

# Re-glazing of an All Glass Tower

**MICHAEL AOKI-KRAMER, BA, JD, LEED AP**  
RDH BUILDING SCIENCES INC, SEATTLE, WA

**AUTHORS:**

JAMES HIGGINS – RDH BUILDING ENGINEERING LTD.  
BRIAN HUBBS, P.ENG. – RDH BUILDING ENGINEERING LTD.  
GRAHAM FINCH, MASC, P.ENG. – RDH BUILDING ENGINEERING LTD.  
ED THIESSEN, P.ENG. – RDH BUILDING ENGINEERING LTD.



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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

# AIA Credits – Learning Objectives

## Participants will:

1. Learn about approaches to identifying, quantifying, and investigating IGU performance problems and how results needed can inform the investigation tools/processes used.
2. Learn about the unique design challenges with replacing structurally glazed IGUs and how those challenges were overcome.
3. Learn how quality assurance procedures can be used to deliver innovative products that meet performance expectations.
4. Learn about how building enclosure repair implementation can be as challenging as figuring out how to repair the damaged building enclosure component.

# Outline

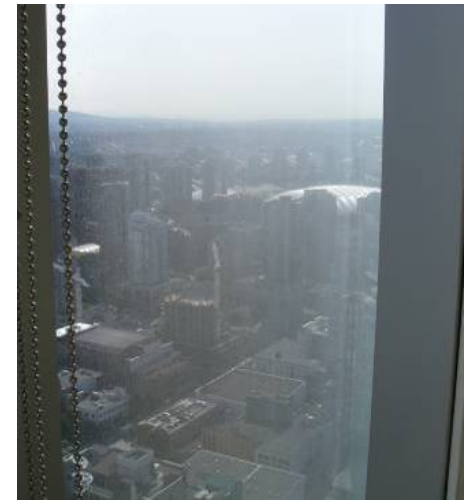
- Background
- Investigating the problem
- Designing the Solution
- Implementing the Repair
- Lessons Learned



# Background

- Residential condo/hotel building constructed in 2002
  - structurally glazed curtain wall – R-5 proprietary triple IGUs
- First fogged IGUs observed in 2003
  - Contractor replaced all desiccant tubes
  - Fogging persisted
  - Corrosion of low-e noticed
  - More desiccant tubes replaced
- 2006 Retained to investigate, continued through 2009
- Acknowledgement of worsening problem
- Owners decide to proceed with re-glazing
- Design in 2012 - Re-glazing in 2013

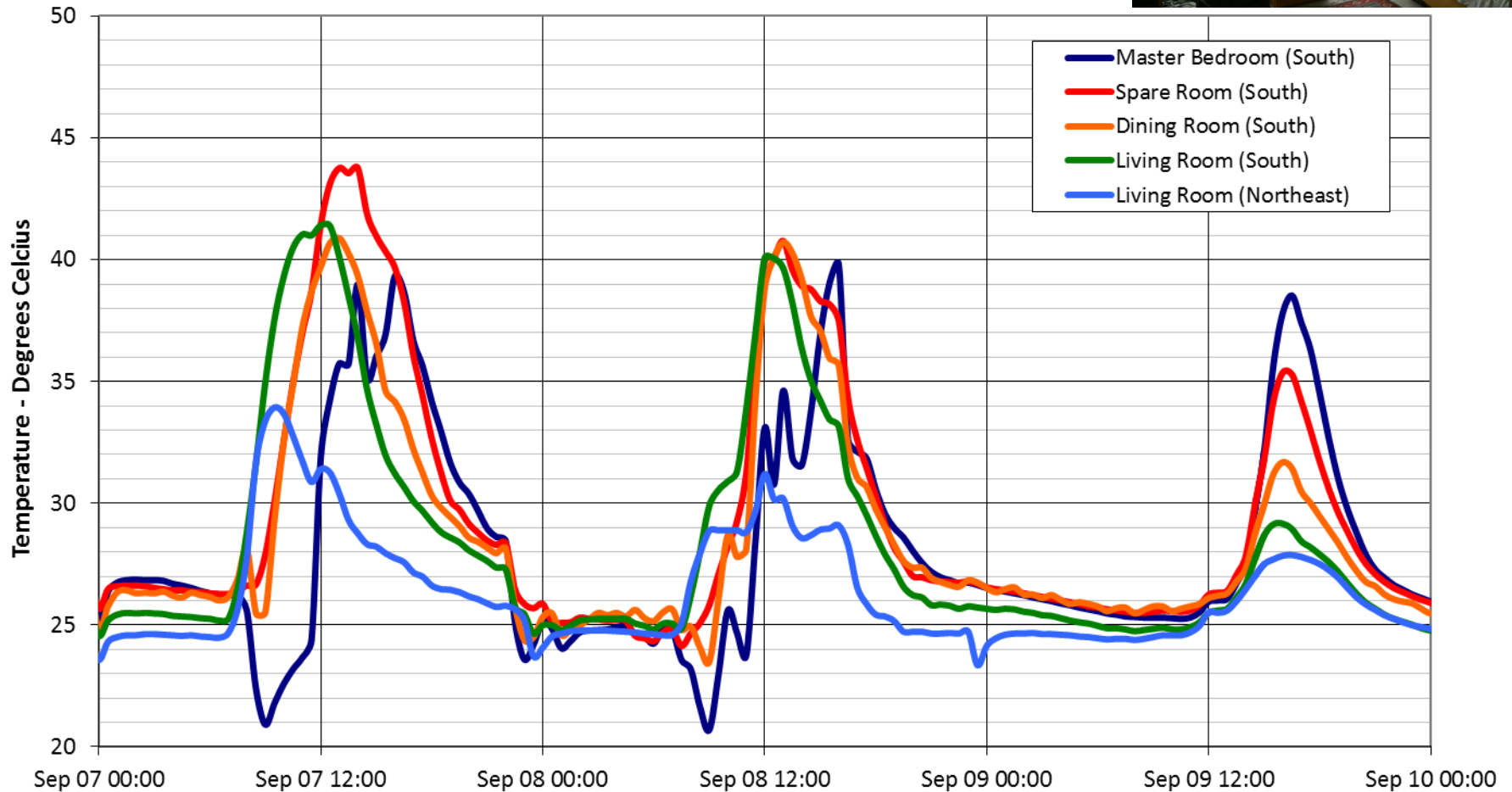
# Issues - Fogged and Corroded Glazing Units (Surface #2)



