



WGA Curtain Wall Failures

Presented by:

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- **Education:** B.S., Civil Engineering, Santa Clara University
- **Registration:** P.E., Civil Engineering, California, Washington, Nevada, and Hawaii
- **Certification:** Registered Roof Consultant (RRC), Roof Consultants Institute, and, Registered Waterproofing Consultant (RWC)
- **Overview:**
 - CEO and Senior Principal at Allana Buick & Bers.
 - Former Turner Construction Employee (Project Engineering and Superintendent)
 - Over 37 years experience providing superior technical standards in all aspects of building technology and energy efficiency.
 - Principal consultant in forensic investigations of building assemblies, failure analysis, evaluation and design of building infrastructure and building envelope evaluation and design.
 - Expert in all aspects of building envelope technology.
 - Completed numerous new construction, addition, rehabilitation, remodel and modernization projects for public and private sector clients.
 - Specialization in siding, roofing, cement plaster, wood, water intrusion damage, window assemblies, storefronts, below grade waterproofing, energy efficiency, solar engineering and complex building envelope and mechanical assemblies.



ABBAE – Firm Overview

- Allana Buick & Bers (ABBAE) is an architectural engineering firm specializing in Building Envelope Systems
- ABBAE has over 31 years of experience with over 5,250+ projects
- 45% of our work is new construction with over \$7B in construction value. 55% of our work is building rehabilitation and repairs.
- Office Locations
 - 12 Offices across Oregon, Washington, California, Nevada, North Carolina, and Hawaii.

ABBAE Building Enclosure Expertise

Building Envelope

- Windows and glazing systems
 - Punched windows
 - Curtain wall/window wall systems
 - Sliding glass doors
 - Skylights
- Exterior wall systems
 - Sheet metal flashings
 - Wall cladding/siding/ GFRC/pre-cast
 - EIFS/cement plaster/stucco
- Roofing systems
 - Steep-slope/low-slope roofs
 - Green/garden roofs
 - Drainage systems
 - Pedestrian plazas
- Waterproofing systems
 - Deck/balcony/lanai
 - Podium
 - Pool/spa deck
 - Below-grade

ABBAE Glazing Testing Expertise

- ASTM E1105-15: Field determination of water penetration of installed exterior windows, curtain walls, and doors by uniform or cyclic static air pressure difference
- Aama 501.2-15: Quality assurance and diagnostic water leakage field check of installed storefronts, curtain walls, and sloped glazing systems
- Aama 501.1-17: Test method for water penetration of windows, curtain walls, and doors using dynamic pressure
- Nafs 2011 –aama/wdma/csa/101/i.S.1/A-440 – North American fenestration standard/specification for windows, doors and skylights

ABBAE Air Barrier Testing Expertise

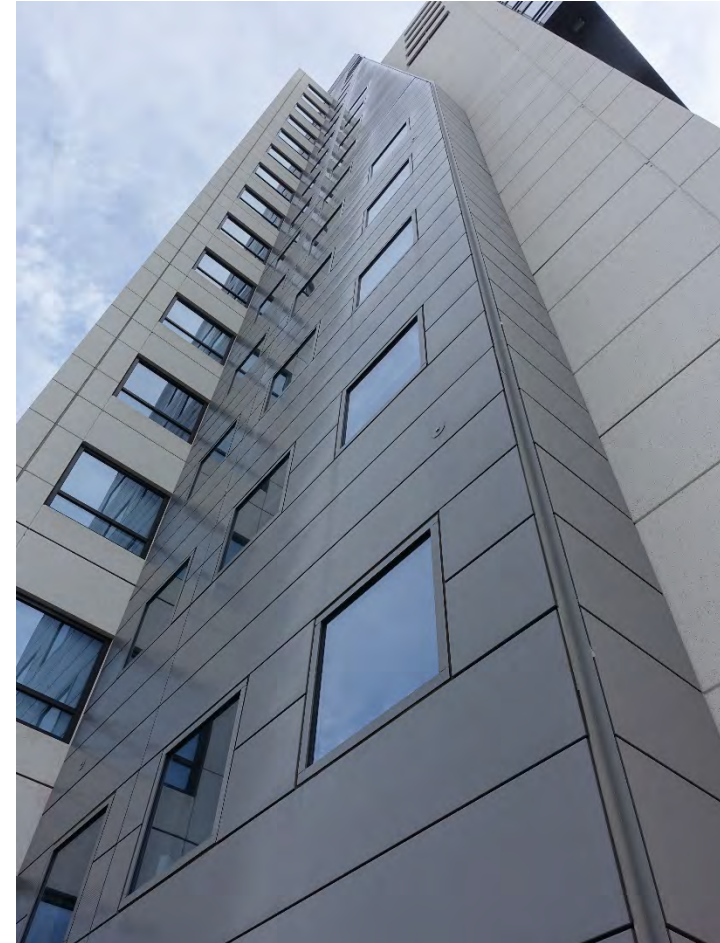
- ASTM E779-10: Standard test method for determining air leakage rate by fan pressurization
- ASTM E1827-11: Standard test methods for determining airtightness of buildings using an orifice blower door
- ASTM E283-04: Standard test method for determining rate of air leakage through exterior windows, curtain walls, and doors under specified pressure differences across the specimen
- ASTM E1186: Standard practices for air leakage site detection in building envelopes and air barrier systems

Learnings From Curtain Wall Failures

- Typical New Failures Discovered in Last 5-10 Years
- Common Modes of Failure in Multiple High-Rise Curtain Wall and Window Wall Systems
- Lessons Learned and How to Avoid Them

Common Modes of Failure

- Gasket Failure
 - Water Intrusion
 - Air infiltration
- Aluminum Coating Failure
 - New primer issues
 - Coating thickness issue
 - Contaminants
- Corrosion of Glass
 - Edge deletion issue
 - Standing water on seals
- IGU Polyisobutylene (PIB) Failure
- Aluminum Thermal Break Failure



Gasket Failures

- Drying out, shrinking and cracking
- Poor quality materials
- Exposure to UV radiation
- Exposure to freeze-thaw cycles
- Improper maintenance

