BEST6

Portland Art Museum

Developing the Glazing System

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Envelope

W|M AC LA

Landscape

INTERFACE ENGINEERING

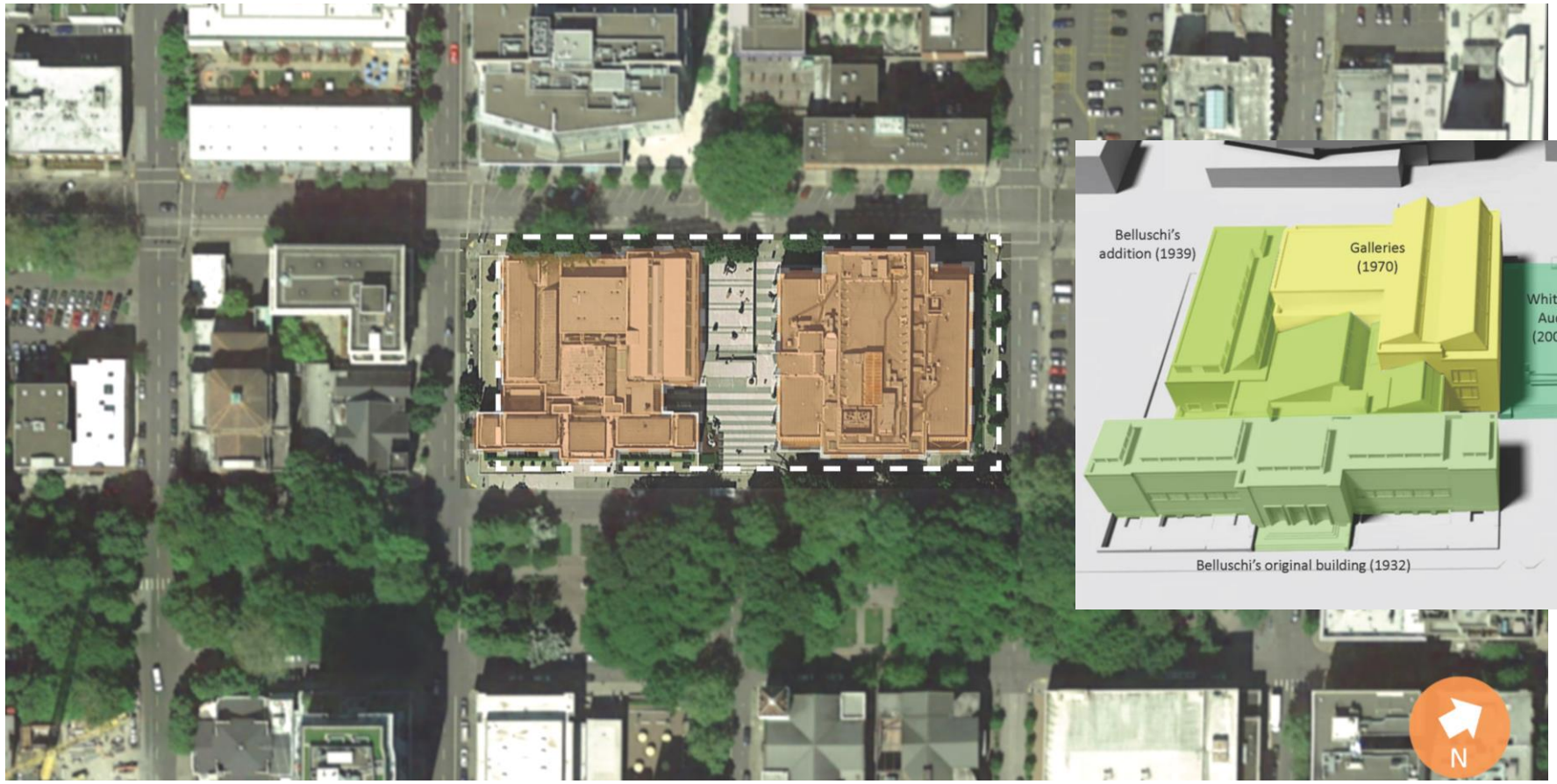
MEPF

kpff

Structural & Civil

Context

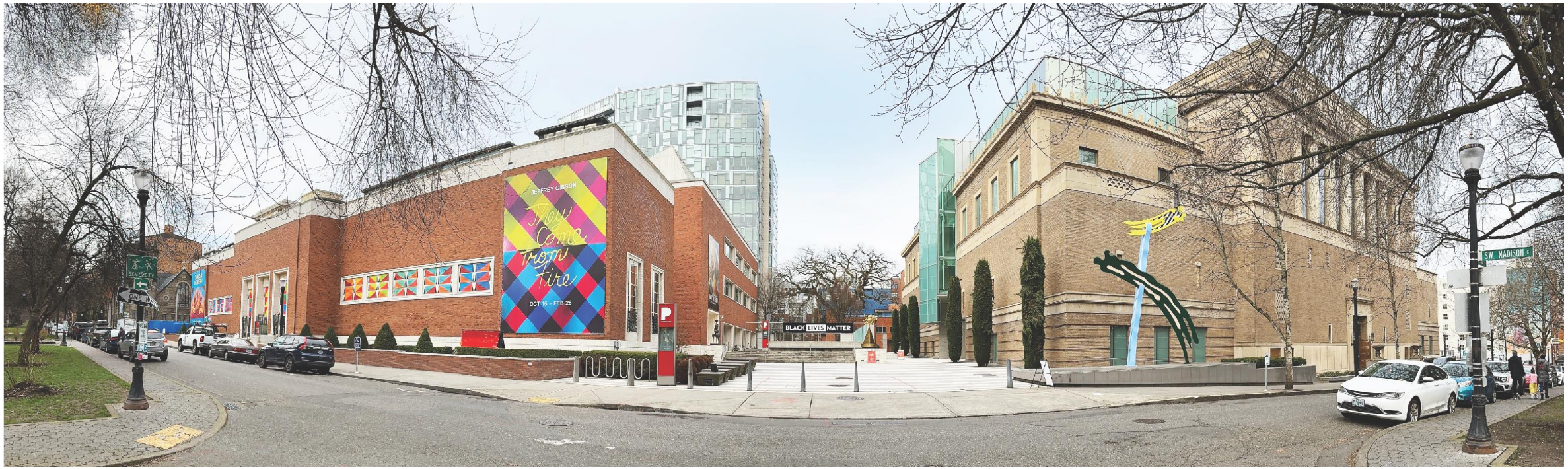
Portland Art Museum



Aerial from Google Earth.

Context

Existing Entry



Rothko Pavilion

New Entry

Rothko Pavilion