# Issues - Overheating

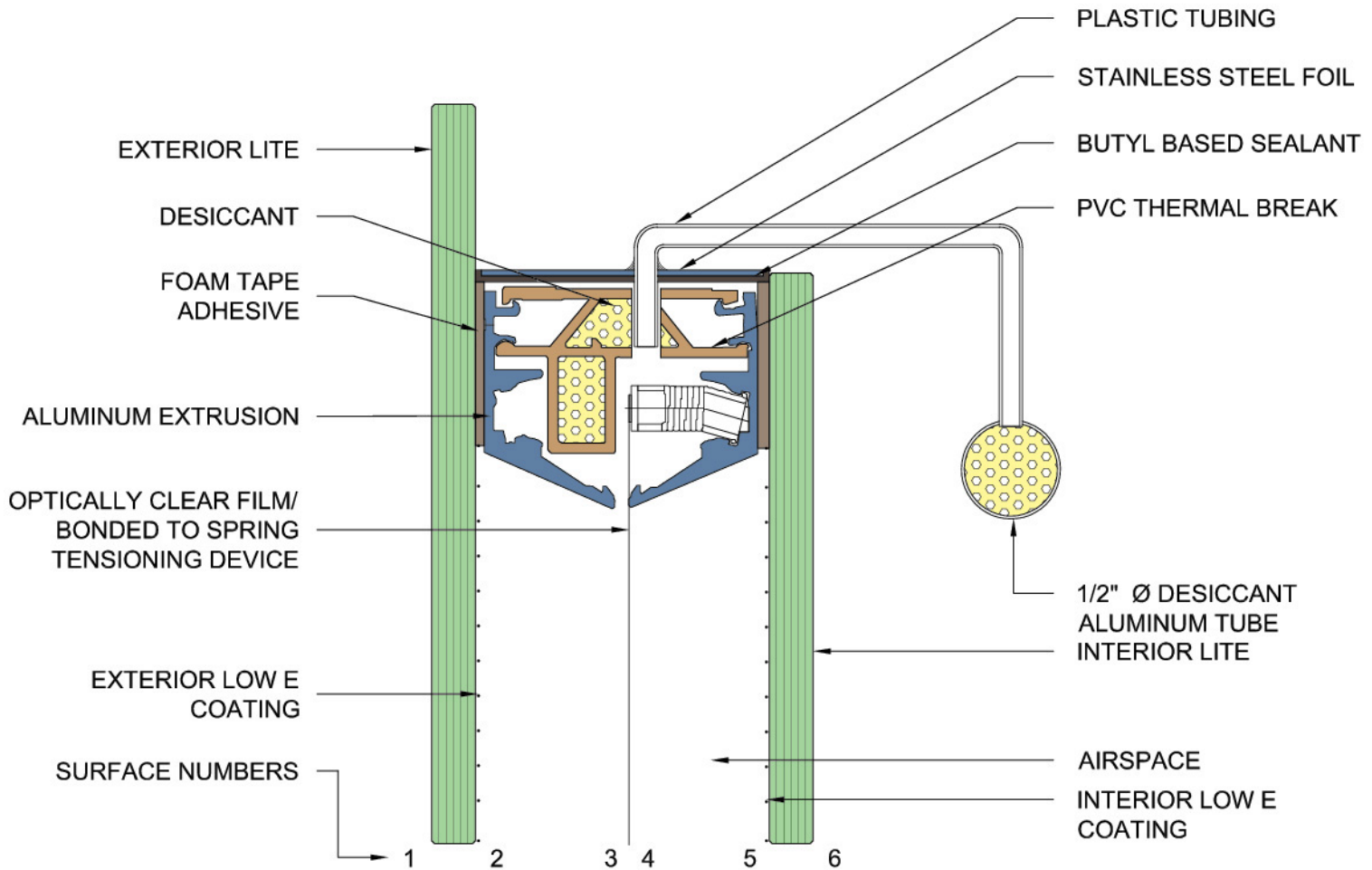


Suite 3903 - Summer 2008 Temperatures - Near Windows





# One Wall - Insulating Glazing Units





# Quantifying IGU Failures in the Field

- Visual Review
  - Rating based on visual observation and level of fogging and low-e corrosion damage visible from 10 feet away
- Dew/frost-point testing (ASTM E-576)
  - Measures how dry the IGU airspace is and estimate the saturation level of the desiccant
  - Can estimate remaining service life of IGUs
  - Can quantify failed units and units close to failure



# Mapping IGU Degredation Over Time

2006 Frost points: -55, -10, -8 C

2008 Frost points: all between 2 and 6 C

## Corrosion Legend

- Clear
- Minor
- Moderat
- Severe

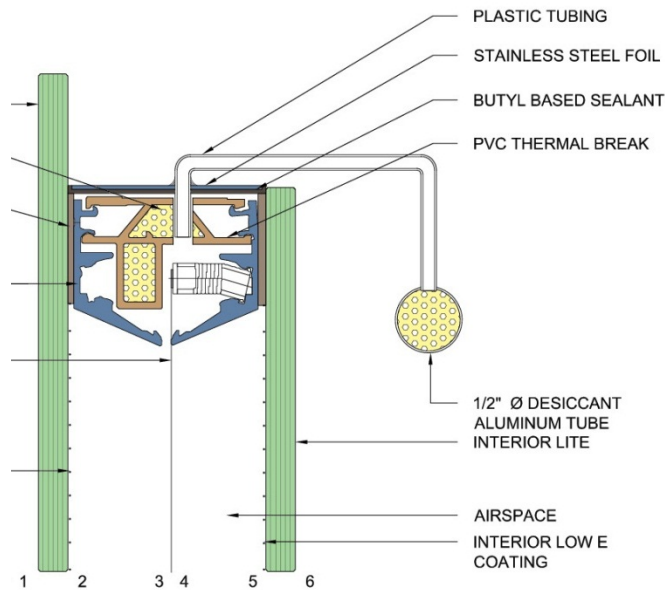


# But How and Why are They Failing So Fast?

- Further testing procedures:
  - Desiccant saturation measmnt.
  - Pressure testing
    - › Measure leakage rate of IGUs
  - Flow testing
    - › Measure flow through the desiccant tube in service
  - Eventual removal
    - › For visual and laboratory testing
    - › Delayed for several years to get safety variance to remove IGUs