Mondavi Center



Leaks Due To Gasket Shrinkage



Mondavi Gasket Shrinkage / Failure



Mondavi Gasket Shrinkage / Failure

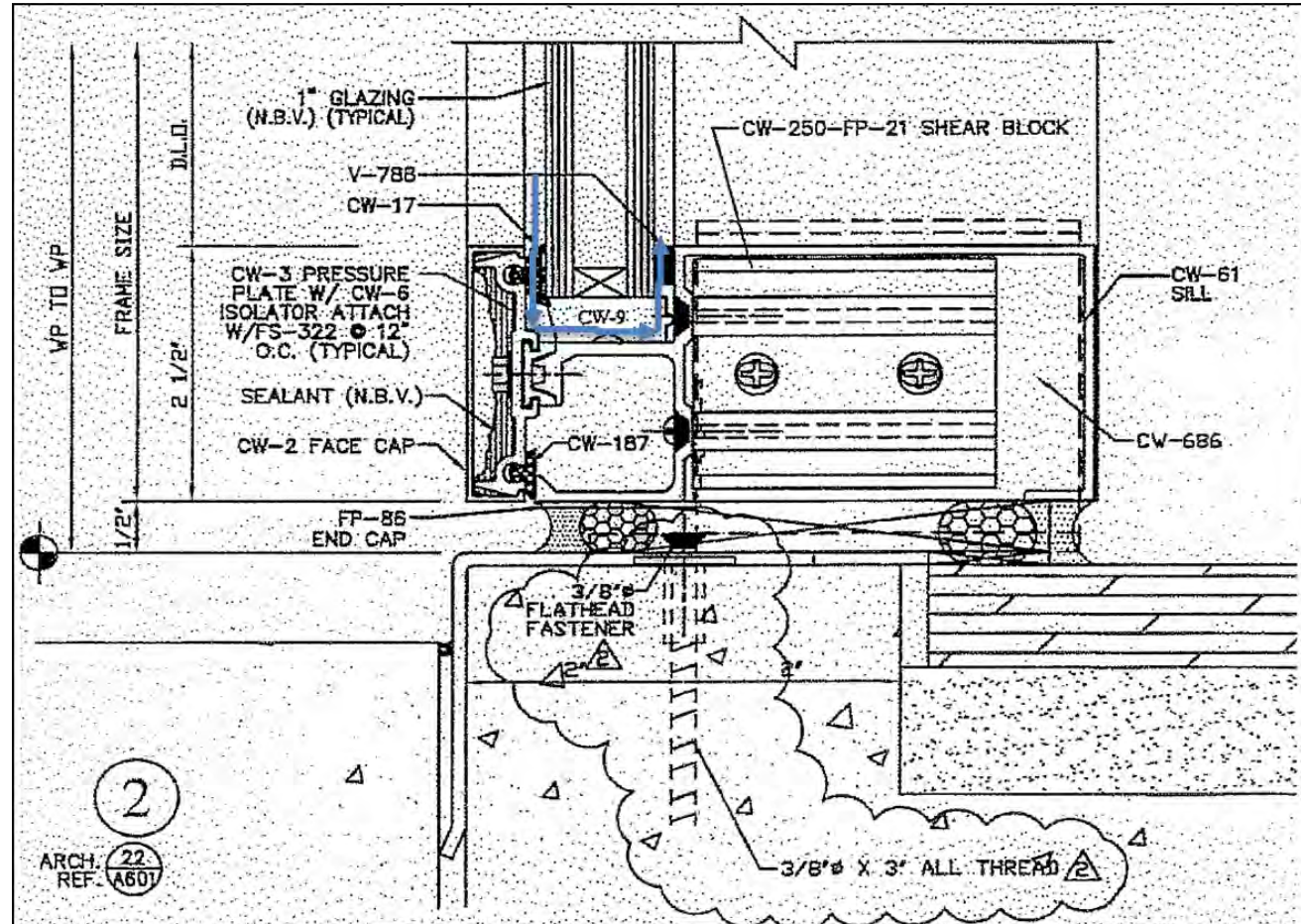


Mondavi Gasket Shrinkage / Failure

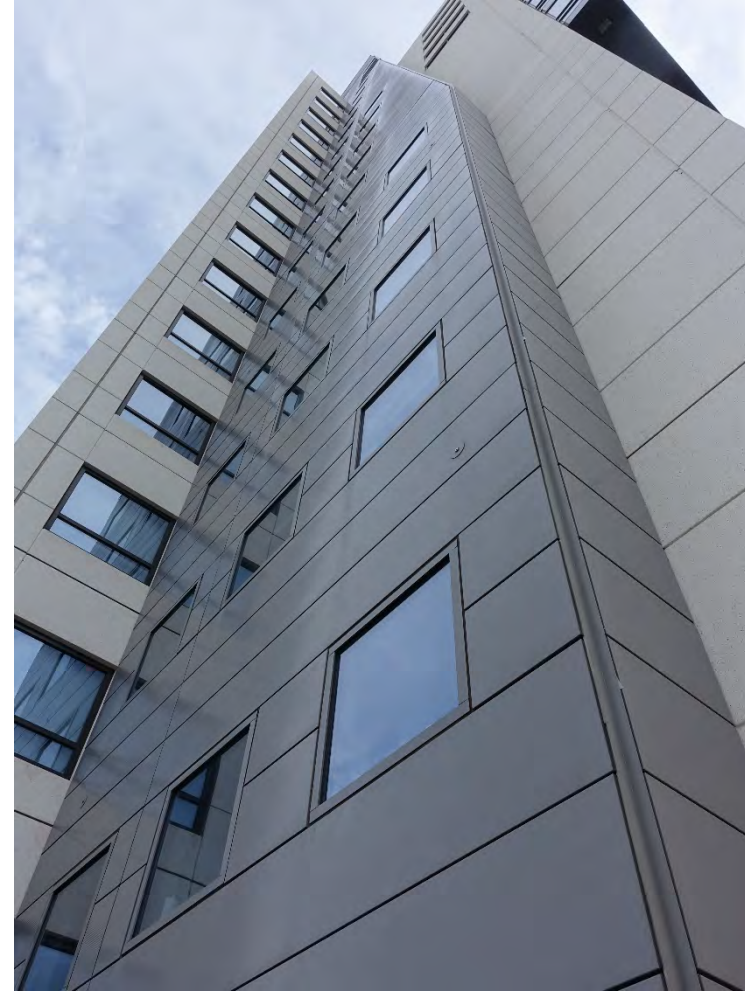


Both Exterior & Interior Gaskets Shrank

15/16" glazing installed produces a loose seal and leaks



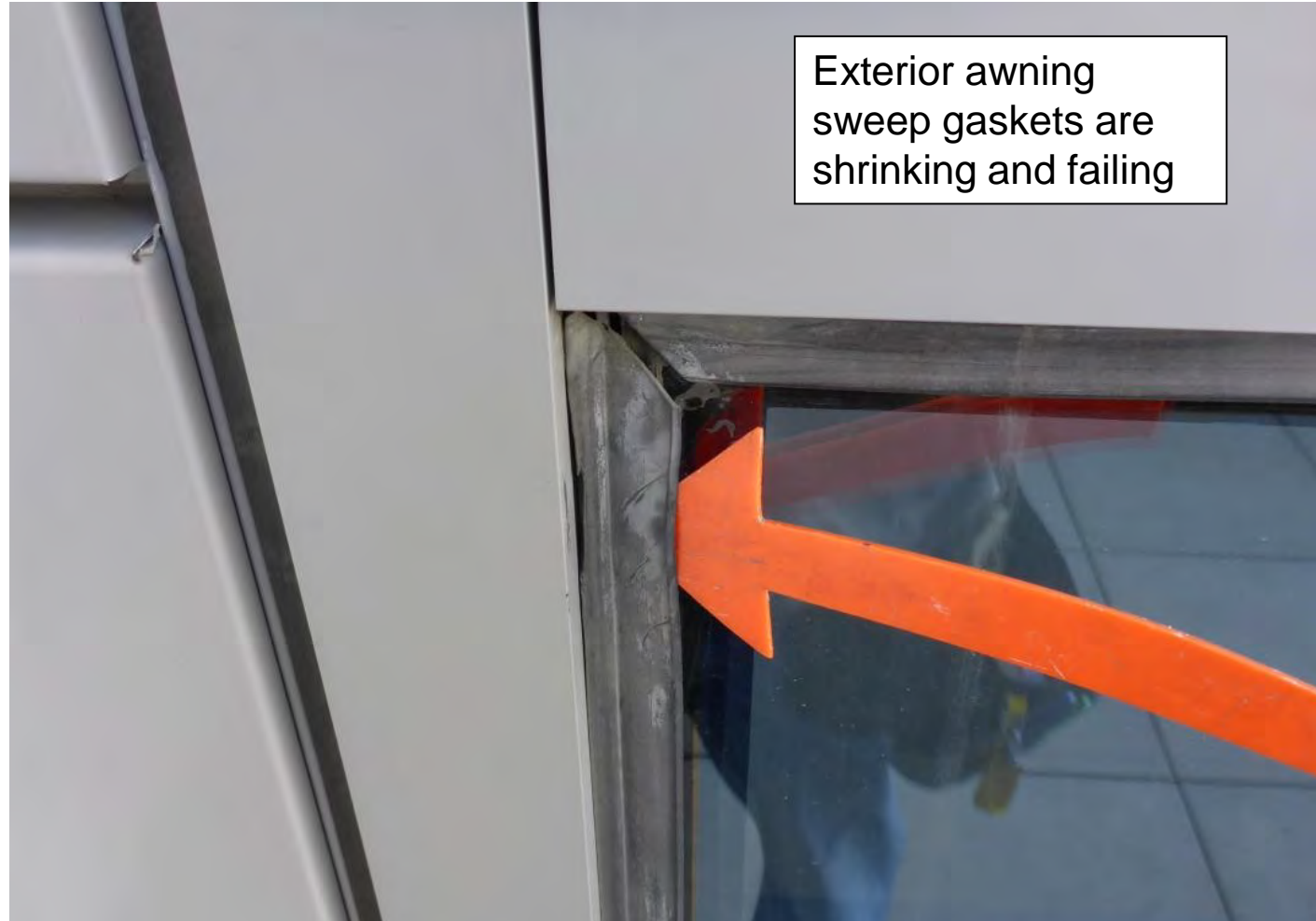
San Jose Condo