East Elevation

Rothko Pavilion

West Elevation

Public Walkway – Views into Museum

Rothko Pavilion

South Addition

Glass Fabrication Process

Overview

The FABRICATOR takes basic glass and treats, frits, finishes and assembles it into IGUs

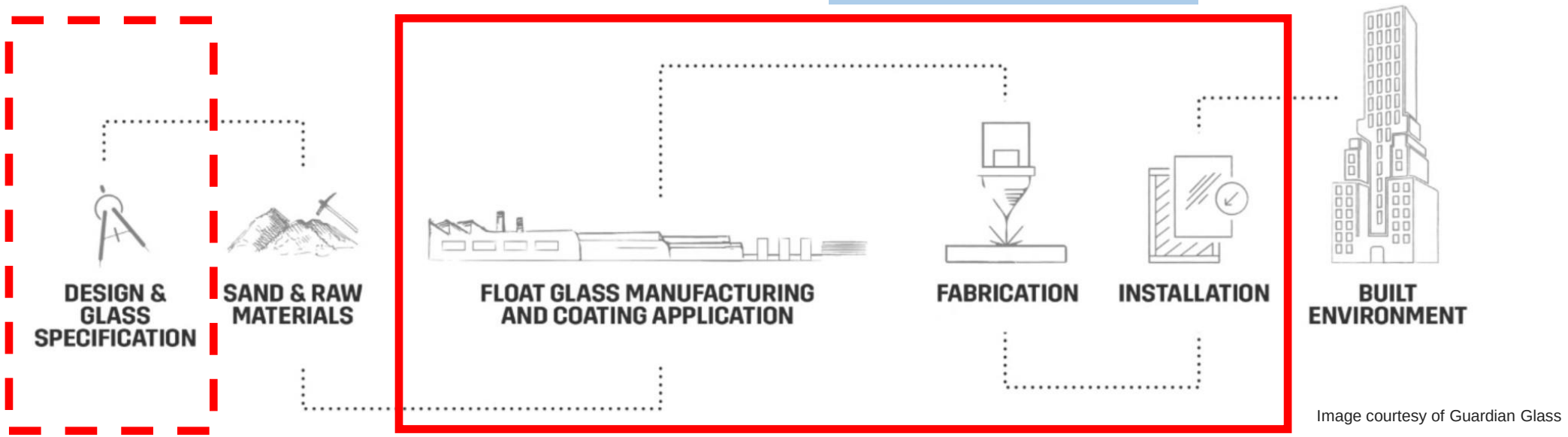


Image courtesy of Guardian Glass

MANUFACTURING, FABRICATION, & INSTALLATION constraints influence available options