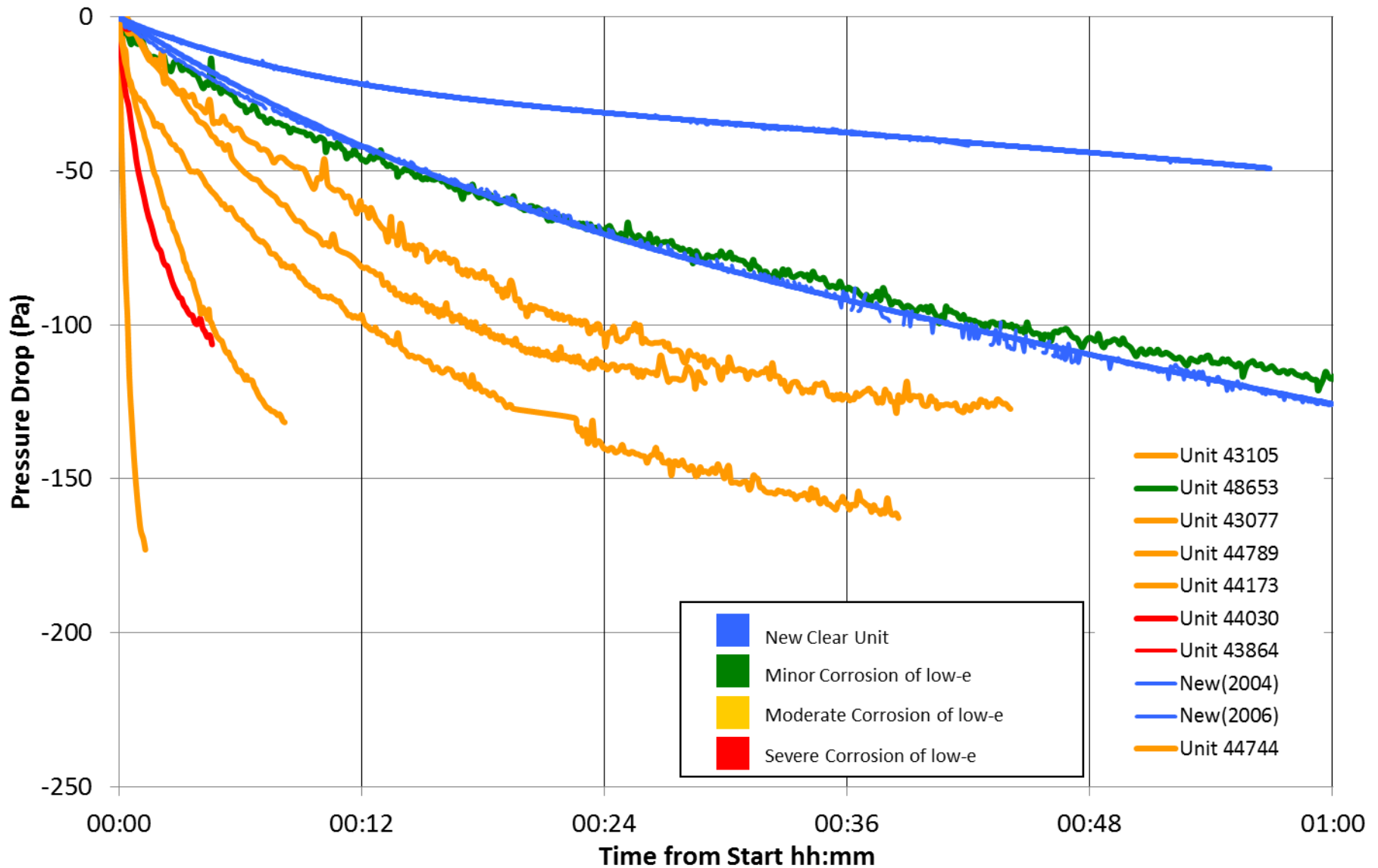
# Dessicant Saturation Testing



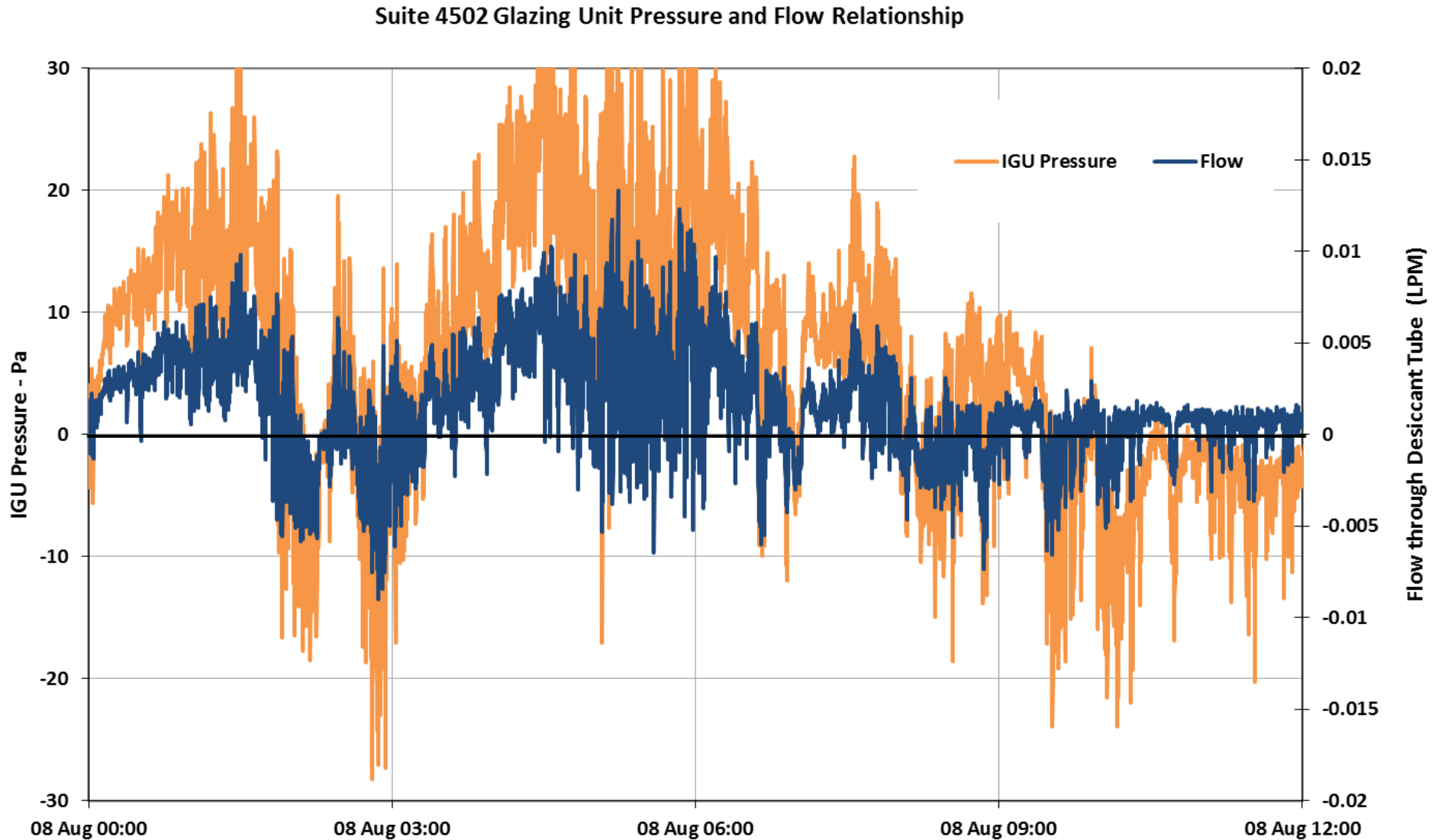
- Once desiccant reaches 80%, it no longer protects IGU from fogging – dewpoint above 0°C (32°F)
- Found saturated desiccant in all fogged units, and drier desiccant in clear IGUs

# In-Situ IGU Pressure Decay Testing

Pressure Test Data - Correlating Level of Low-e Corrosion to Pressure Decay - Suite 3903



# Pressure and Flow Through Dessiccant Tube



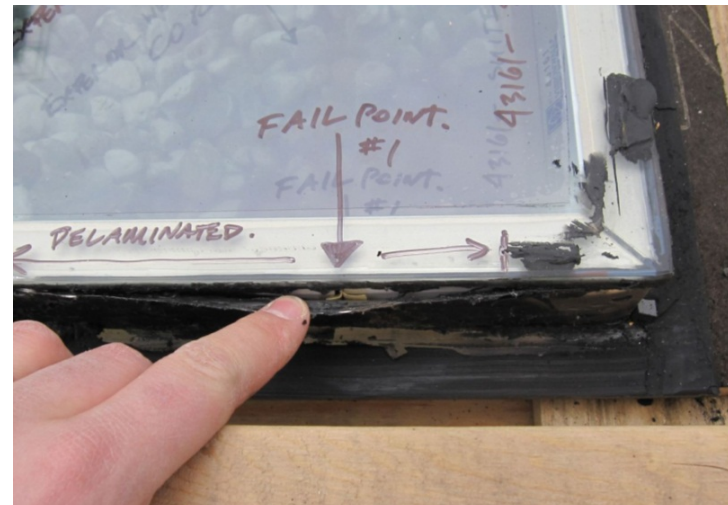
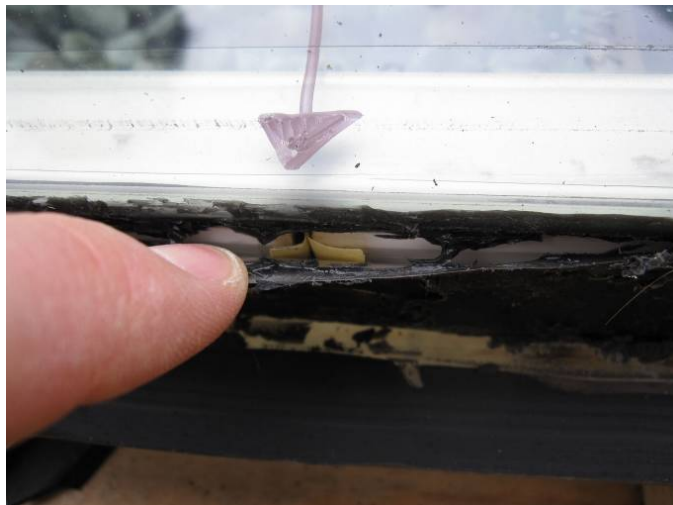


