15th Canadian Conference on Building Science and Technology

November 6-8, 2017

Vancouver, BC, Canada

MORRISON HERSHFIELD

Lessons Learned from Laboratory Testing Failures of Glazing Systems

Andy Lang, AScT

Session Outline

- Typical Laboratory Testing Procedures
- Failures and Corrective Actions
  - Water penetration
  - Structural
  - Air leakage
- Other Lab testing procedure considerations
- Summary/Conclusions

Typical Test Standards and Procedures

- ASTM E2099 – *Standard Practice for the Evaluation of Pre-Construction Laboratory Mockups of Exterior Wall systems*
- AAMA 501 – *Methods of Test for Exterior Walls*

Provide recommended test sequence for evaluating performance of mockups.

AAMA 501 Test Sequence

- 50% Structural Load (ASTM E330)
- Air Leakage (ASTM E283)
- Static Water Penetration (ASTM E331)
- Optional Dynamic Water Penetration (AAMA 501.1)
- Optional Interstory Lateral Displacement – elastic limit (AAMA 501.4)
  - Repeat Air Leakage and Static Water Penetration
- Optional Interstory Vertical Displacement (AAMA 501.7)
  - Repeat Air Leakage and Static Water Penetration
- Optional Thermal Cycling (AAMA 501.5)
  - Repeat Air Leakage and Static Water Penetration
- 100% Structural Load (ASTM E330) – *(commonly done before seismic)*
  - Repeat Air Leakage, Static Water Penetration, and optional Dynamic Water Penetration
- 150% Structural Load (ASTM E330)
- Optional Interstory Lateral Displacement – inelastic limit (AAMA 501.4)

Test Failures – Water Penetration

- Leak around glazing unit (multiple locations)