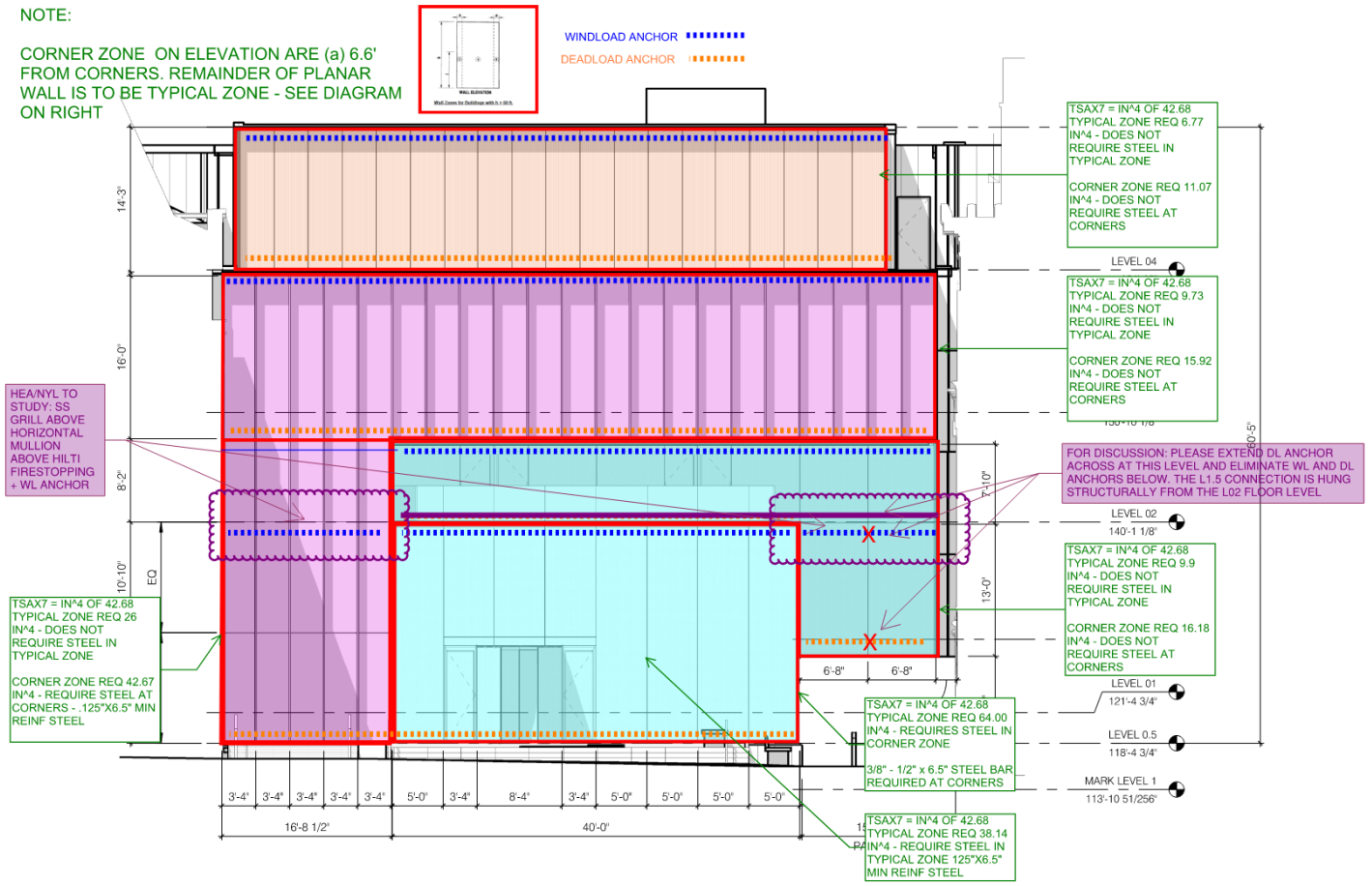
The MANUFACTURER makes basic float (annealed) glass with color and coatings

The GLAZIER takes IGUs and system components (mullions) and builds the project

System Studies

Gravity and Lateral Load Analysis

- Structural Analysis – Anchoring and movement strategies
- Lateral Analysis – Wind/seismic capacities and movement requirements
- Glass Size– Above determines glass lite size and joint movement criteria
- Curtainwall – Establishes framing size/ reinforcement and special conditions
- Conclusion – Establishes the initial system requirements as a check for meeting design intent