Gasket Failure



Gasket Failure - San Jose Condo



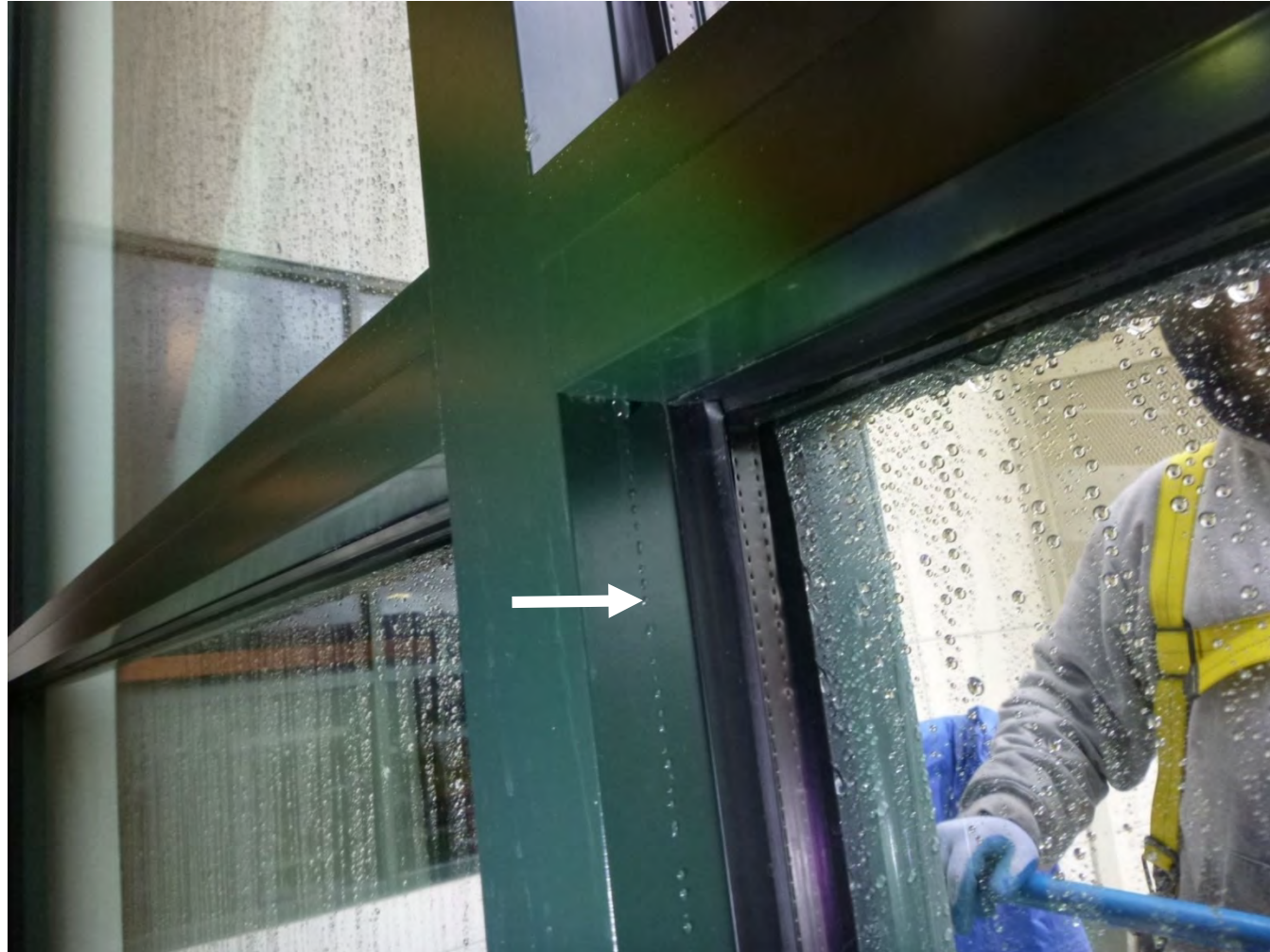
Gasket Failure- San Jose Condo



College Library



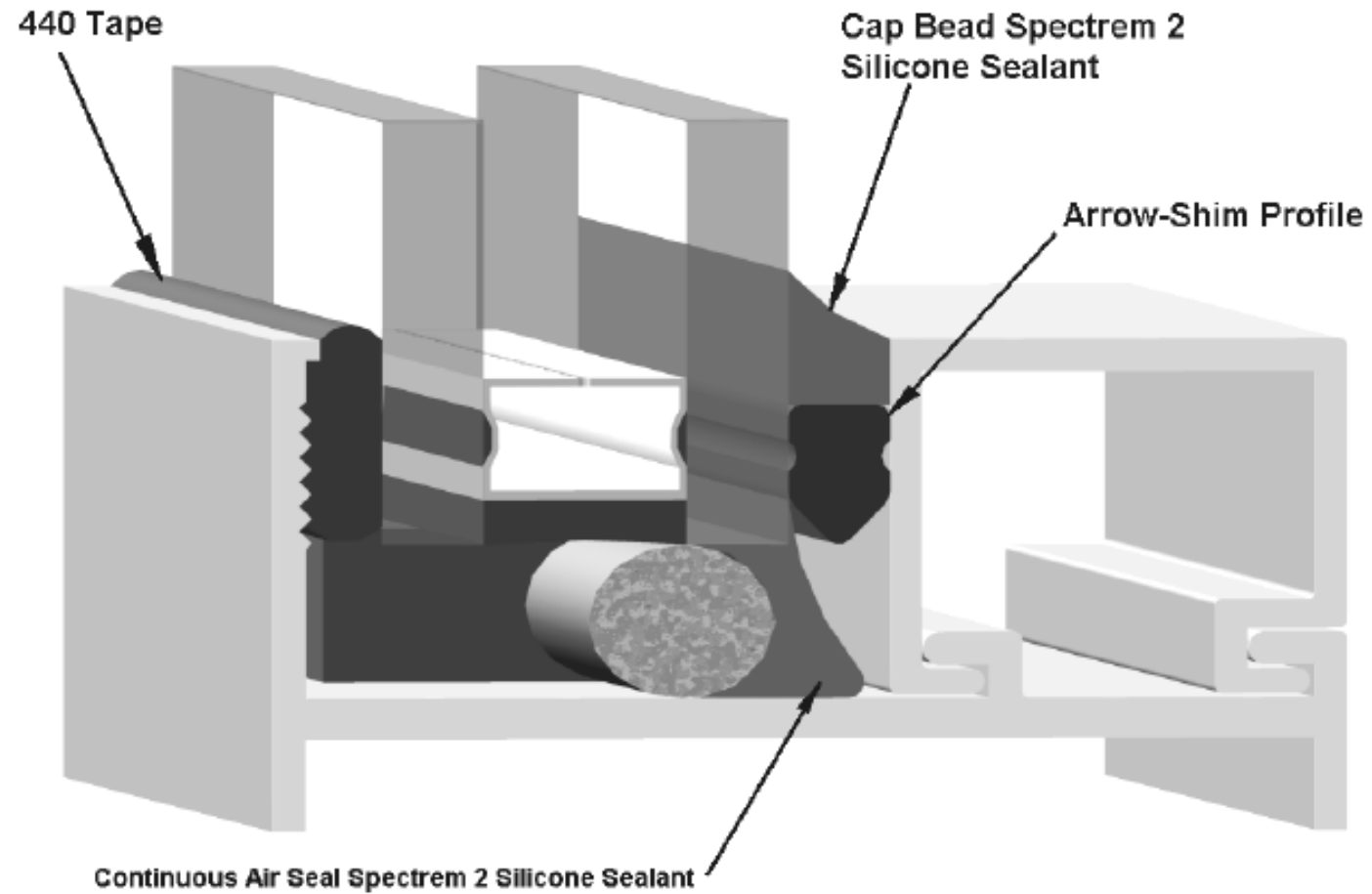
Gasket Failure - Causing Leaks



Gasket/Seal Failure Impact

- Water intrusion
- Air infiltration
 - Energy loss
 - Condensation

Glazing Gaskets Enhanced



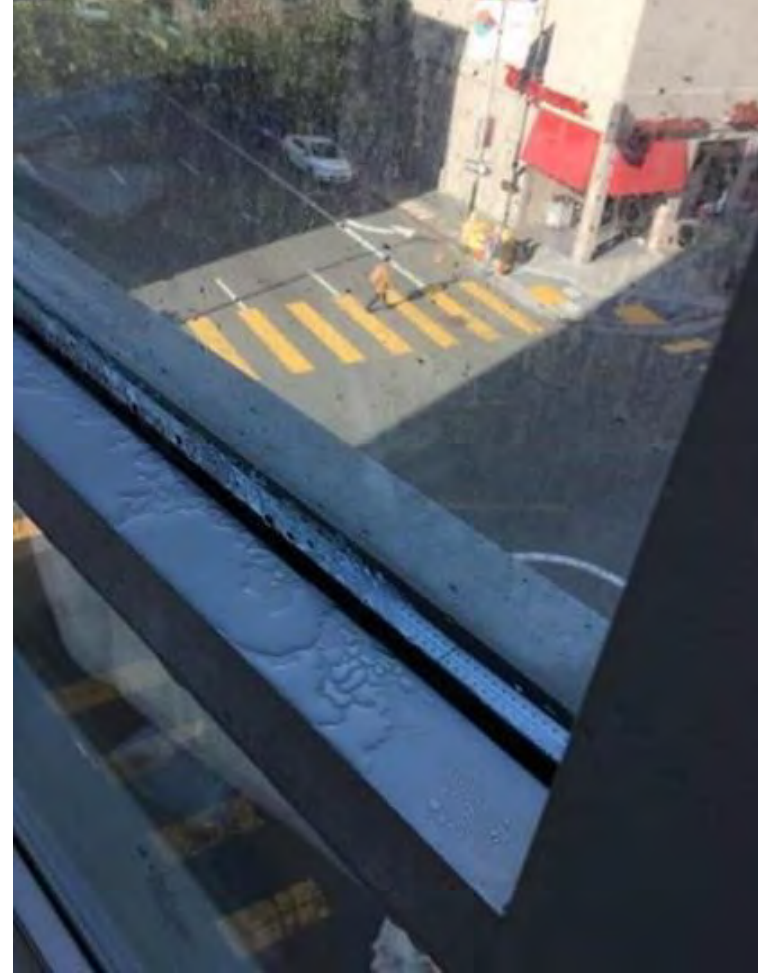
Air Infiltration Can Cause

- Air Infiltration can lead to:
 - Energy loss
 - Creating an Air Tight Enclosure Makes all the Difference
 - ASHRAE 90.1 User Manual
 - “Controlling infiltration is important to achieving energy- efficient building.”
 - Air infiltration creates additional loading on the mechanical system
 - Newer Codes (2009 IBC) will require Air Barriers and on-site testing
 - Condensation
 - Commonly mistaken for water intrusion