Test Failures – Water Penetration

- Poor heel bead application
- Unsealed screw holes for reinforcing steel

- Modified plant QA/QC procedures

Test Failures – Water Penetration

Fireplace vents

- Leak at fastener penetrations
- Leaks at vent penetration through backpan

Test Failures – Water Penetration

- Disassembled and modified method of sealing vent penetrations

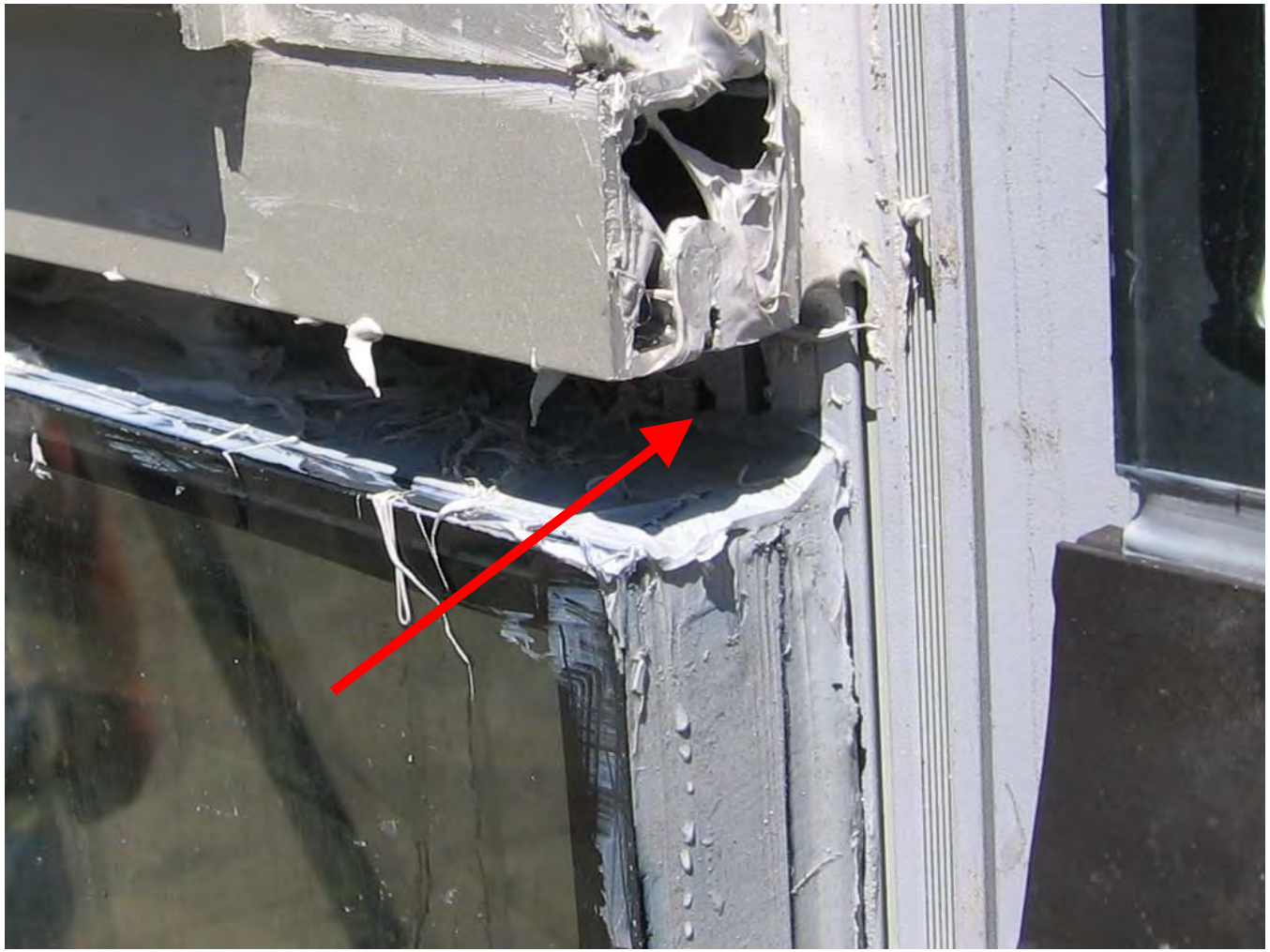
Test Failures – Water Penetration

- Bottom corners of vision glass with SSG

Test Failures – Water Penetration

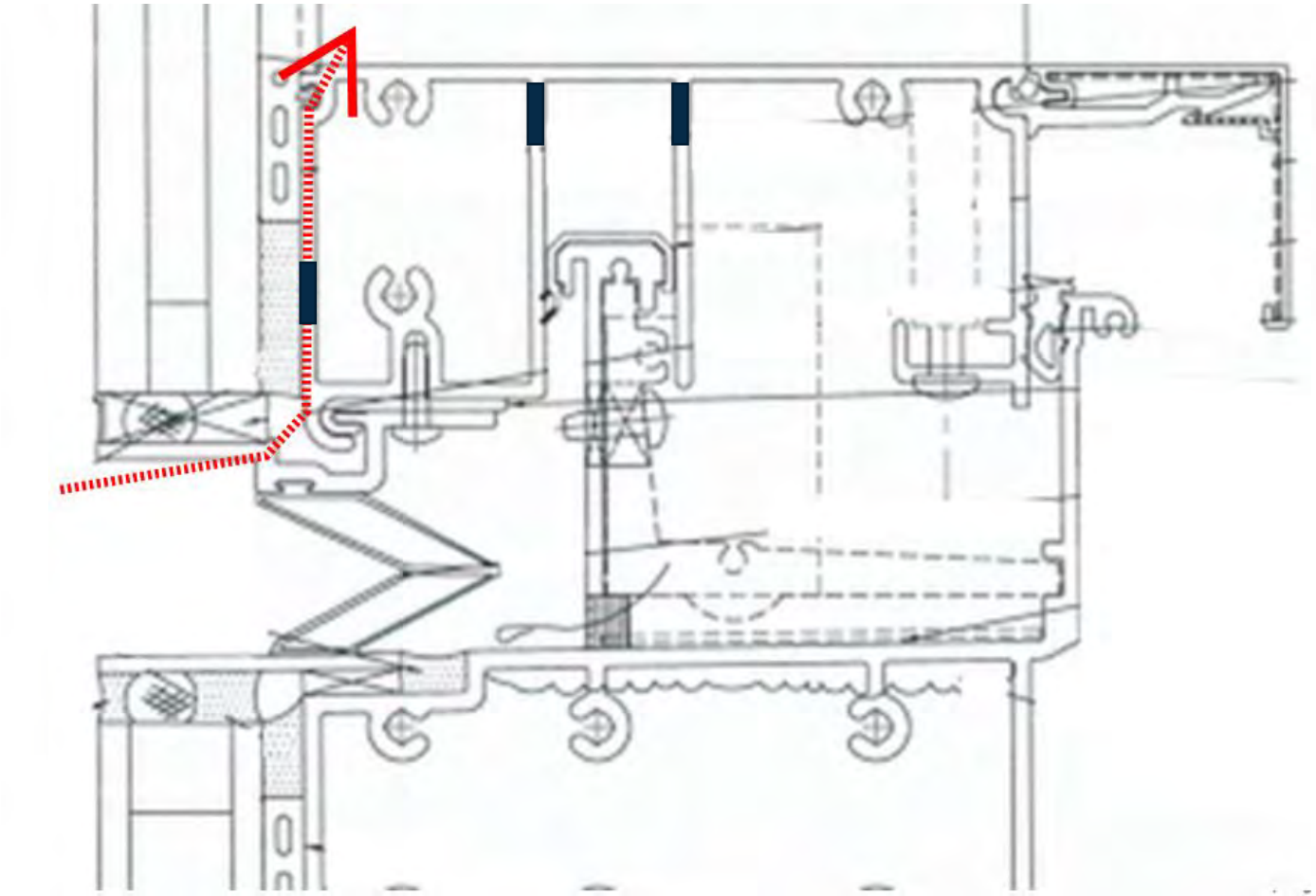
- Discontinuity of structural silicone where sealant extends across gasket chase

- Modified sealant application and QA/QC in plant



Test Failures – Water Penetration

- Sealant discontinuity at horizontal to vertical mullion joint



- Suggested to add continuity notches
- Modified sealant application and QA/QC in plant