System Studies

Interior Daylight and Glare Analysis

- Interior Daylight – ‘Visual discomfort’
- Climate-based illuminance modelling and clear-sky-based direct solar exposure modelling
- Exterior Context – Important to model/consider
- High-risk areas identified w/ suggested mitigation strategies
- Conclusion – Shading & glass opacity/diffusion most effective for interior daylight control

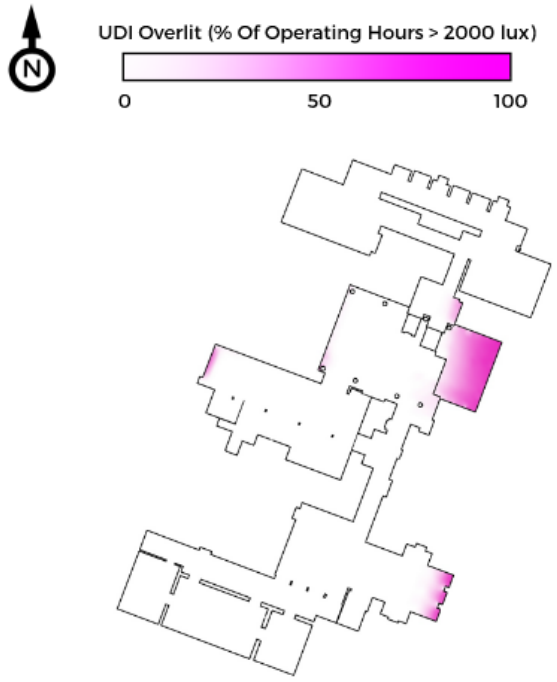


Figure 5a: Illuminance-Based Over-Lit Condition Predictions – L1

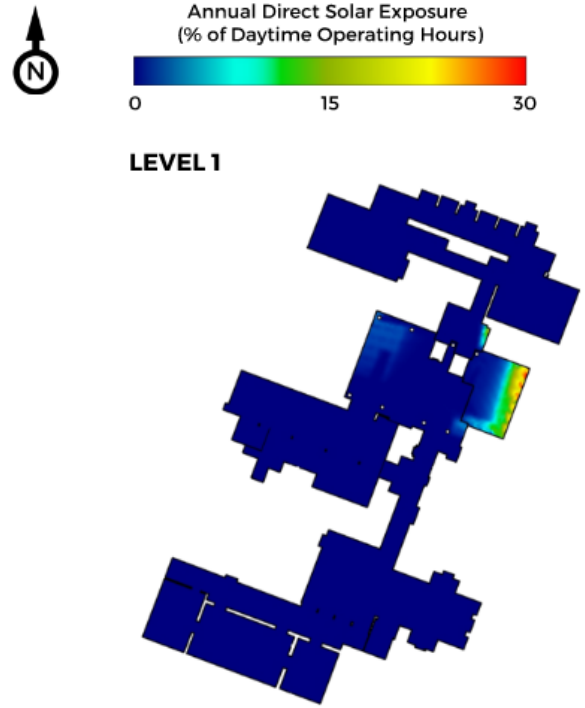


Figure 7a: Frequency of Direct Solar Exposure – L1

Images courtesy of RWDI

System Studies

Exterior Solar Reflection Screening Analysis

- Exterior Reflections – Impacts to surrounding properties
- Visual glare & heat gain modelling
- Exterior Context – Important to model/consider
- Conclusion – Low risk due to building setback, adjacent building shading, and traffic patterns