San Francisco Residential Building



Condensation Due to Gasket Shrinkage



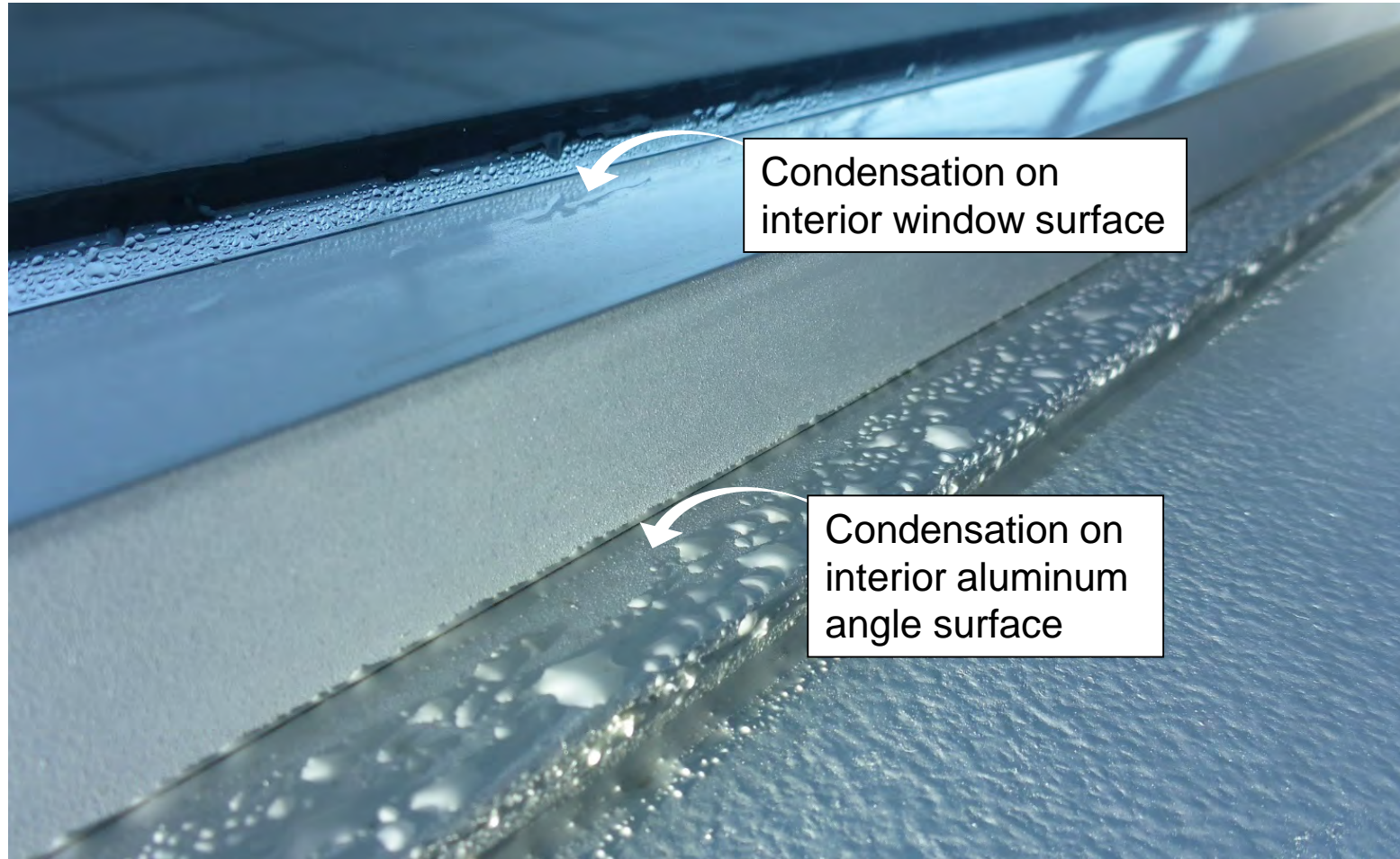
Avoiding Gasket Failure

- Specifying silicone gaskets
- Quality control testing/commissioning to check for specified materials
- Using wet seals on inside in conjunction with gaskets

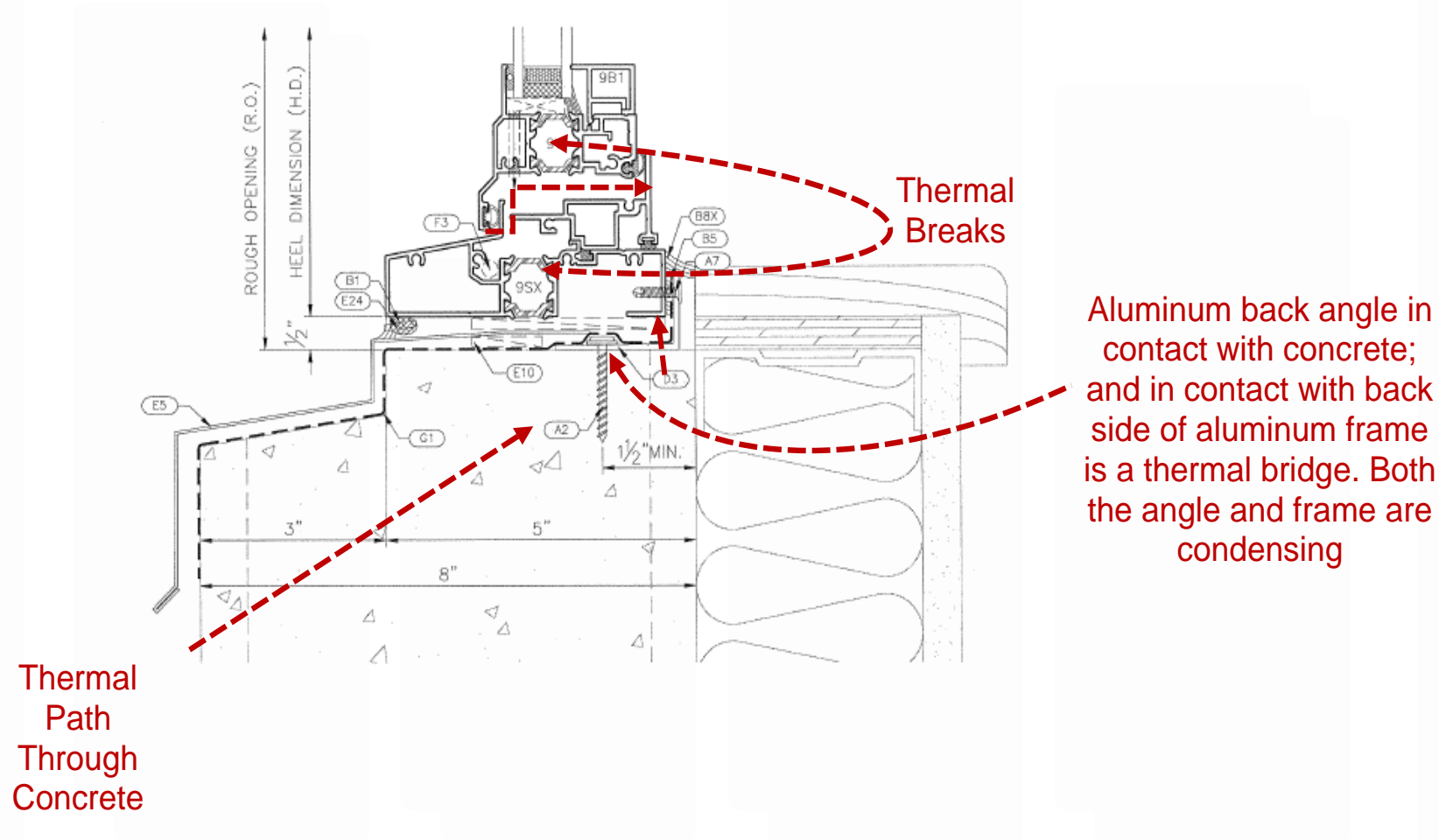
Thermal Break Failure

- Can cause condensation on frame
- Aluminum frame in contact with concrete
- Occurs when thermal breaks are missing or bypassed