Test Failures – Water Penetration (after Vertical Displacement)

- Leak at base of vertical to sill horizontal

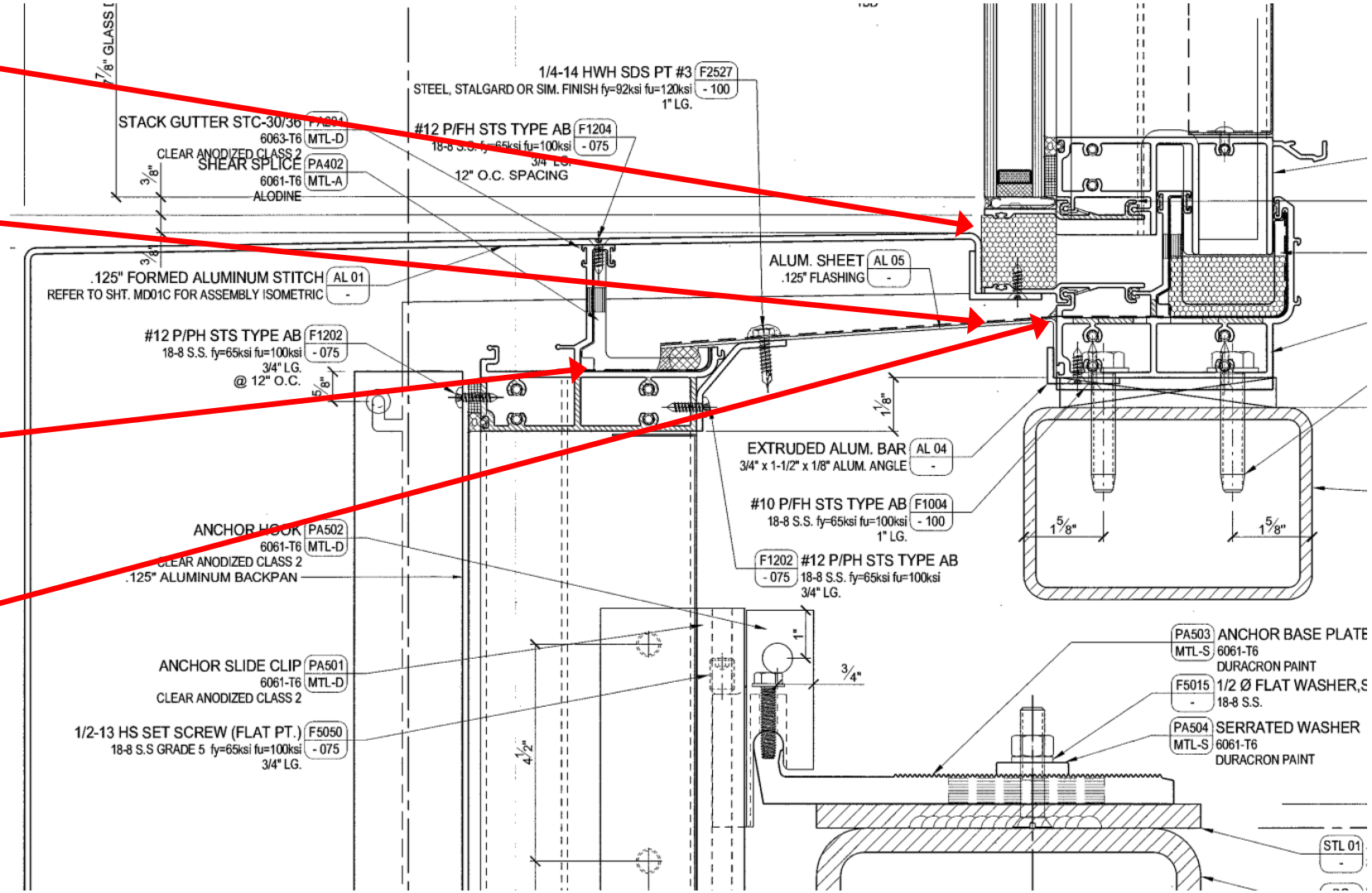
- Confirmed not sealed at time of plant assembly – updated assembly procedures

