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BUILDING ENCLOSURE CONFERENCE

RESTON VA 2022

MAY 10-11

Testing Tales From the Northwest

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RDH Building Science

abaa EDUCATION

Learning Objectives

- Identify air barrier testing requirements in US energy codes
- Understand the impact and importance of mockup testing
- Describe the impact of residential exhaust fans on airtightness test results
- Describe the key elements of an air barrier quality assurance plan

Not Covered

- Single family residential
- Why air barriers are important
- How to perform air barrier testing

Brief History of Airtightness in IECC

- 2009 & Prior
  - Requirements for fenestration
  - Generic language about air sealing
- 2012
  - Defines & requires an air barrier
  - 3 different compliance paths – materials, assemblies, or testing (0.4 cfm/sf)
- 2015 – Similar to 2012
- 2018 – Similar to 2015, but with C406.9

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More Widespread Adoption

- Many jurisdictions are considering adding testing requirements
  - CA, OR, NY, CO, UT, Toronto, others
- Some hesitancy around the testing itself
  - Will there be enough people to perform the testing?
  - Can we test really large buildings?
  - Will the people running the tests be qualified?
  - What happens if the test fails?

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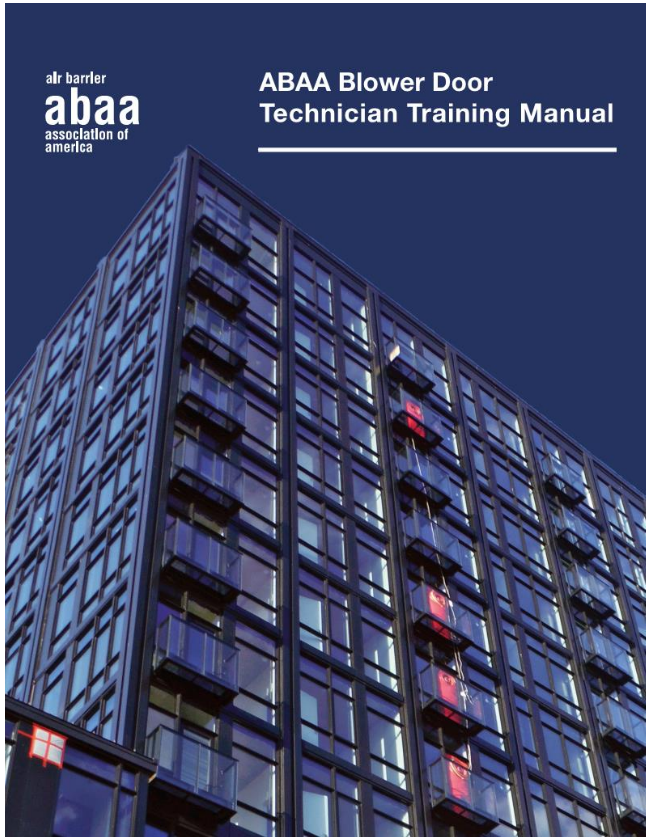
Whole Building Airtightness Program

- First ever ISO 17024 compliant certification program for airtightness testing
- Pilot program rolled out in March
- 5 day intensive course with mockup testing
- 3 more classes this year
- Essential for larger adoption of testing



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Brief History of Airtightness in WA

- 2009
  - Defines & requires an air barrier
  - Air barrier must be tested – goal is 0.4 cfm/sf but not required to pass
- 2012
  - Similar to 2009, but need to pass at 0.4 cfm/sf
  - Failed test requires an investigation, explanation, and attempt to seal leaks
- 2015 – Same as 2012, but with 0.3 cfm/sf
- 2018 – Big changes

2018 WA Energy Code

C402.5.1.2 Building test. The completed building shall be tested and the air leakage rate of the *building envelope* shall not exceed 0.25 cfm/ft^2 at a pressure differential of 0.3 inches water gauge (2.0 L/s x m^2 at 75 Pa) at the upper 95 percent confidence interval in accordance with ASTM E 779 or an equivalent method approved by the *code official*. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the building owner and the *code official*. If the tested rate exceeds that defined here by up to 0.15 cfm/ft^2, a visual inspection of the air barrier shall be conducted and any leaks noted shall be sealed to the extent practicable. An additional report identifying the corrective actions taken to seal air leaks shall be submitted to the building owner and the Code Official and any further requirement to meet the leakage air rate will be waived. If the tested rate exceeds 0.40 cfm/ft^2, corrective actions must be made and the test completed again. A test above 0.40 cfm/ft^2 will not be accepted.