Condensation



How Condensation Can Occur

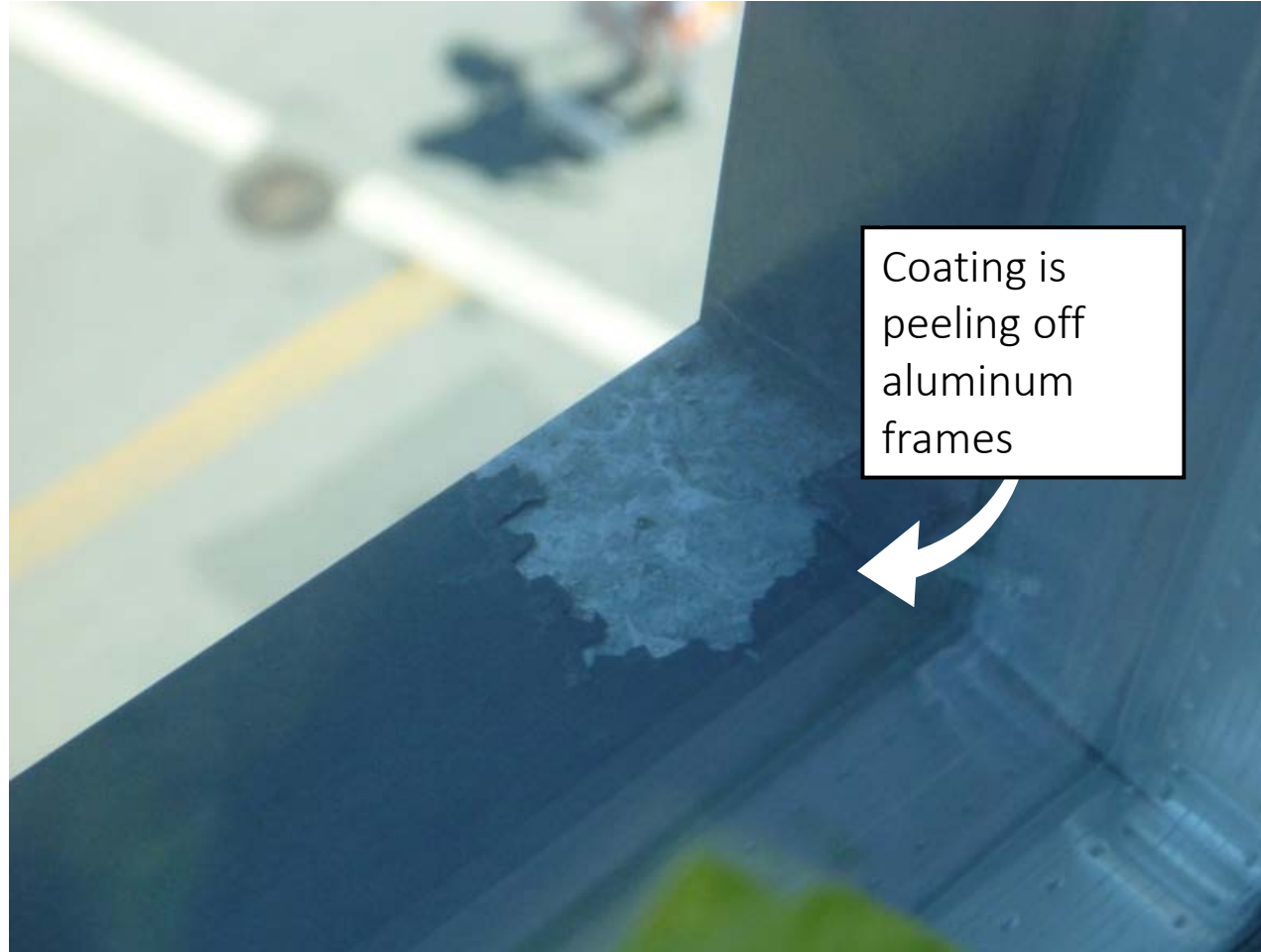


Aluminum Coating Failure



Coating is blistering
on window sill
flashings

Aluminum Coating Failure



Coating is
peeling off
aluminum
frames

Aluminum Coating Blistering



Coating is bubbling
on window frames

San Francisco Condo #2



Coating Erupting and Blistering



Coating Failure Causing Pitting



Aluminum Coating Failure Causes

- Proper surface preparation and pre-treatments
- Substitution of Chromimum Phosphate wash
- Coating requirements are not followed
 - Improper thickness of coating
- Lack of surface prep – leading to trapped contaminants

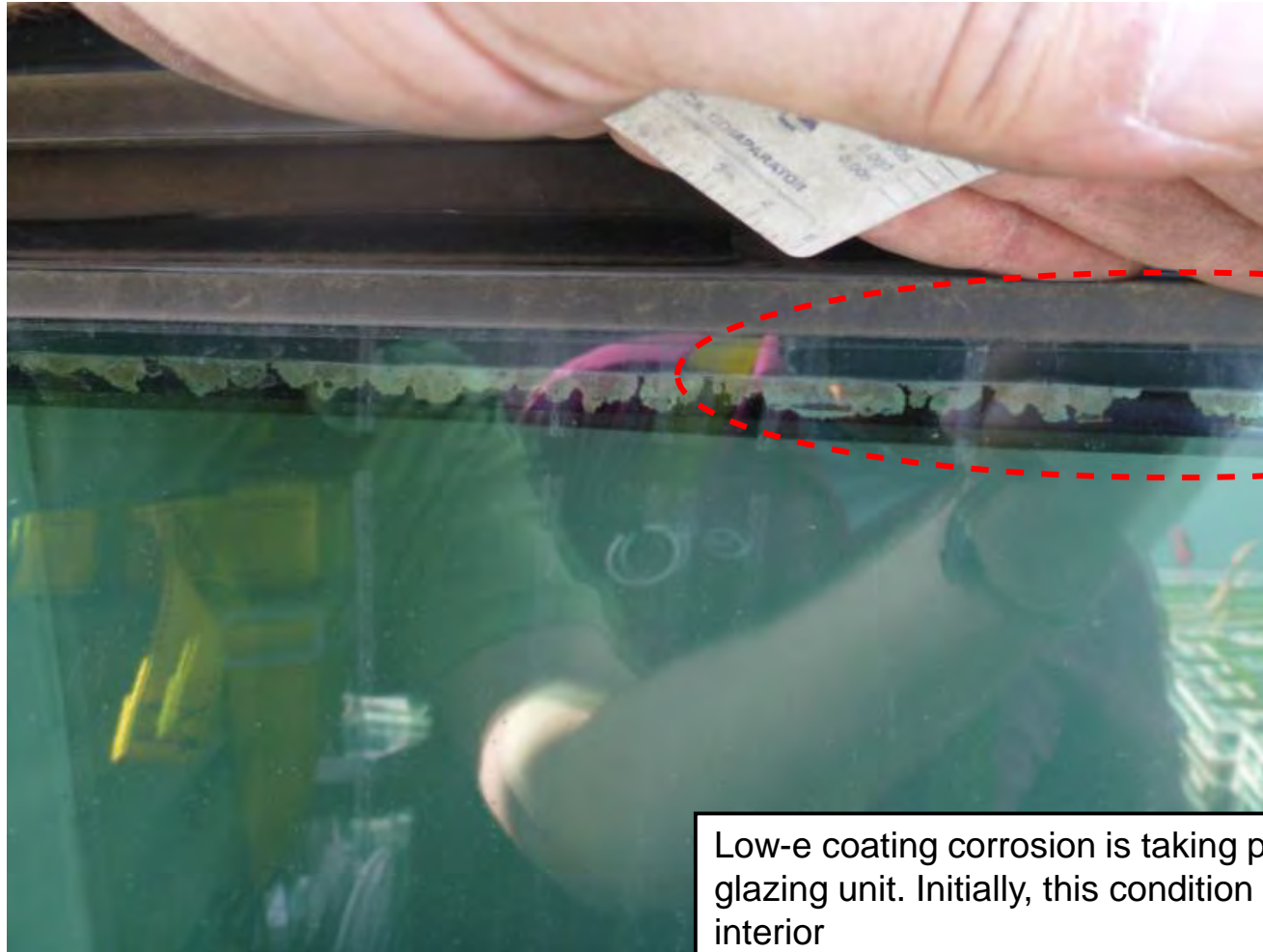
San Francisco Condo # 3



Corrosion/Tarnishing of Silver Coatings



Start of Low-E Coating Corrosion



Low-e coating corrosion is taking place at the edges of the glazing unit. Initially, this condition is not visible from the interior