Test Failures – Water Penetration

- Leak at low sloped step-back in curtain wall plane

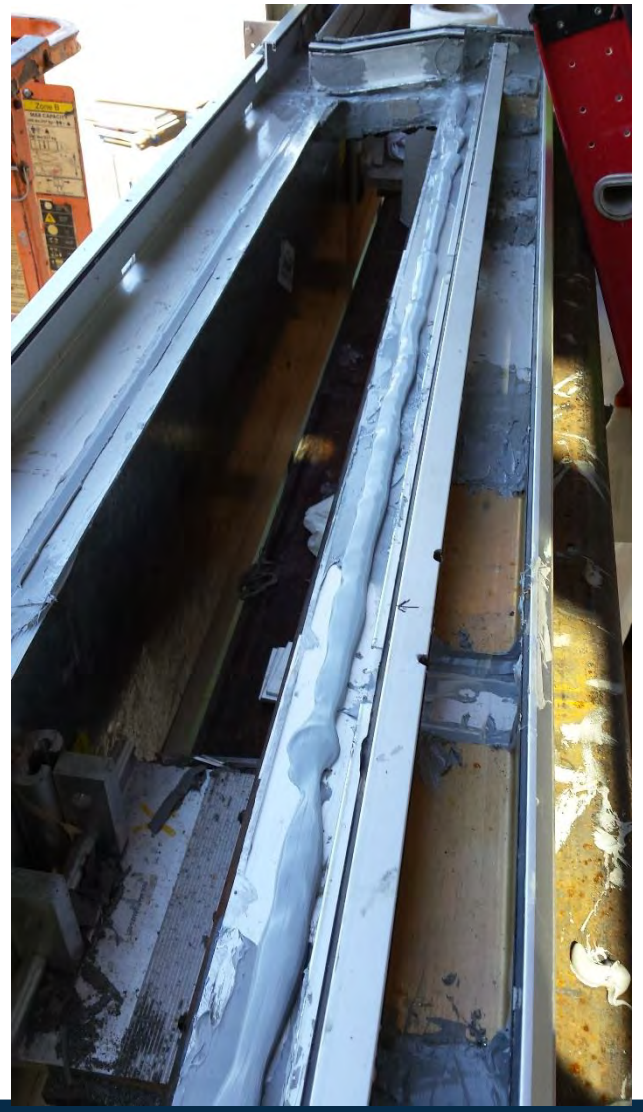
Test Failures – Water Penetration

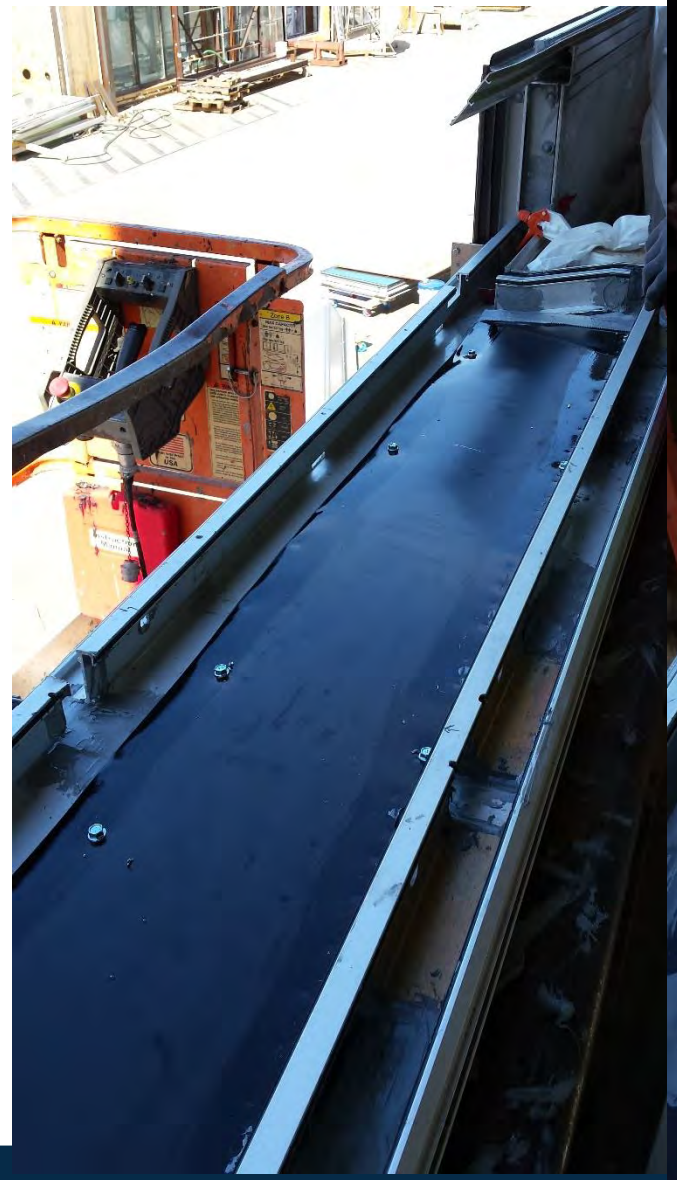
- Foam gasket allowed direct water into system
- Voids in seal of extruded silicone at joints in aluminum components
- Water penetrated around shear splice
- Water penetrated at end of aluminum flashing with down-turn leg