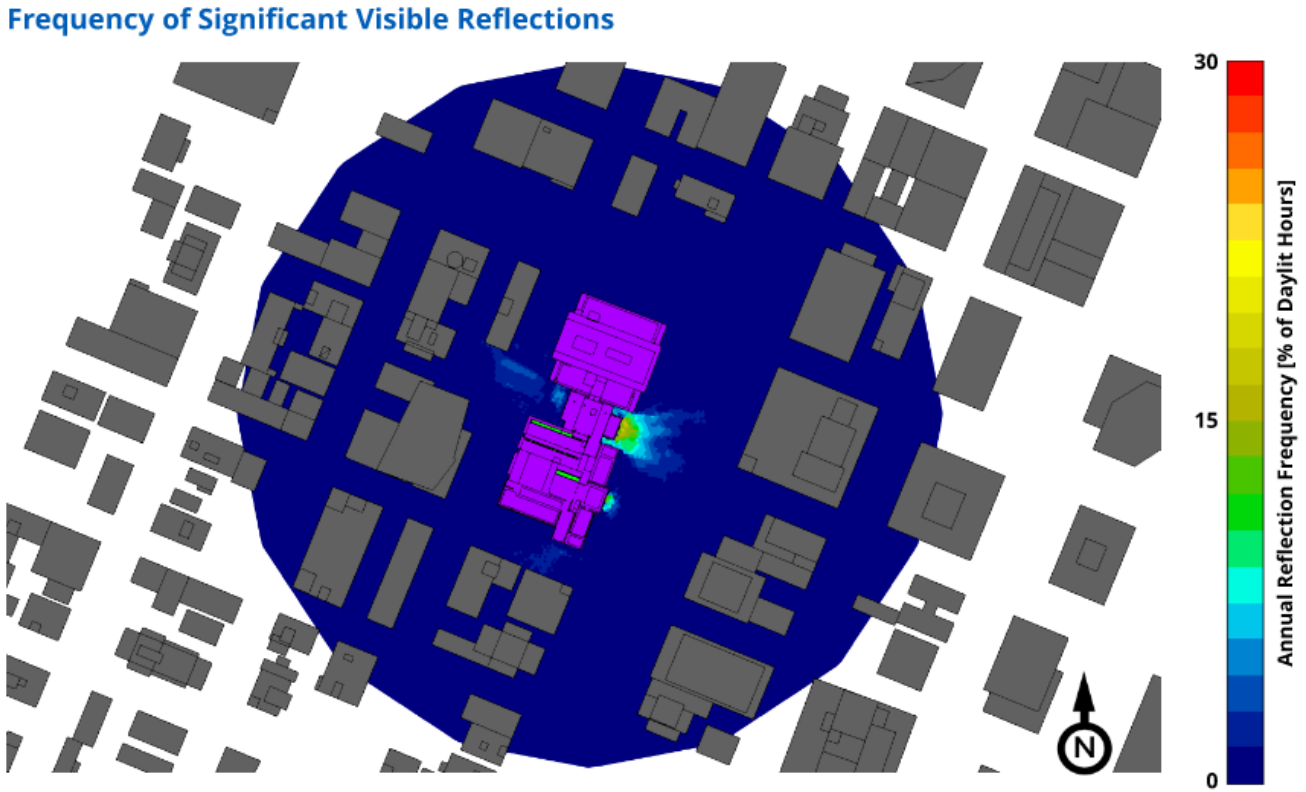


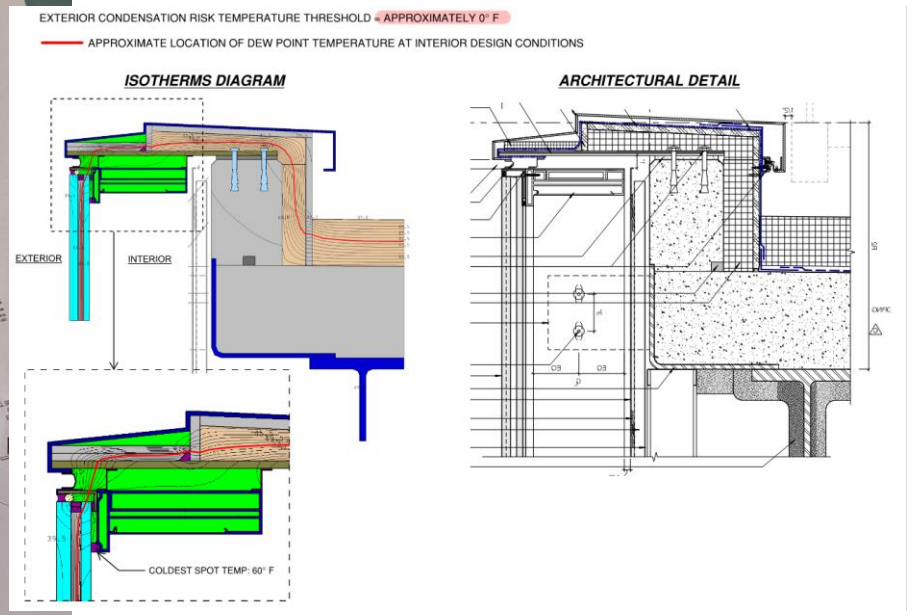
Figure 6c: Frequency (% of Daylit Hours) Where Significant Visible Reflections Can Occur

Images courtesy of RWDI

Design & Detailing

Iterative Process

- Glare/Solar Analysis – Glass size, placement, coating, frit, and shading strategies
- Thermal/Condensation Analysis – In-system vs. perimeter conditions. Insulation, component location/materials, drainage, airflow
- Workshop Review – Design team and glazier. Constructability, sequencing, performance, aesthetics
- Mock-Up Samples – Frit analysis, IGU samples, curtainwall framing. Small scale
- Conclusion – Highly iterative process to establish design intent. Large mock-up needed to confirm final direction