# In-Situ Monitoring Results

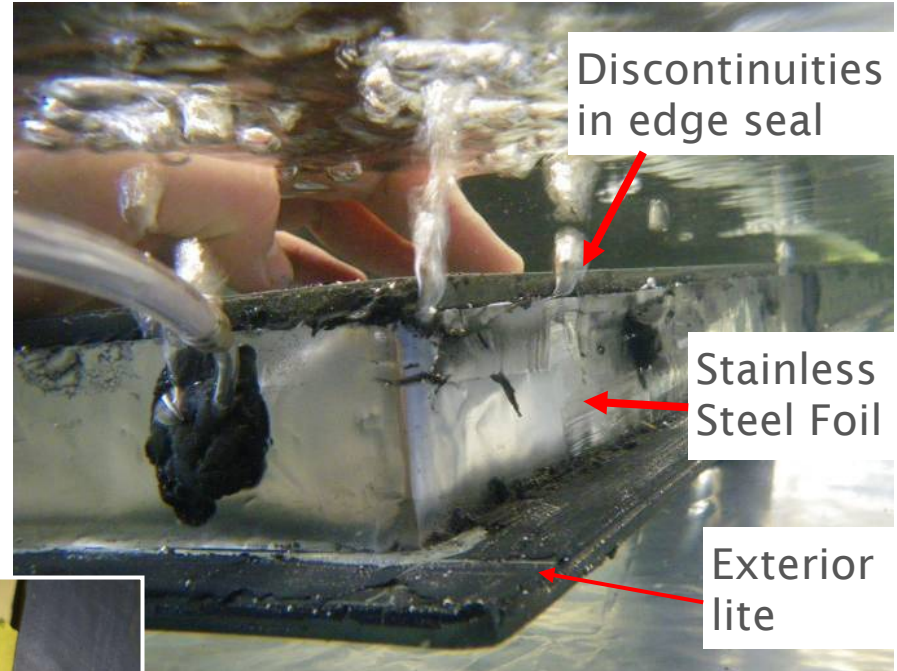
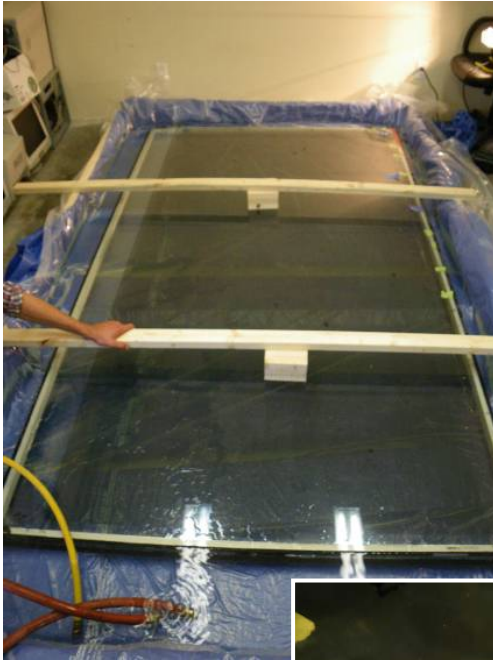
- Air flows from outside into the IGU through edge seal defects then into suite through desiccant tube
- Desiccant tube flow rate of  $<0.01$  L/min = 1-5 Liters of air per day just from wind
- Estimated service life of external desiccant tubes with these average flow rates is  $<5$  years to saturation
  - Not accounting for other leaks (as indicated by pressure decay testing)
  - Could this replaceable desiccant tube design have worked in theory? No, not with 10x more desiccant by volume within IGU edge seal than desiccant tube.



# IGU Removal and Testing



# IGU Perimeter Seal Discontinuity Testing



➔ Over 20 unique leakage locations observed in addition to the desiccant tube hole

# Investigation Summary

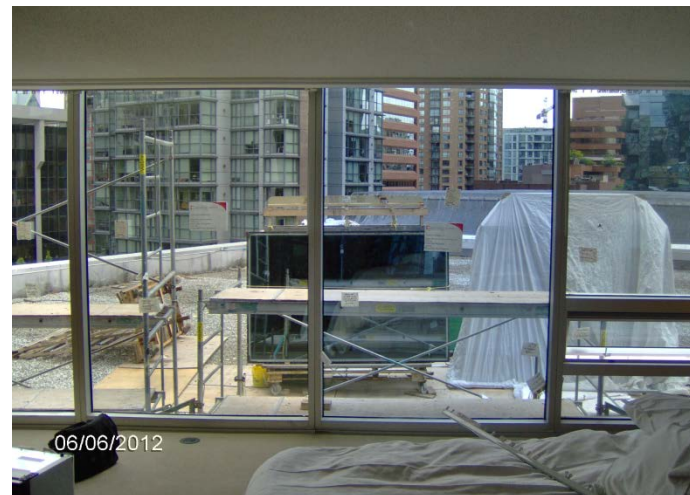
- Systemic failure of IGUs due to an inadequately sealed “thermally efficient” edge spacer
  - PVC, aluminum, stainless steel foil & hot-melt butyl differential expansion/contraction
  - No real durable structural edge seal
  - Removable desiccant tubes easily overwhelmed in service
  - IGU failure led to frequent fogging and permanent corrosion of silver low-e coating on surface #2
- All residential IGUs need to be replaced
- Cooling HVAC units and in particular ducting is undersized for the clear glazing used.
- Mechanical under design can be resolved using high performance glazing in most suites

# Design – Selecting Glass and Coatings

- Criteria: Match existing residential portion plus improve performance
  - Lower SHGC to reduce overheating and issues with undersized AC units
  - All-glass triple vs previous PET suspended film triple
  - Durable edge seal
- Original low-e coating not available (old AFG) and hard to match
- Narrowed down hundreds of new alternate options for Owners and City to choose from
- Many plant and site mock-ups for color



# Design – Selecting Glass and Coatings



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**Why Full Size Mock-ups are Performed**

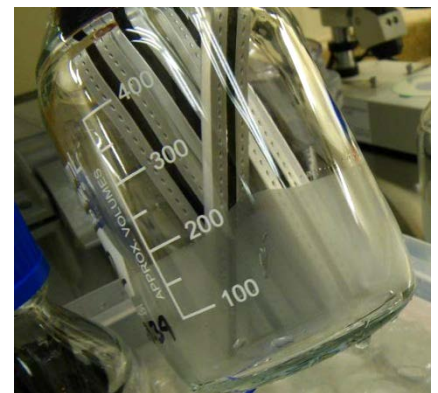
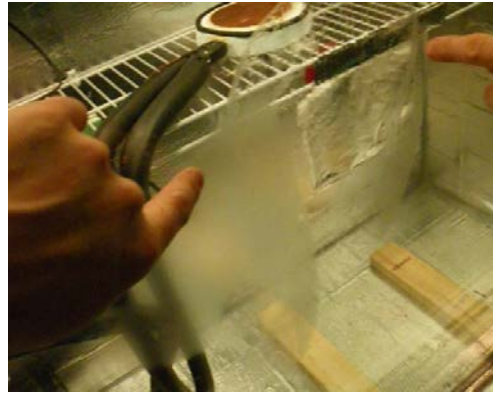
**Best Match ?**