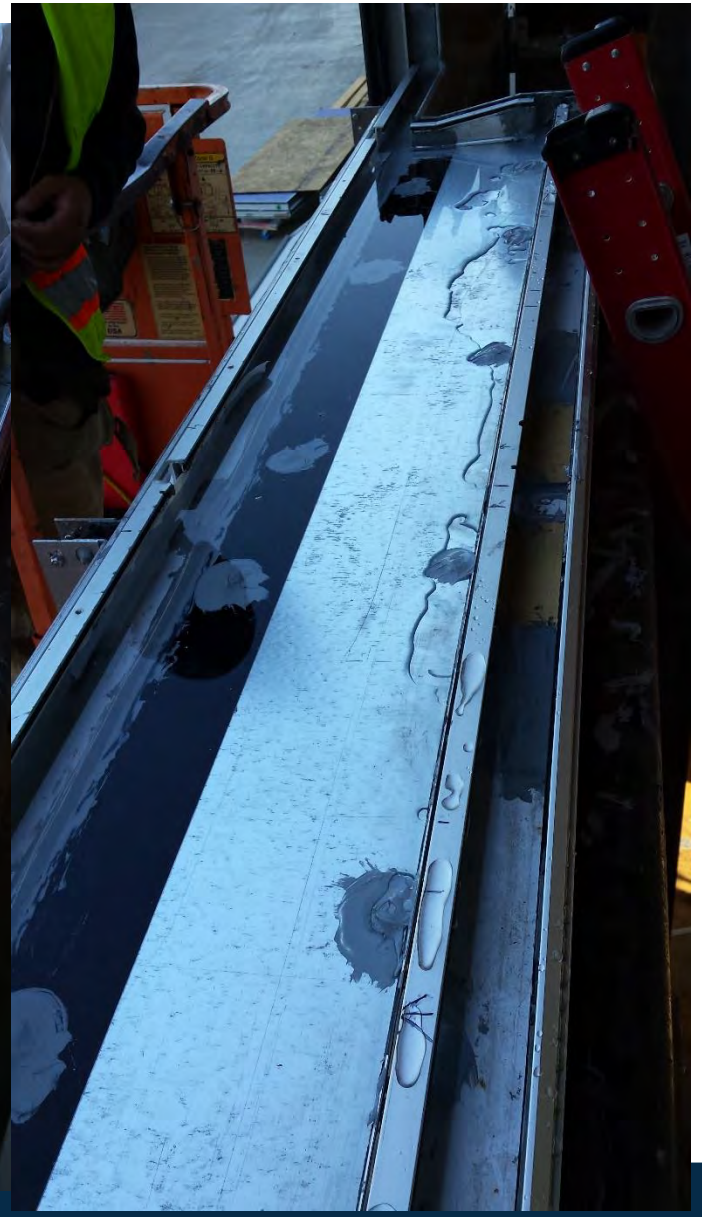


Test Failures – Water Penetration

- Disassembled and re-constructed with modified installation and sealing methods



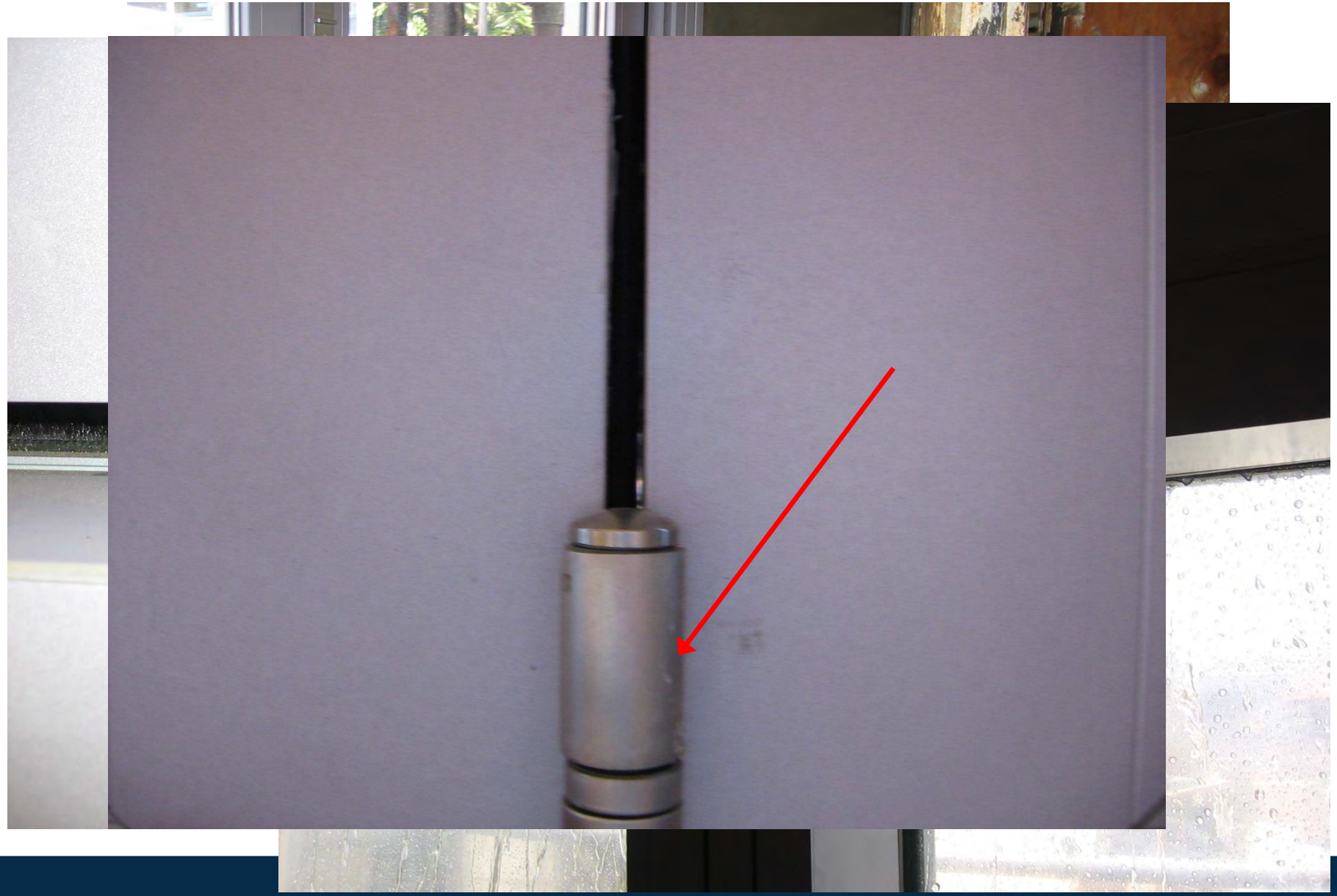




Test Failures – Water Penetration

- Bi-fold windows

- Re-design and follow-up lab testing of bi-fold windows



Test Failures - Structural