Images courtesy of SNYL

Frit Studies

Performance

Bird Safety

- Reduce Bird Impacts
- ‘2x4 Rule’
- Place Frit on #1 or #2 surfaces

Visibility

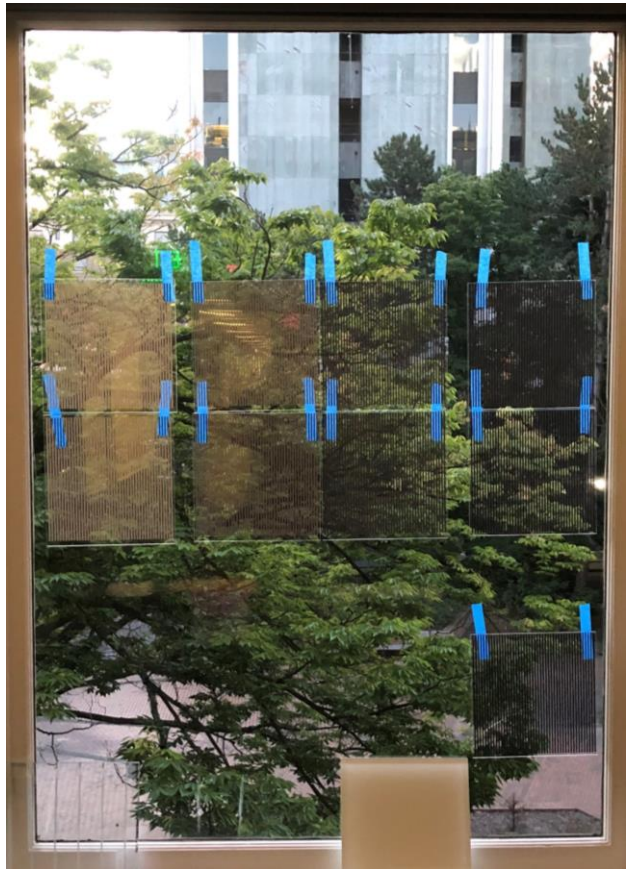
- Exterior & Interior Views
- Visual Comfort of Patrons
- Moiré Effect

Solar

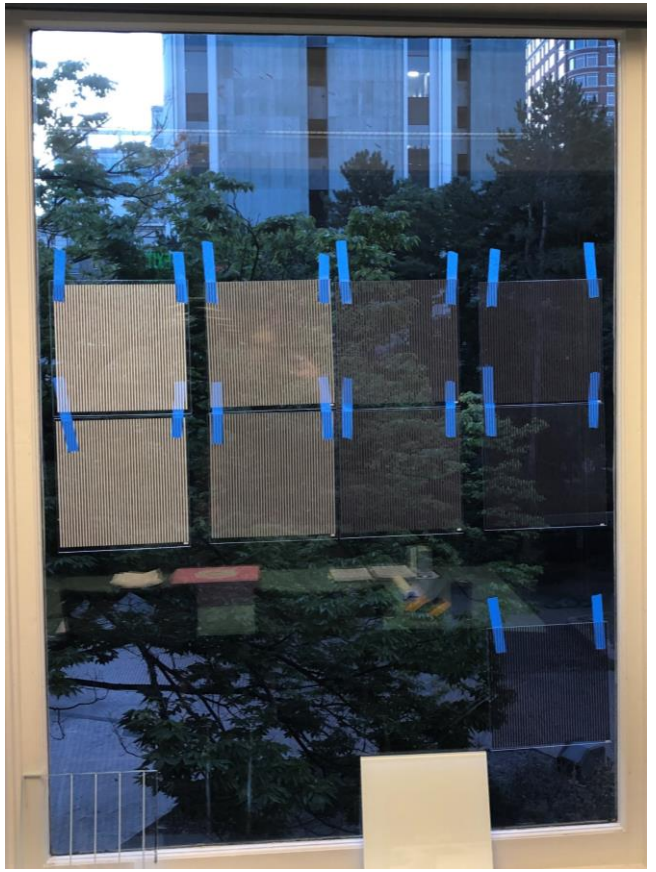
- Exterior Solar Reflection
- Interior Daylighting
- UV Control

