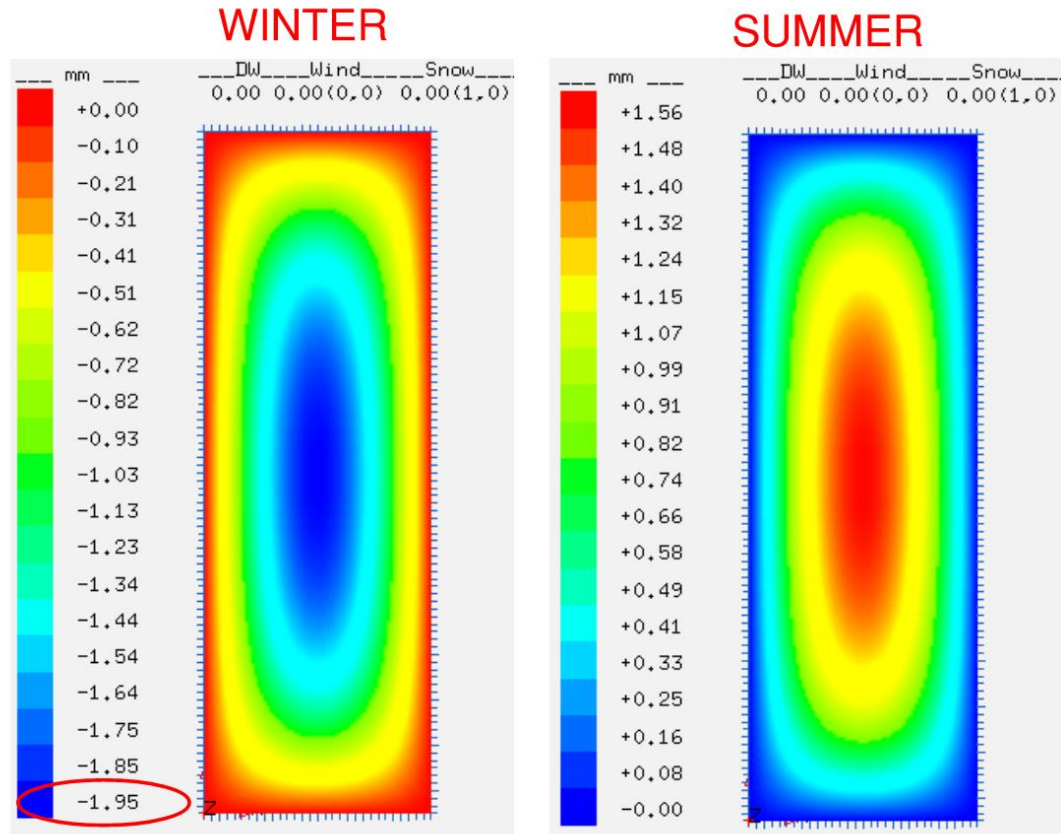
Climatic Load Deflection



Climatic Load Deflection



Climatic Load Deflection



Recommendations:

- Select a glass fabricator plant that is at a similar altitude as the site
- Engineer glass thickness in IGU assembly
- Some manufacturers offer pre-pressurization for final elevation
- Site crimped/sealed capillary tubes not recommended

Thank you!



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