- Awning Window

- Installed additional locks at jambs

Test Failures - Structural

- Sliding door

- Decreased downturn leg of deflection header

Test Failures - Structural

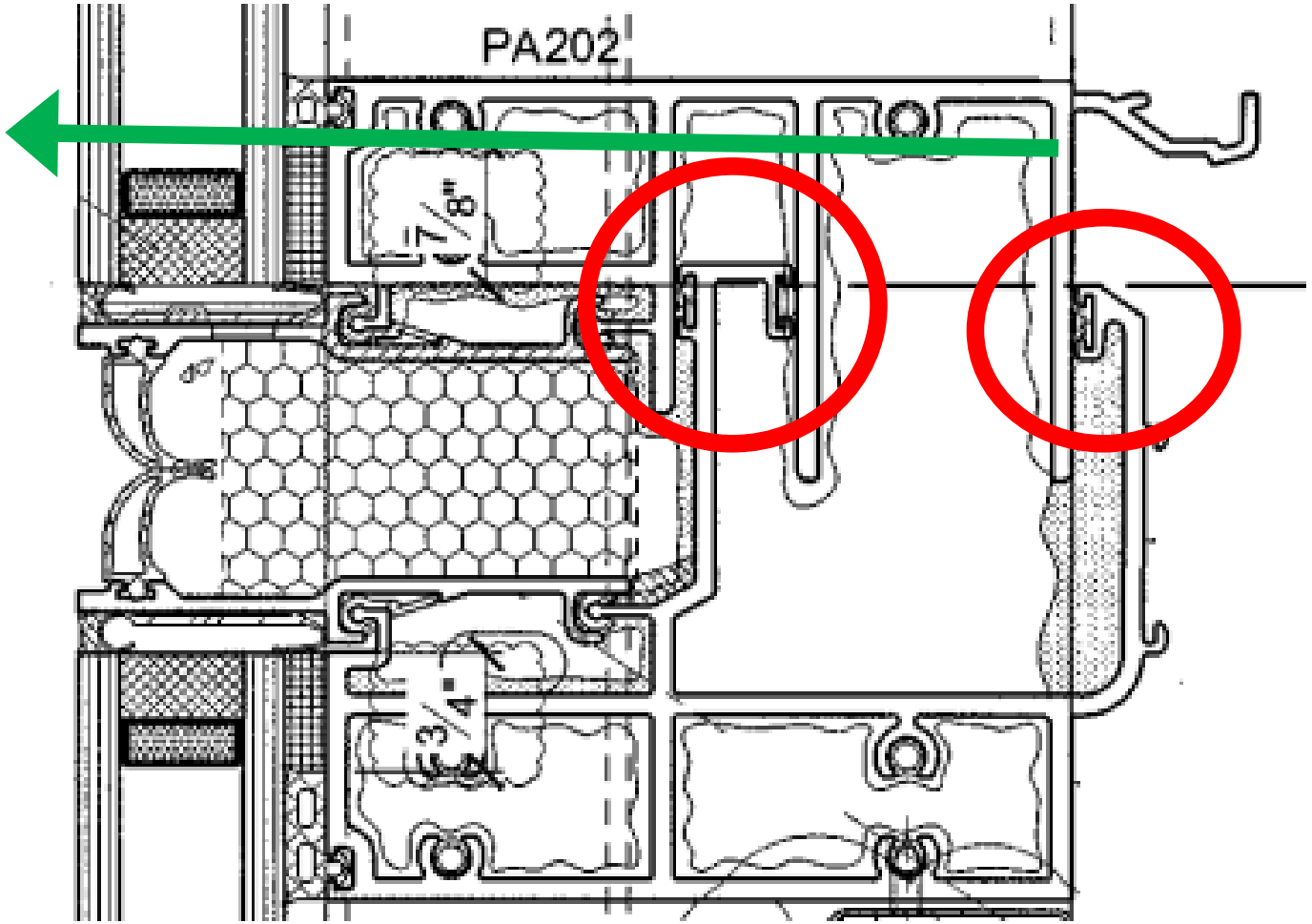
- Unitized curtain wall panel

Test Failures – Air Leakage

- Wind whistling noises under negative load