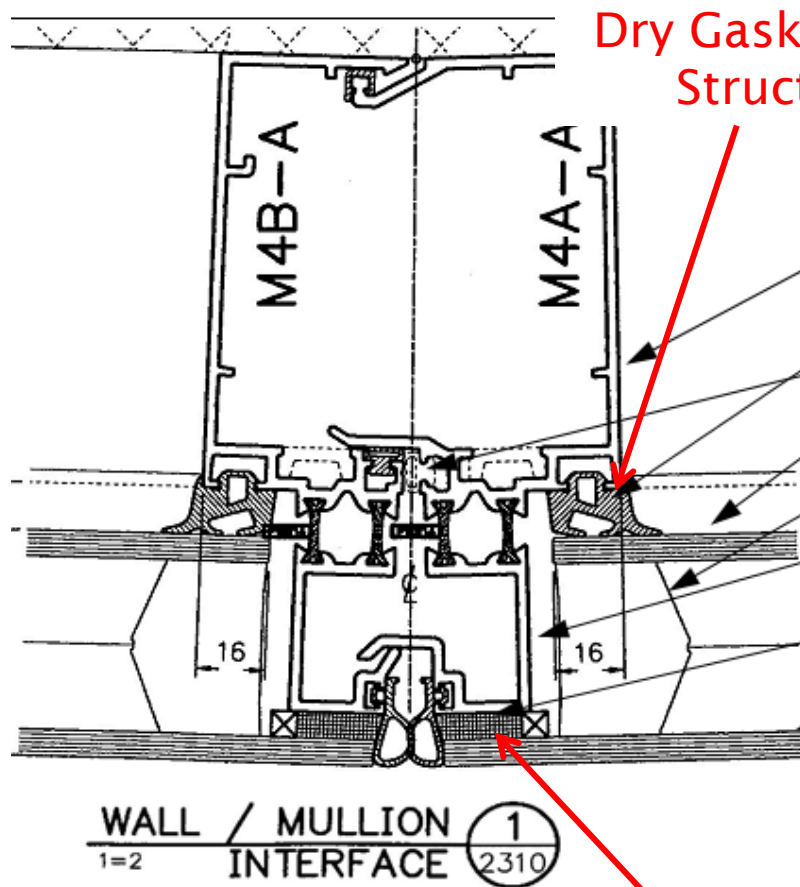
# Design – Selecting IGU Spacers and sealants

- Trend towards “thermally broken” edge spacer bars with plastic thermal breaks (polyurethanes, PVC)
- Have investigated the fogging of several brand-new IGUs where VOCs were present
- Need to be careful with edge seal spacer selection
- Triple Glazed so spacer conductivity is less of a factor
- **Anodized aluminum spacer, PIB primary seal, silicone secondary seal**