Enclosure

- Heat Gain
- Durability
- Aesthetics



Daylight Dominant



Interior Lighting Dominant

Frit Studies

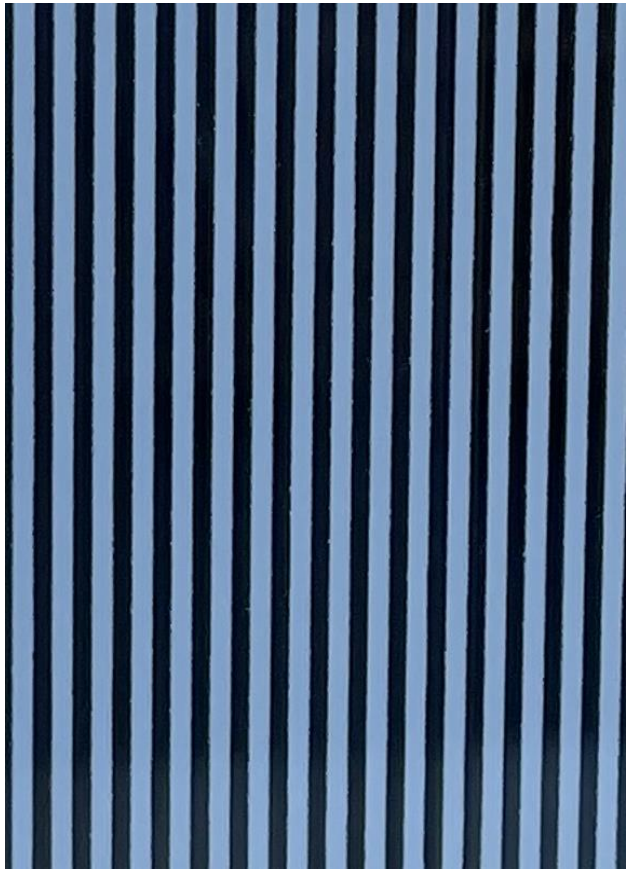
Studies & Mock-up

- Two patterns used – Bird Safe (left panel) and 50% coverage (right panel)
- Focus on exterior frit color – all white, all dark gray and hybrids
- Focus on interior frit color – all white, all dark gray
- Conclusion – Exterior: All white has the desired visual effect
- Conclusion – Interior: All dark gray has the best visual transparency
- **Dual Color Frit** – White exterior/Dark gray interior

Frit Studies

Mock-up

- Full-scale IGUs tested for building mock-up – dual frit and white frit
- IGUs shipped from fabricator using identical materials, equipment, and procedures to be used for actual building
- Frit – digital printing only due to large format glass sizes
- Observation – Frit applied directly to glass has ‘rougher’ edge vs. overlaid frit
- Conclusion – Dual frit displays a random streaking effect due to edge roughness – looks permanently ‘dirty’
- **White frit selected for building** – mock-up saves the day!



Frit – Digital Print Edges

Building Mock-up – Dual and White Frit

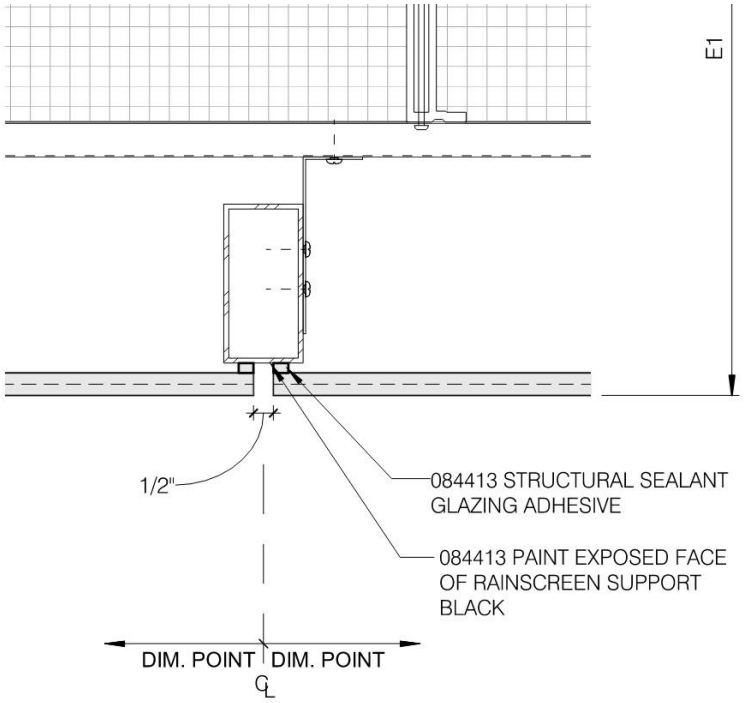
Glass Rainscreen

Design/Assist Process

Critical to vet initial details for actual conditions and installation

- Glass rainscreen – Custom assembly w/ design; assist from glazier
- Construction documents establish design intent and basic detailing
- Mock-up – tests detailing and constructability against project conditions and initial design intent
- Conclusion – Mock-up is an invaluable tool when customization is required