Test Failures – Air Leakage

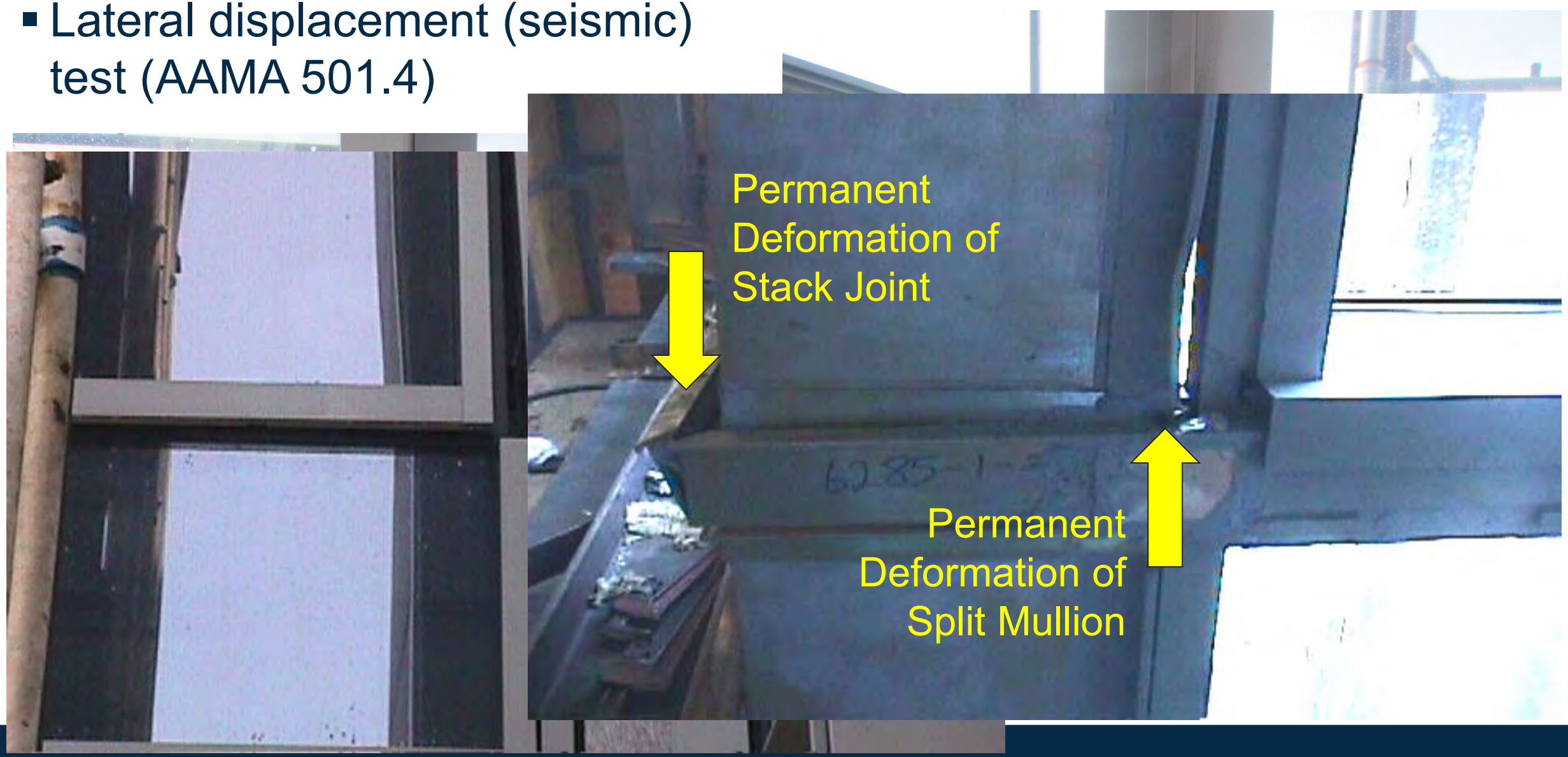
- First run extrusions out of tolerances
  - Allowed upper panel to shift outward in relation to lower panel
  - Opened interior air seal gasket



- Improved fabrication tolerances
- Increased gasket size

Other Test Considerations

- Lateral displacement (seismic) test (AAMA 501.4)