Continuing Low-E Coating Corrosion

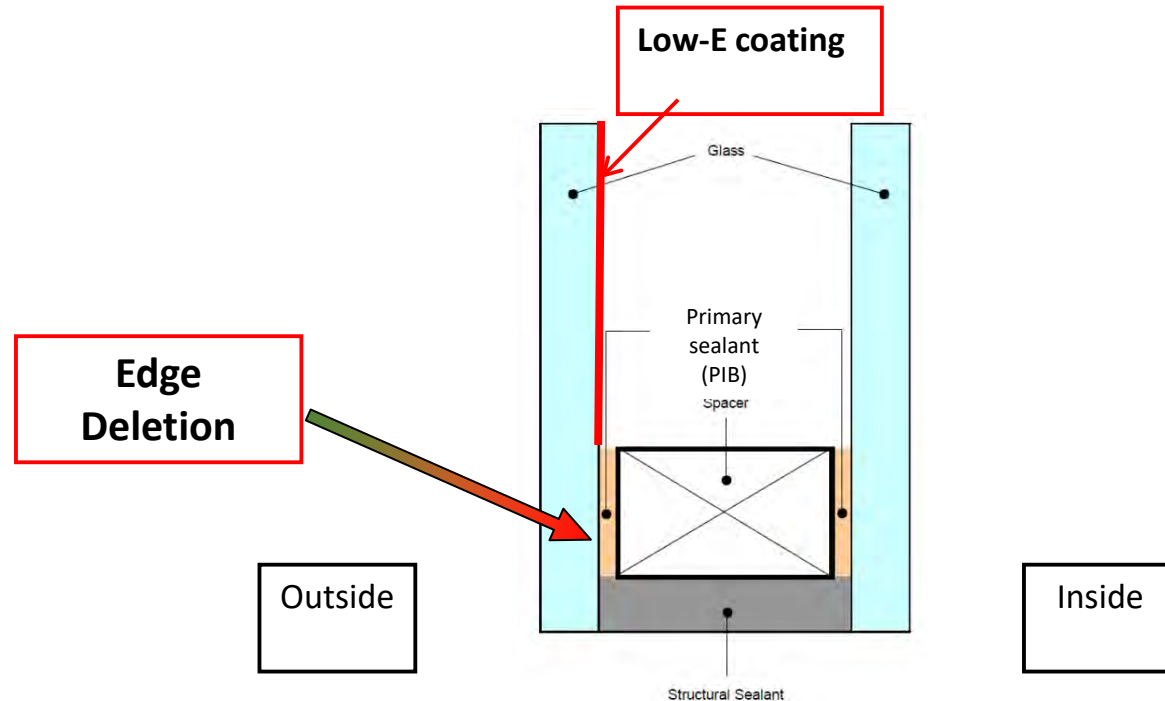


Causes of IGU Seal Failure

- Lack of or improper Edge Deletion
- Standing water on top of silicone sealant

Edge Deletion Issue

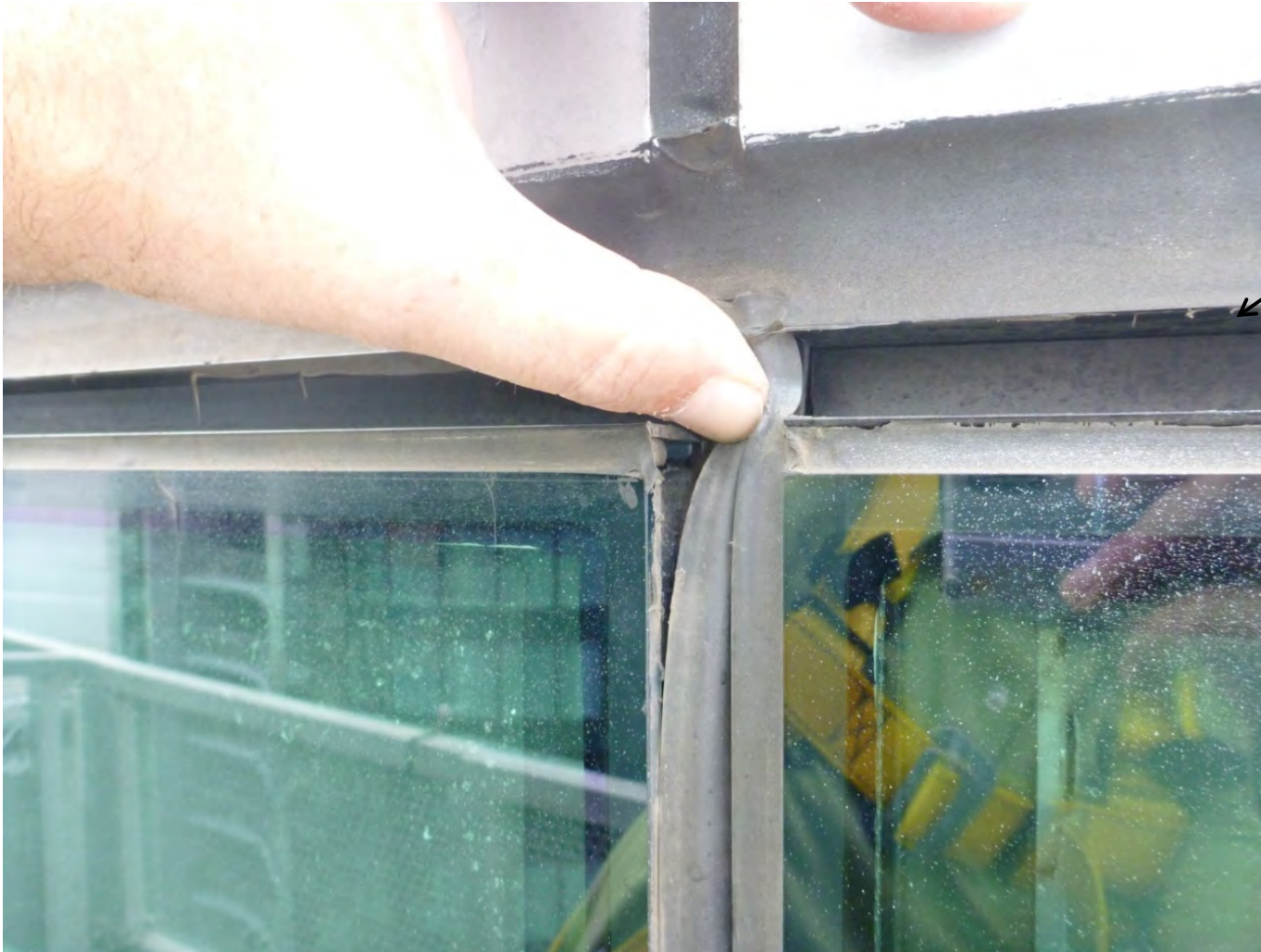
- Microscopically thin and virtually invisible metal or metallic oxide layers (silver) deposited on the glass to reduce the U-factor and (SHGC) Solar heat gain by suppressing radiative heat flow.