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How Are We Doing?

- Lots of data from testing in WA
  - 200+ buildings tested
  - More than 15,000,000 sf of enclosure area tested
- Median result: 0.217 cfm/sf
- Tightest: 0.025 cfm/sf
- Leakiest: 0.886 cfm/sf
- Sortable by:
  - Test date
  - Occupancy type
  - Air barrier type (walls)
  - Enclosure area

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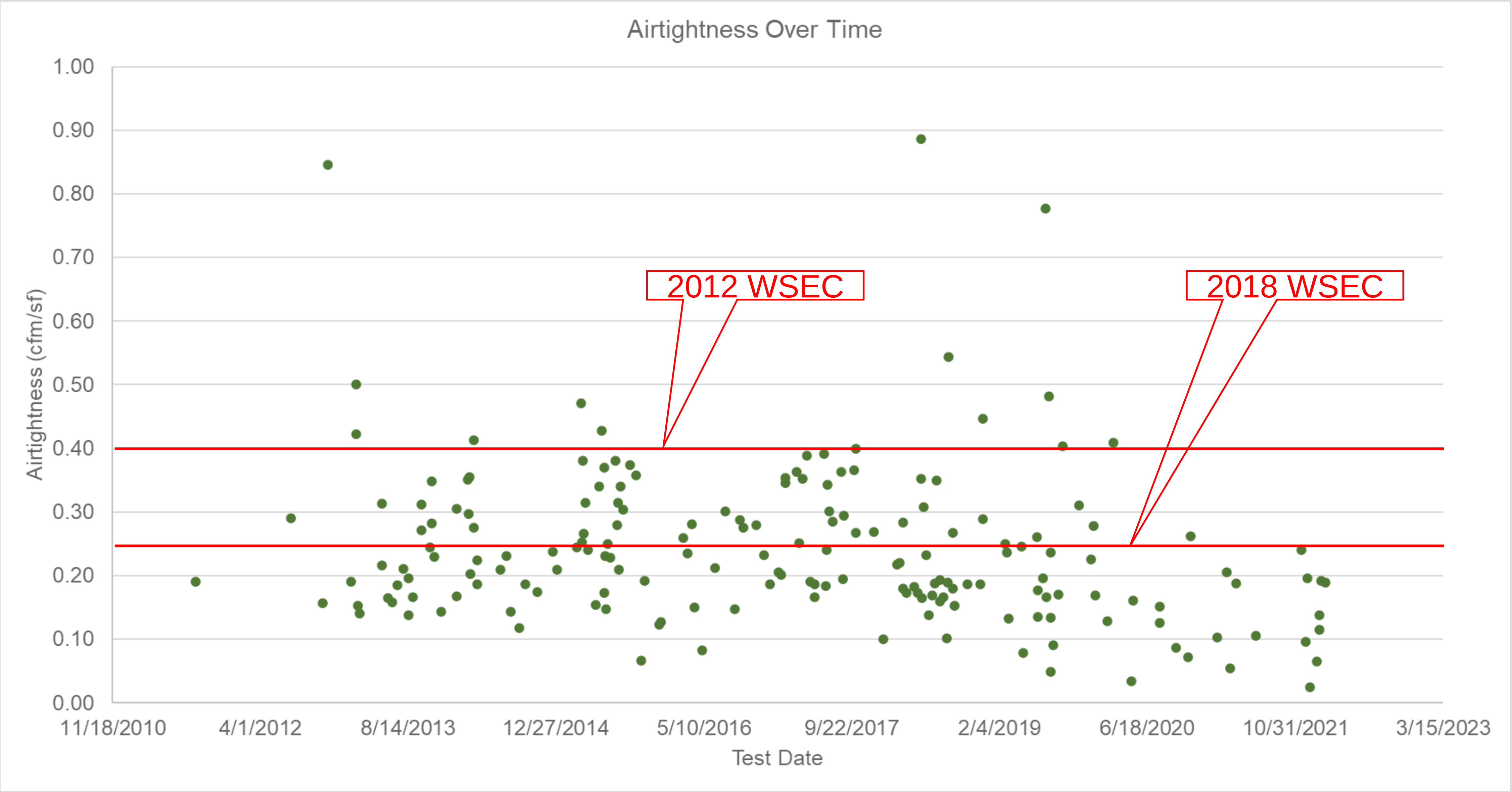