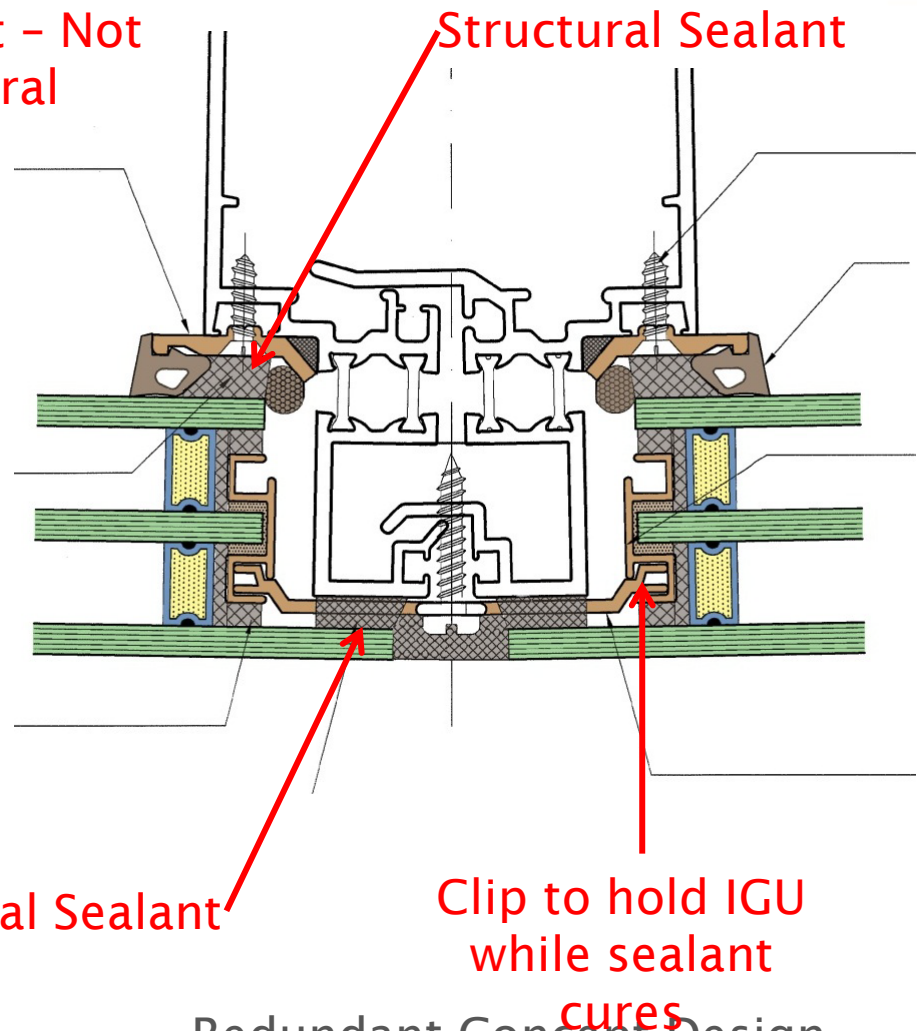




# Design – Gluing the Glass on the Building

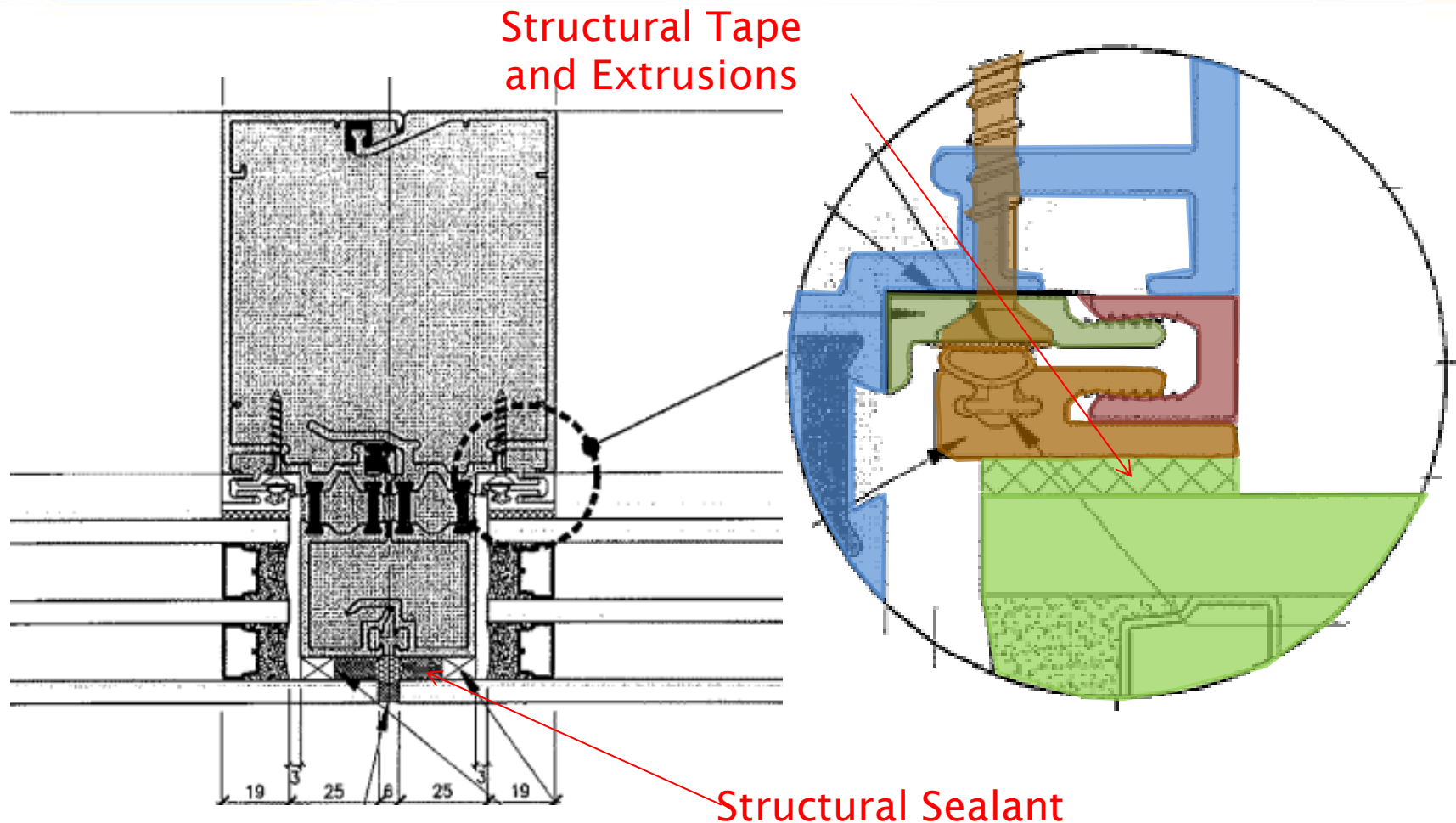


Original Design  
Done in Factory: Ideal  
Conditions



Redundant Concept Design  
Done in the Field

# Design – Final Structural Silicone/Tape Detail

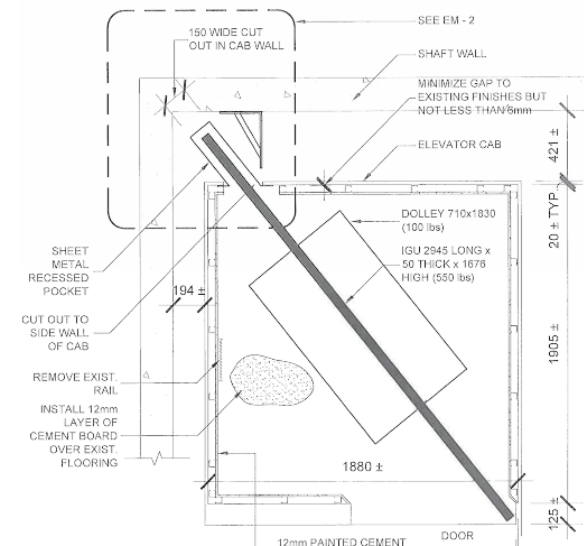
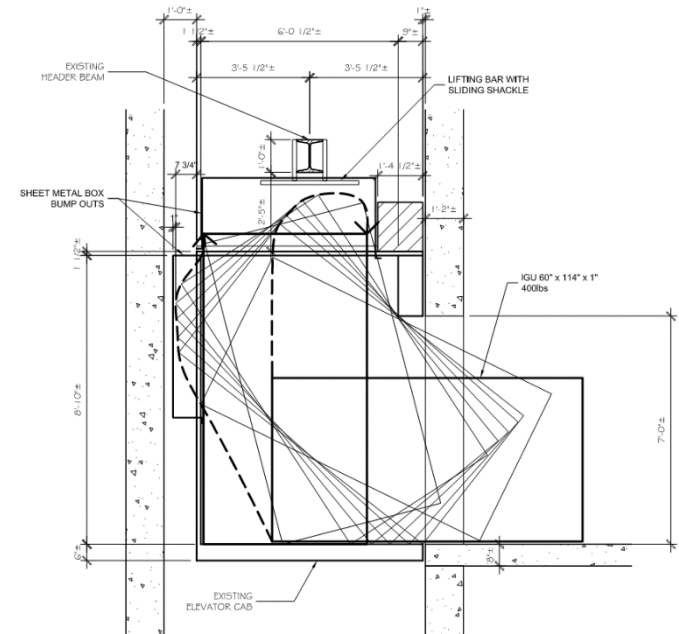
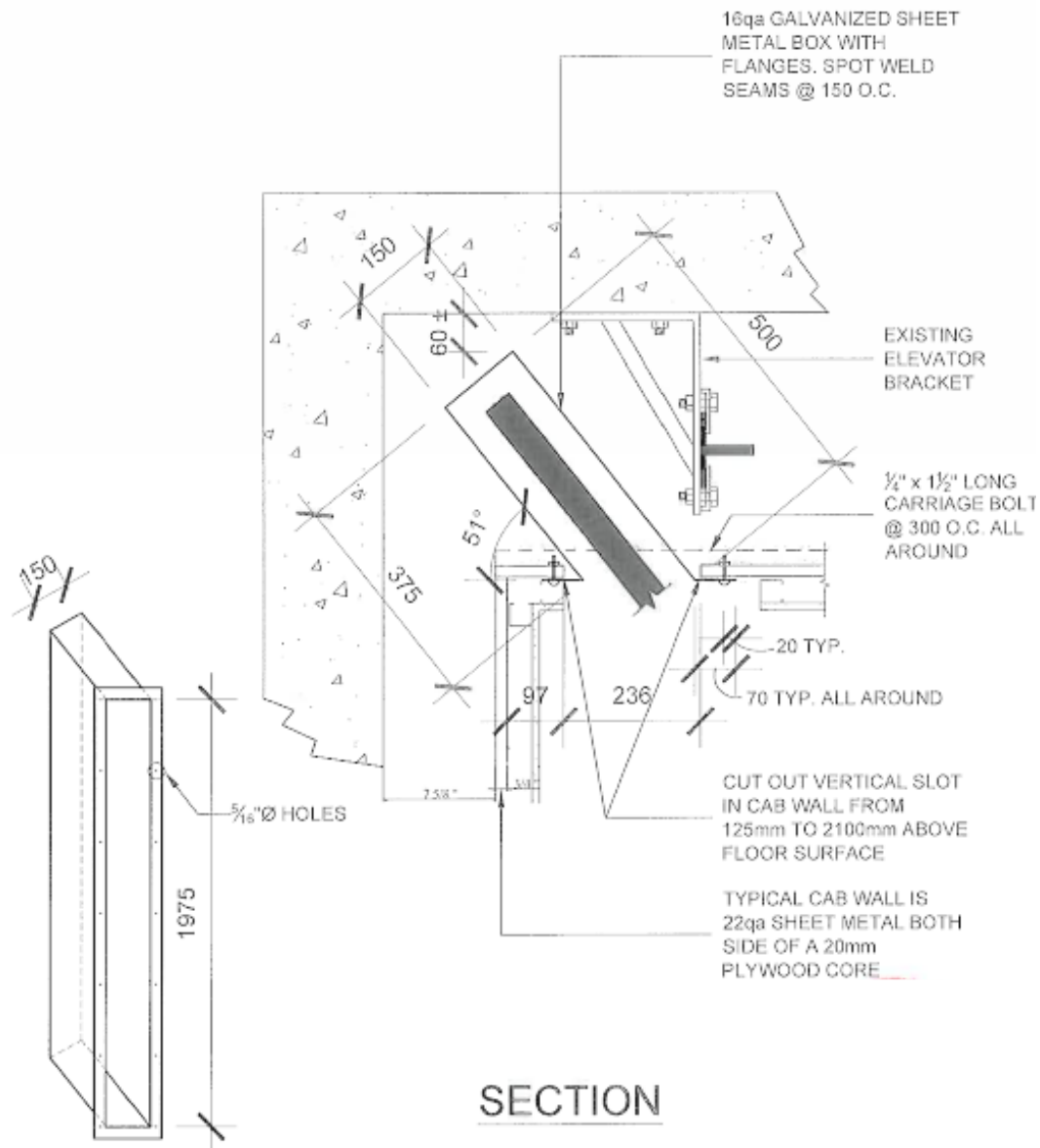


Final Design for re-glazing and Installation  
2 redundant structural adhesive joints (1 in factory, 1 on site)

# Construction Management Challenges

- No way to get IGUs to the suites from the ground
- Ability to work in inclement weather key to success of project
- Normal suspended work platforms would have been dangerous, unavailable in all but calm weather and very time consuming to move material. 1-2 unit per crew per working day. Required 5-6 units per crew day to complete work in 1 summer.
- Construction Team:
  - Construction Manager: RDH
  - Glazing Contractor: Glasstech
  - IGU Manufacturer: Garibaldi Glass
  - Glass Supplier: Viricon and Guardian