PAM - South Addition



Initial Detail 1.0– Typ. Glass Rainscreen

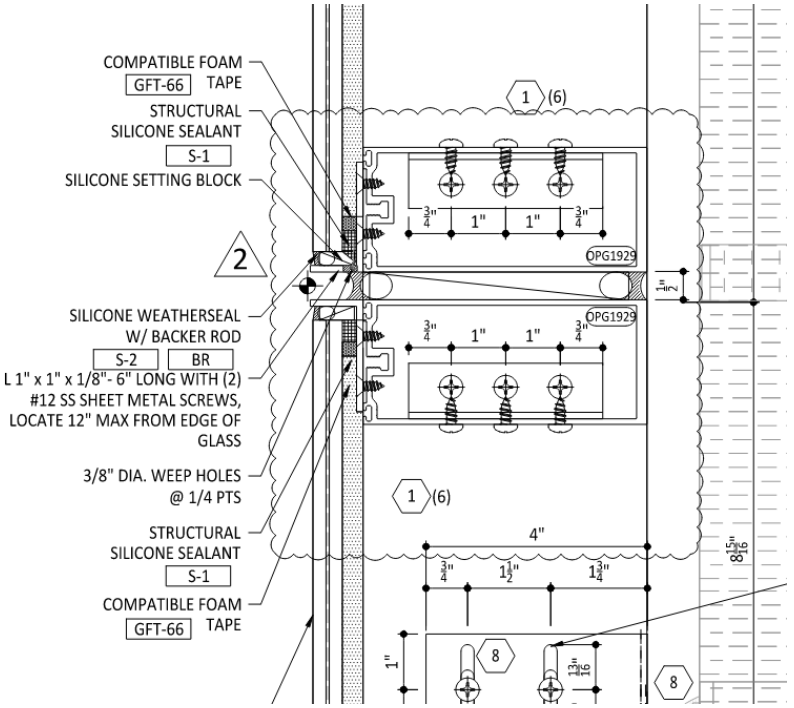
Glass Rainscreen

Mock-up – Detail Testing

Mock-up as a tool for testing detail construction

- Glass rainscreen – Detail 2.0 addressed design intent with additional components
- Intersections and transitions became complicated
- Mock-up – Proved that Detail 2.0 was difficult to build
- Conclusion – Mock-up identified the need for simplicity and revealed critical waterproofing conditions

PAM - South Addition



Detail 2.0 – Typ. Glass Rainscreen

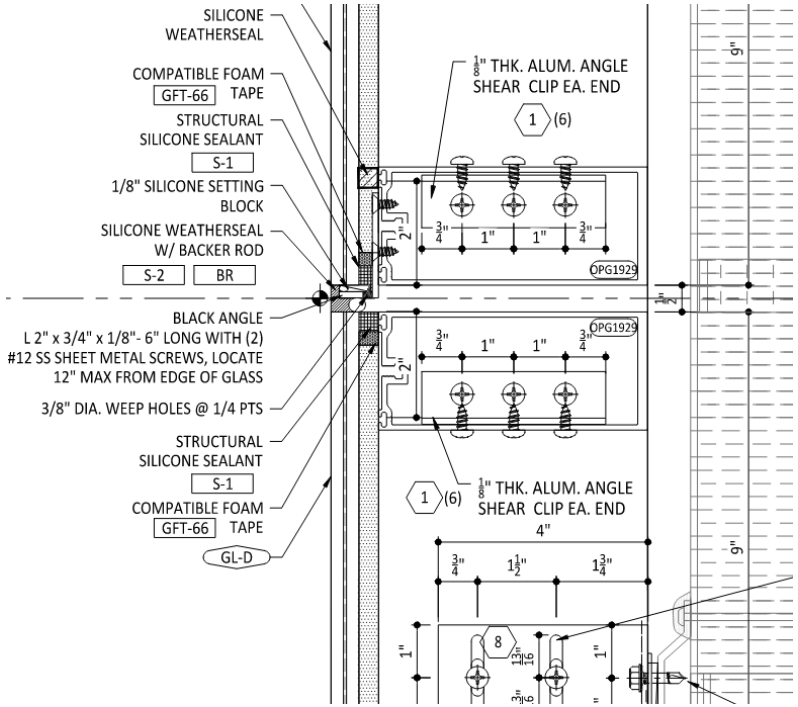
Glass Rainscreen

Mock-up – Finalizing Design

Mock-up as a flexible platform for corrections and refinements

- Glass rainscreen – Detail 3.0 reduced to essential components
- Intersections and transitions simplified
- Constructability – Establishes best techniques and experience of installers for integration into design
- Materials – Final revisions and selection
- Conclusion – Mock-up allows all parties to provide input and sign-off before construction begins

PAM - South Addition



Detail 3.0 – Typ. Glass Rainscreen

Thank you!