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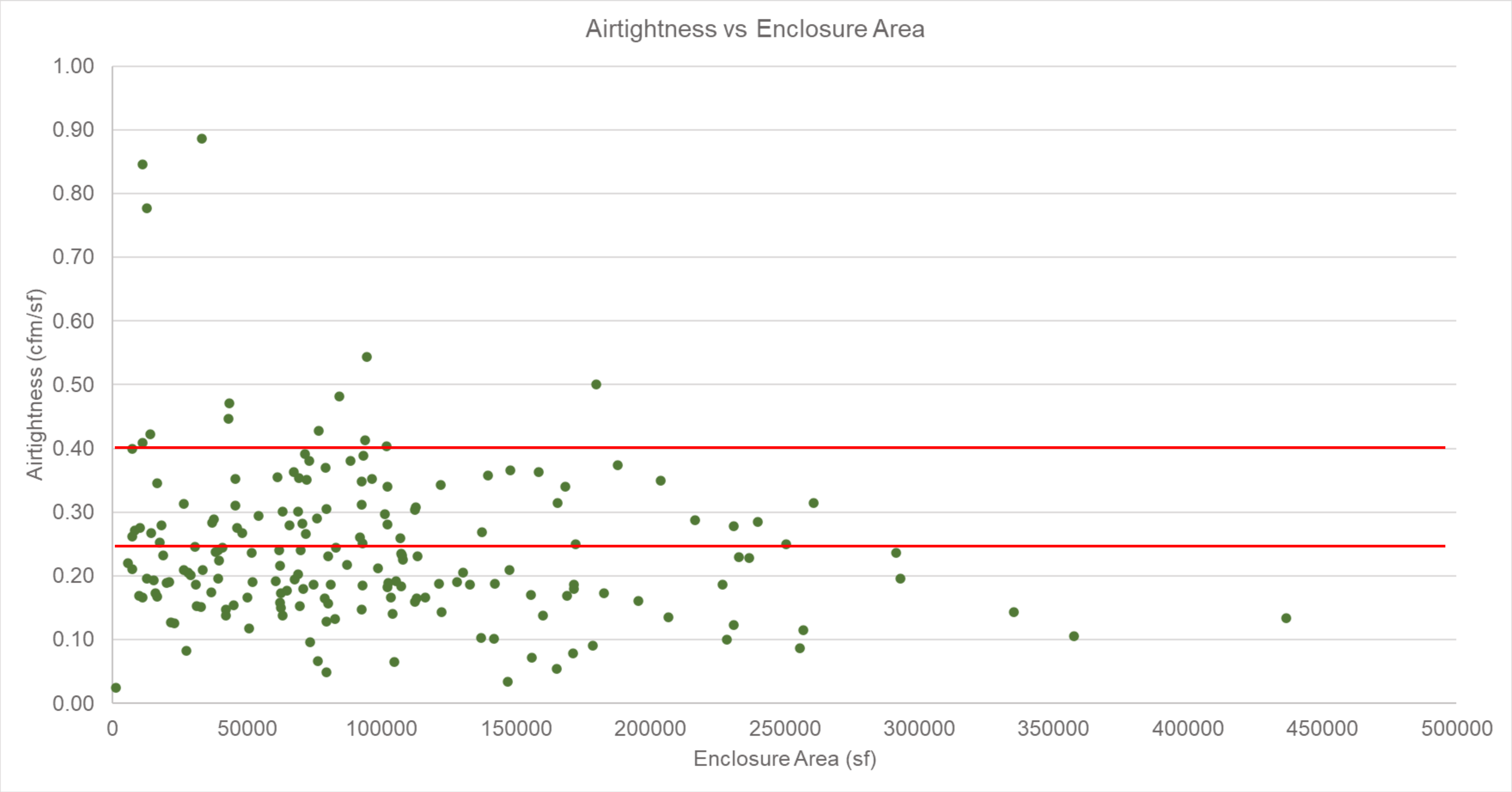

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Takeaways

- Lots of tight buildings
- Trending toward tighter results in recent years
- More variability in smaller buildings
- How did we get here?