Edge Deletion During Manufacturing



Standing Water on IGU Seals



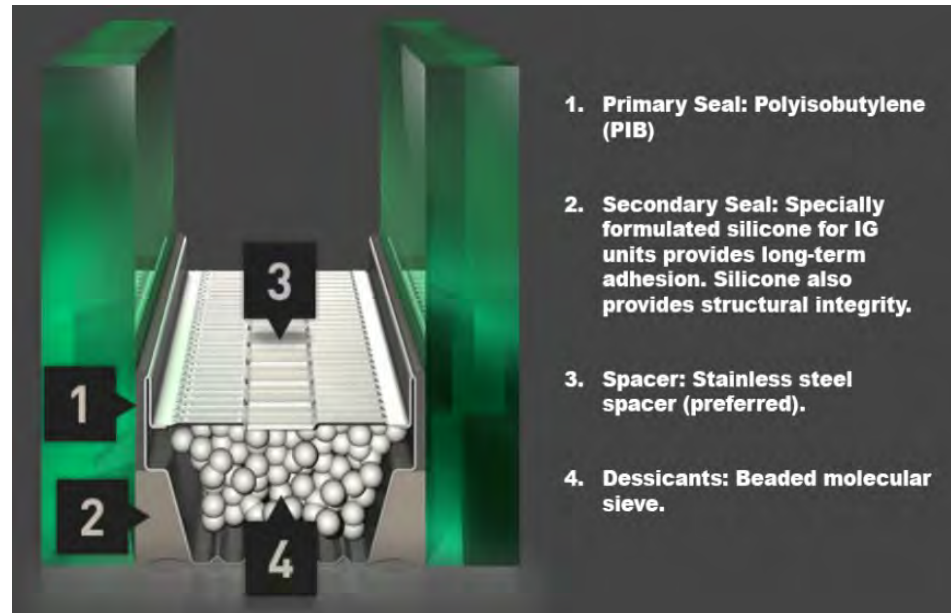
If the ends of the sealant joints are not closed, water is able to infiltrate on top of the primary seal

Prevention

- Proper edge deletion needs to occur during the manufacturing process to ensure proper bonding of the IGU sealants
- Design of the glazing and curtain wall assembly should not allow water to stand on top of the silicone sealant because silicone is permeable
- Design installation of glass should be on blocks and properly drained to prevent dual glazing to sit in water

PIB Migration

- PIB (primary) and secondary sealants prevent air/ water infiltration in IGU airspace
- PIB moves from window edge, obscuring vision



PIB Migration/Failure in IGU



PIB Migration, Moving/Walking Up



PIB Migration



Case Study- SF Condo w/ PIB Migration



Case Study- SF Condo w/ PIB Migration



Case Study- SF Condo w/ PIB Migration



Case Study- San Pedro Condo w/ PIB Migration



Case Study- San Pedro Condo w/ PIB Migration



Replacing Glass is Very Expensive



Replacing failed glazing on
650 unit high-rise building
can cost over \$100MM

Replacing Glass, Slow and Tedious

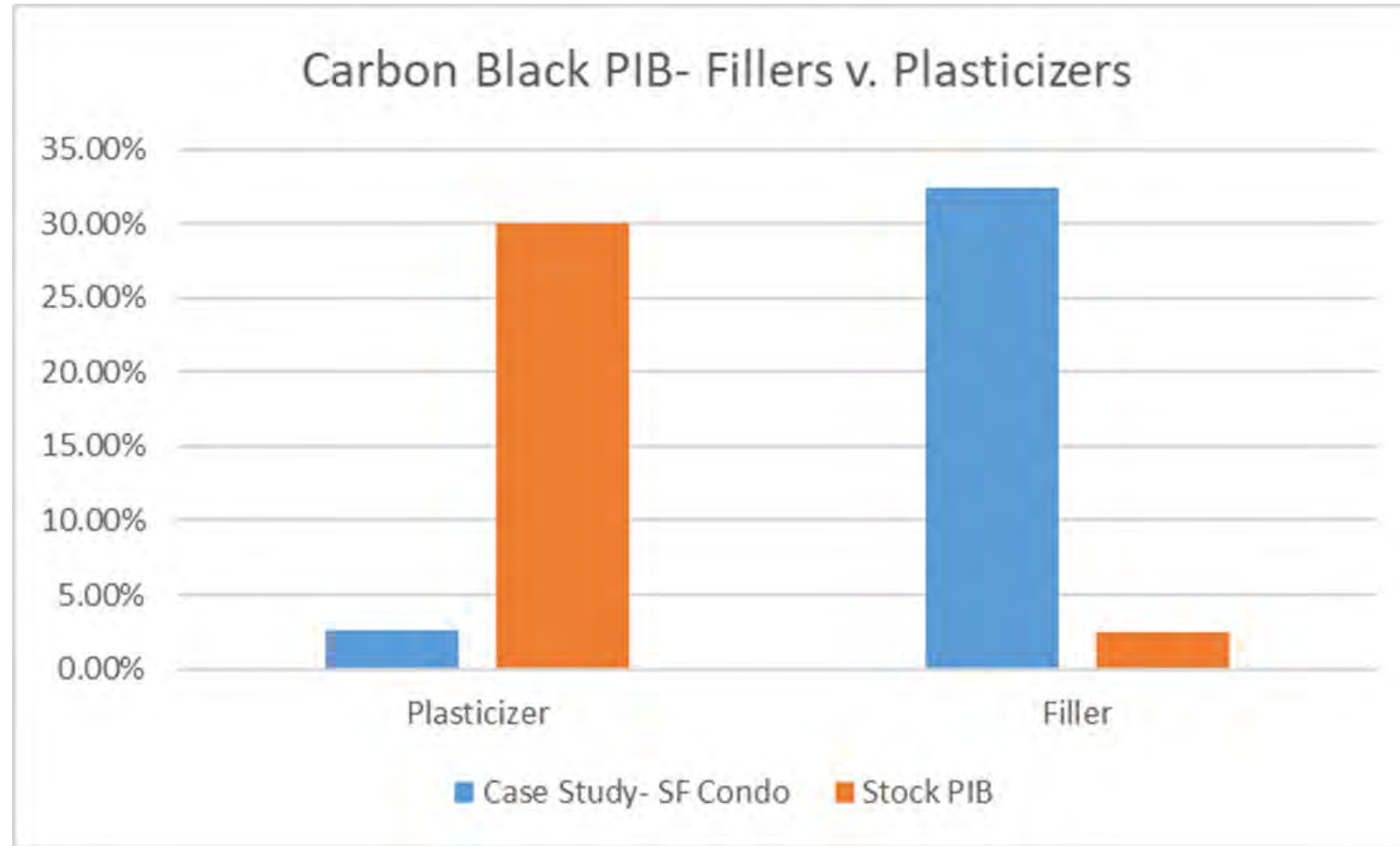


2 guys on window
washing rigs

3 guys on the inside
handling glass



Case Study- SF Condo w/ PIB Migration





Conclusion

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