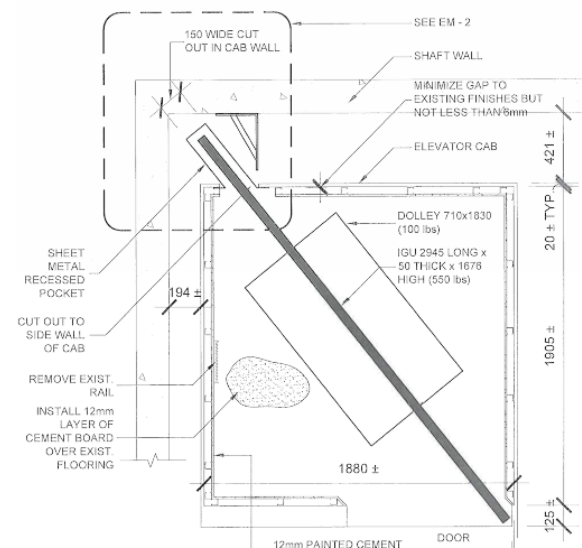
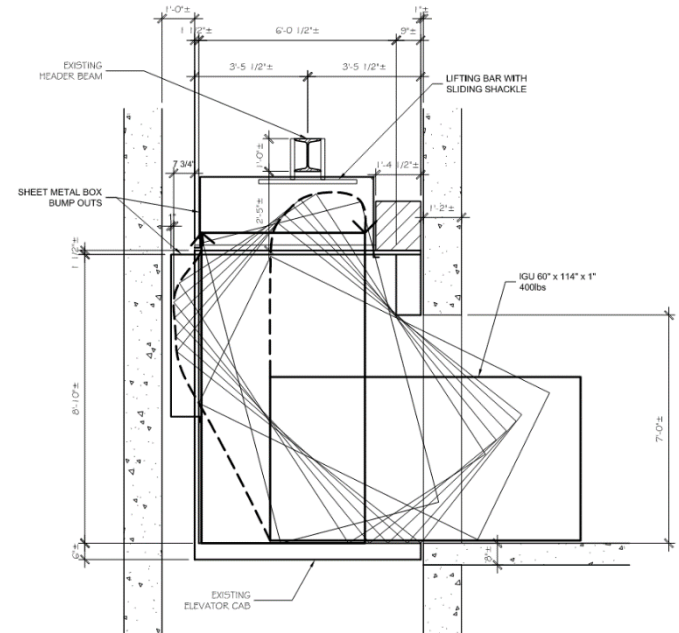
# CM – How get IGUs from Street to Suites



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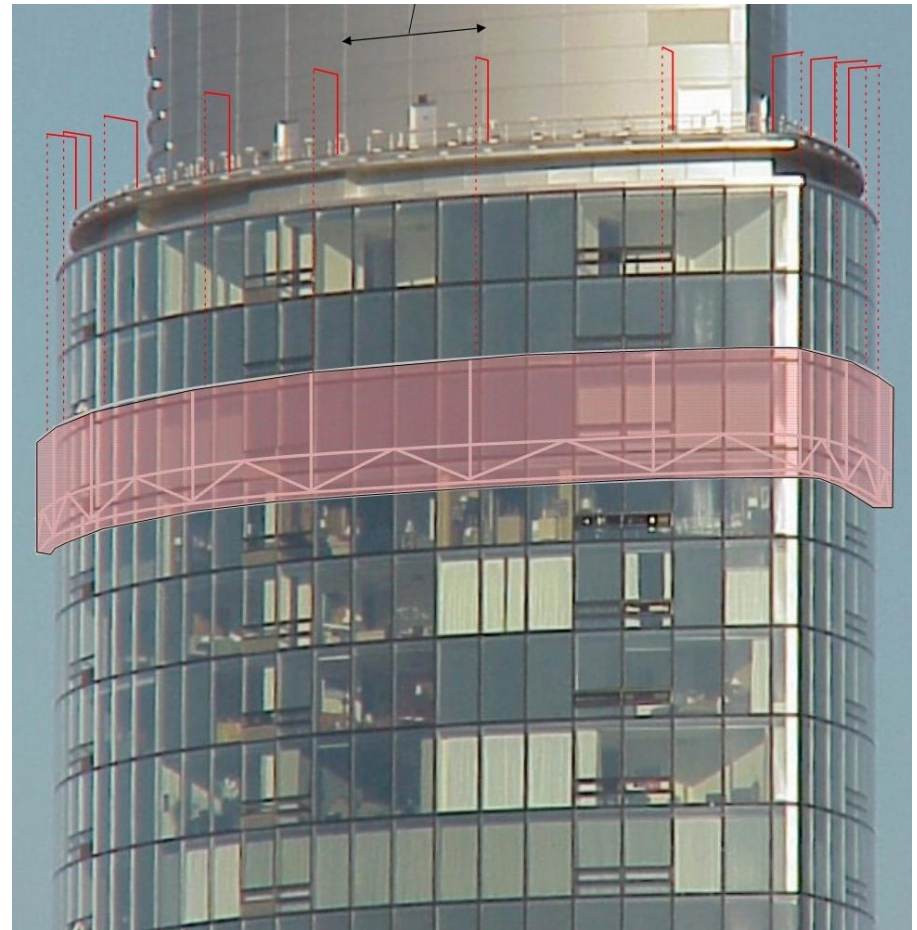
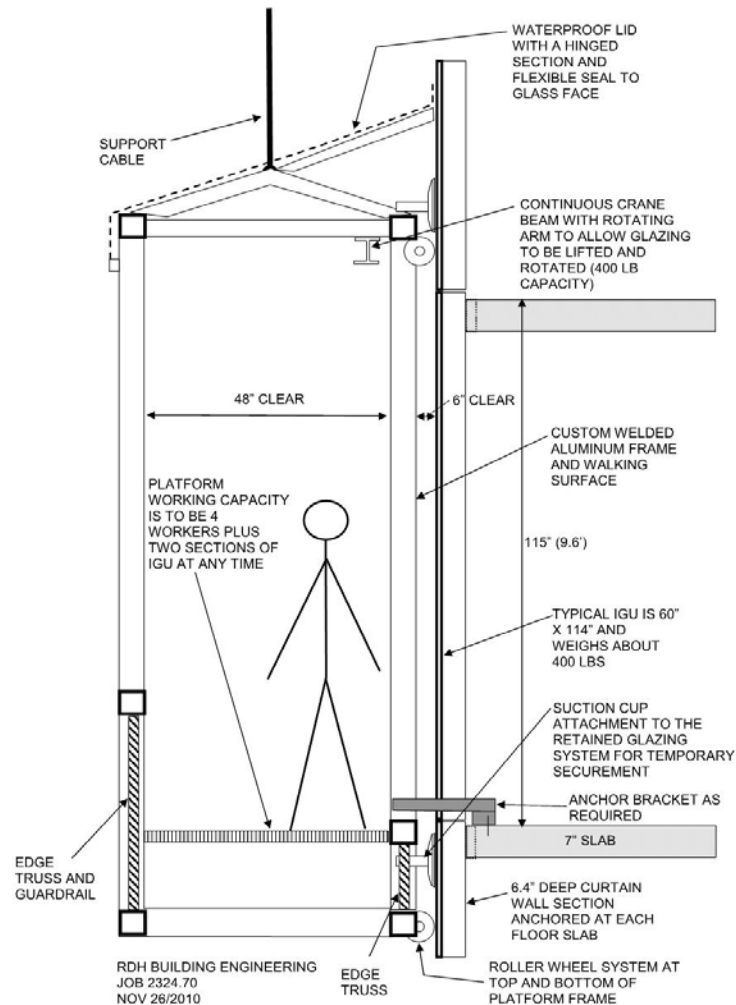