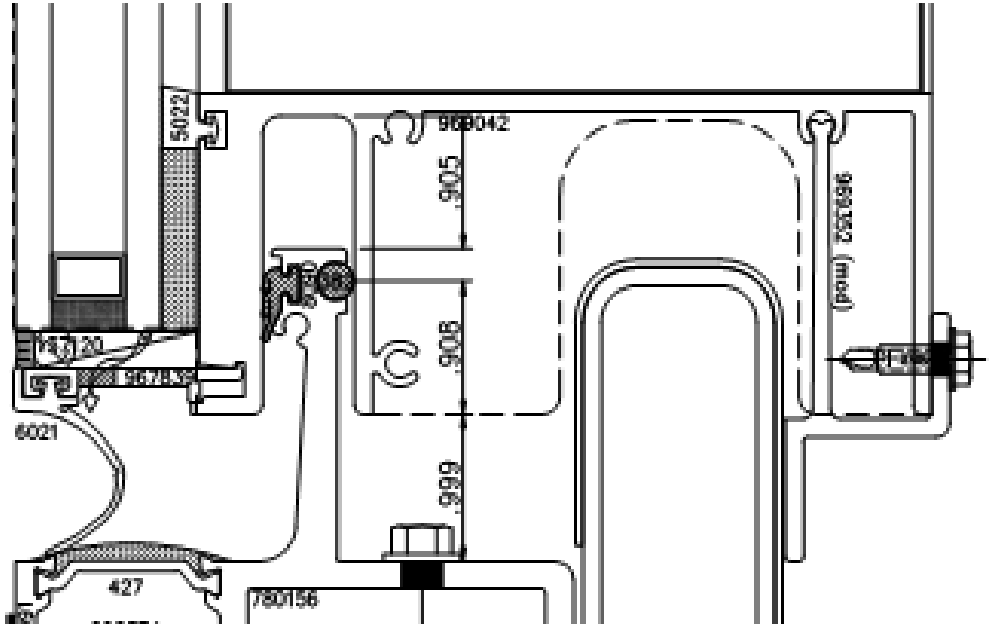


Other Test Considerations

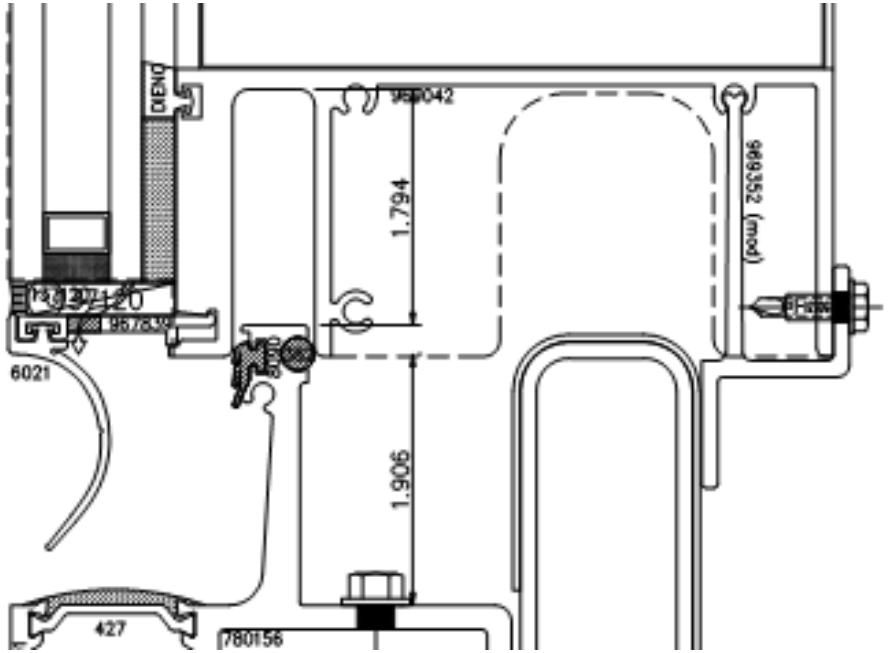
- Thermal cycling test (AAMA 501.5)
  - Time consuming (costly)
  - Rarely (never?) results in failures

Other Test Considerations

- Vertical Displacement Test (AAMA 501.7)
  - Requires more complex test chamber framing system
  - Follow-up tests in “open” position?



“normal” position



“open” position

Other Test Considerations

- Suspended access tie-back pull test
  - Typically 600 pound force – outward, up, down and both sideways
  - Sometimes with 6.24 psf (300 Pa) negative pressure

Other Test Considerations

- Air Exfiltration vs Infiltration
  - Common in the US to only require infiltration testing.
  - Example: NAFS in US requires only air infiltration testing of windows, in Canada windows tested for both infiltration and exfiltration.

Summary and Conclusions

- Test failures provide valuable insight into the performance of aluminum framed glazing systems.
- Resulted in:
  - Changes to system design
  - Improved assembly procedures
  - Improved QA/QC
- Had laboratory testing not been undertaken, may have resulted in water leaks, structural failures and/or excessive air leakage.
  - Investigation and repairs may have been extremely difficult and costly to execute post construction.

Summary and Conclusions

- Project-specific lab testing can add significant cost to a project and owners will want to avoid this testing if possible.
- Laboratory mock-up testing is recommended for all custom systems with no previous test data
  - Consideration for extent/area of custom glazing system
- Also recommended for systems that have any significant modification/variations from previously tested system.
- Full series of testing recommended (per AAMA 501 and ASTM E2009)
  - Include “optional” dynamic water penetration test and lateral (seismic) displacement tests.
  - Vertical displacement and thermal cycling tests may be optional, particularly if similar system has previous test results.

THANK YOU

Morrison Hershfield