SECTION





# CM – All Weather Work Platform (60km/hr wind)



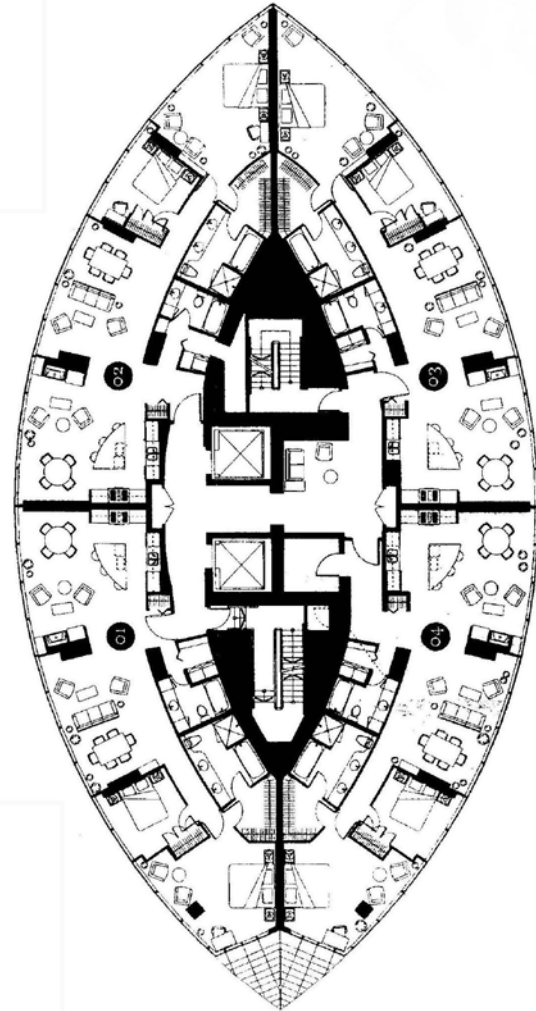
# CM - Suspended Scaffolding



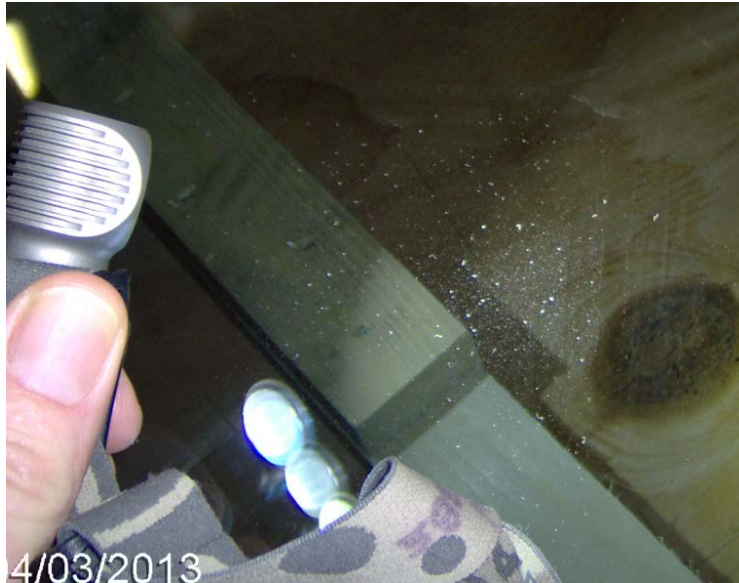


# IGU Replacement Floor by Floor

- Over 66 window bays per floor and almost 100 IGUs
- All removal and replacement work done in 1 week per floor
- 2 crews working from opposite sides of the building clockwise
- All with the building fully occupied

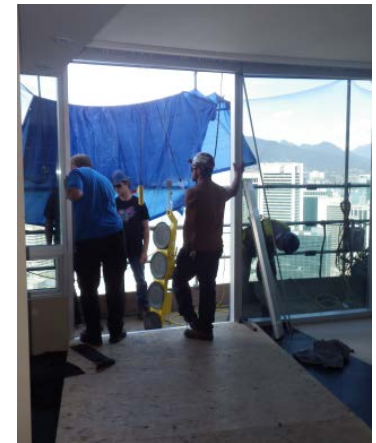


# QA – IGU Factory Visits



# QA – IGU Replacement

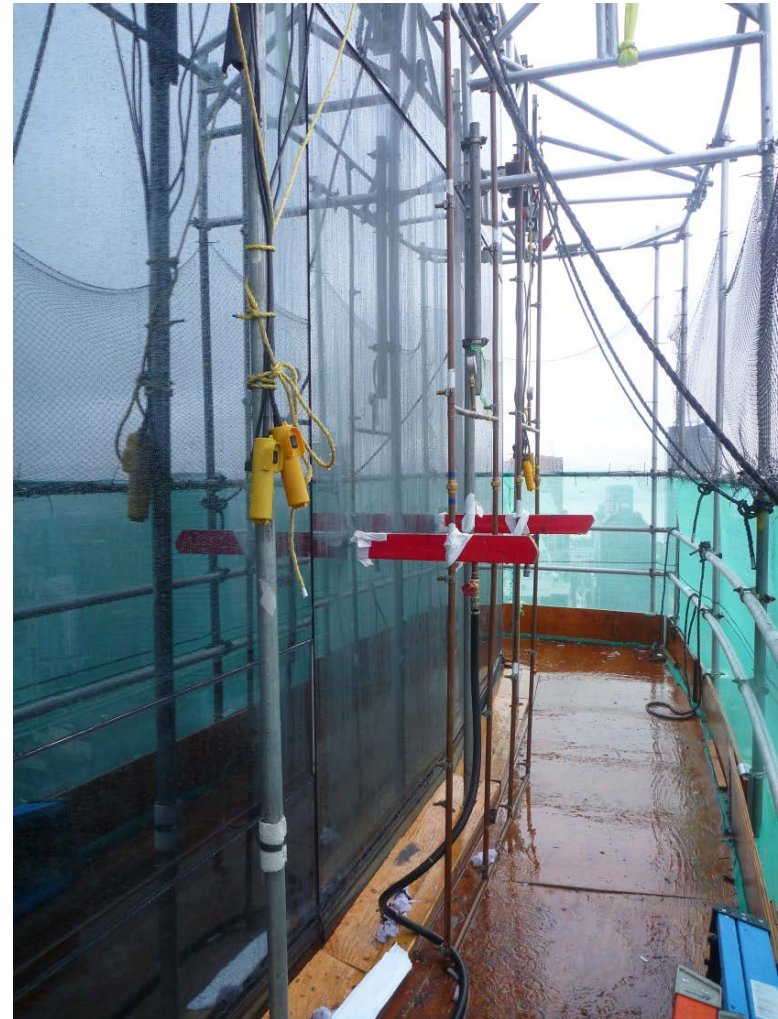
- Remove old IGU with specialty sealant cutting tool
- Clean aluminum frame without abrading surface
- Install frame adapters and foam tape on frame
- New IGU ( $\pm 600$  lbs.) is rolled from the loading bay up a modified residential elevator and onto stage





# QA – IGU Replacement

- Water and some smoke testing was completed during initial installations
- Testing continued at intervals to ensure installation quality remains consistent
- On site and in lab testing of materials used was also completed



# Lessons Learned

- Innovative new products are being brought to market that address the drive towards ever greater energy efficiency. Few of these products have a long proven track record of success. Inevitably some will fail.
- High level due diligence review is required before recommending these systems for use on our buildings.
- Lessons learned from failures provide valuable insight for our future projects.

# Lessons Learned

- Edge seal durability very important in thermally efficient IGUs
- Plant QA review is critical when specifying unique IGU's that cannot be manufactured on conventional glazing lines
- Site QA and testing during construction is critical when using a field applied blind seal structural glazing system.
- A suitable all weather work platform is key to the success of a reglazing project of this size.

# Questions

**MICHAEL AOKI-KRAMER**, BA, JD, LEED AP

maokikramer@rdh.com

→ [rdh.com](http://rdh.com)