Quality Assurance

- Design
  - Specify the right materials
  - Review all the details (look for what is missing)
- Construction
  - Use experienced (certified/accredited) contractors & installers
  - Review submittals & shop drawings (by others?)
  - Mockups
  - Regular site visits (deficiency logs)
  - Testing

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Mockups & Preliminary Testing

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Data Trends

- Occupancy type
  - Multifamily
  - Commercial
  - Institutional
- Air barrier strategy
  - Fluid applied
  - Mechanically attached sheet
  - Self-adhered
  - Sealed sheathing
  - Glazed assemblies

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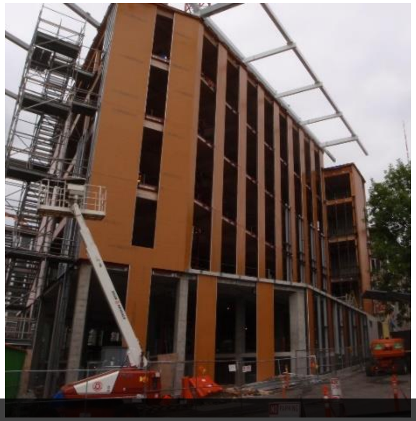
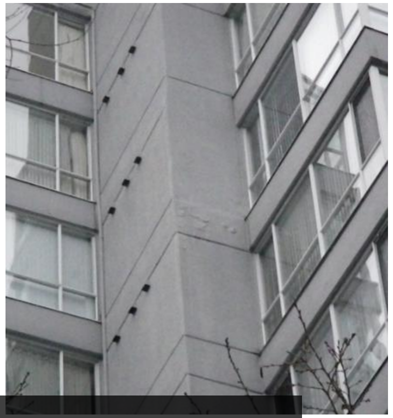
Many Air Barrier Systems Available

Loose Sheet Applied Membrane – Taped Joints & Strapping

Sealed Gypsum Sheathing – Sealant Filler at Joints

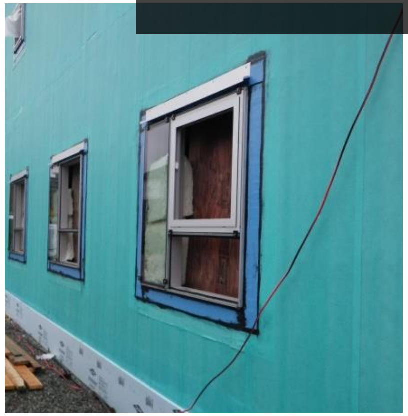


Liquid Applied Sealants/Membranes

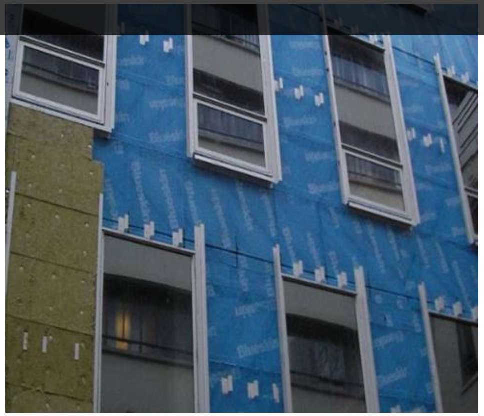


Mass Walls (concrete)

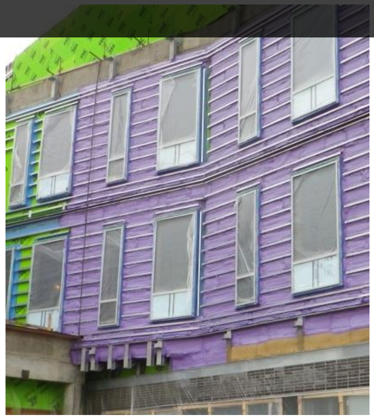
BUT, IT'S THE DETAILS THAT MATTER



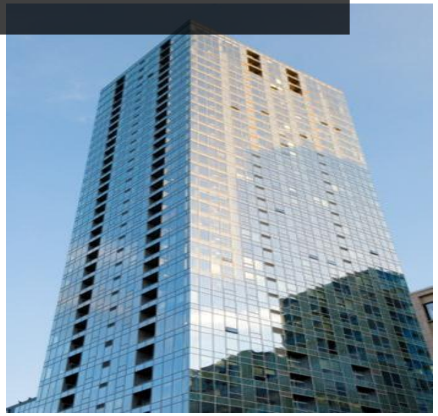
Self-Adhered vapor permeable membrane



Self-Adhered vapor impermeable membrane



Sprayfoam



Curtainwall, window-wall & glazing systems

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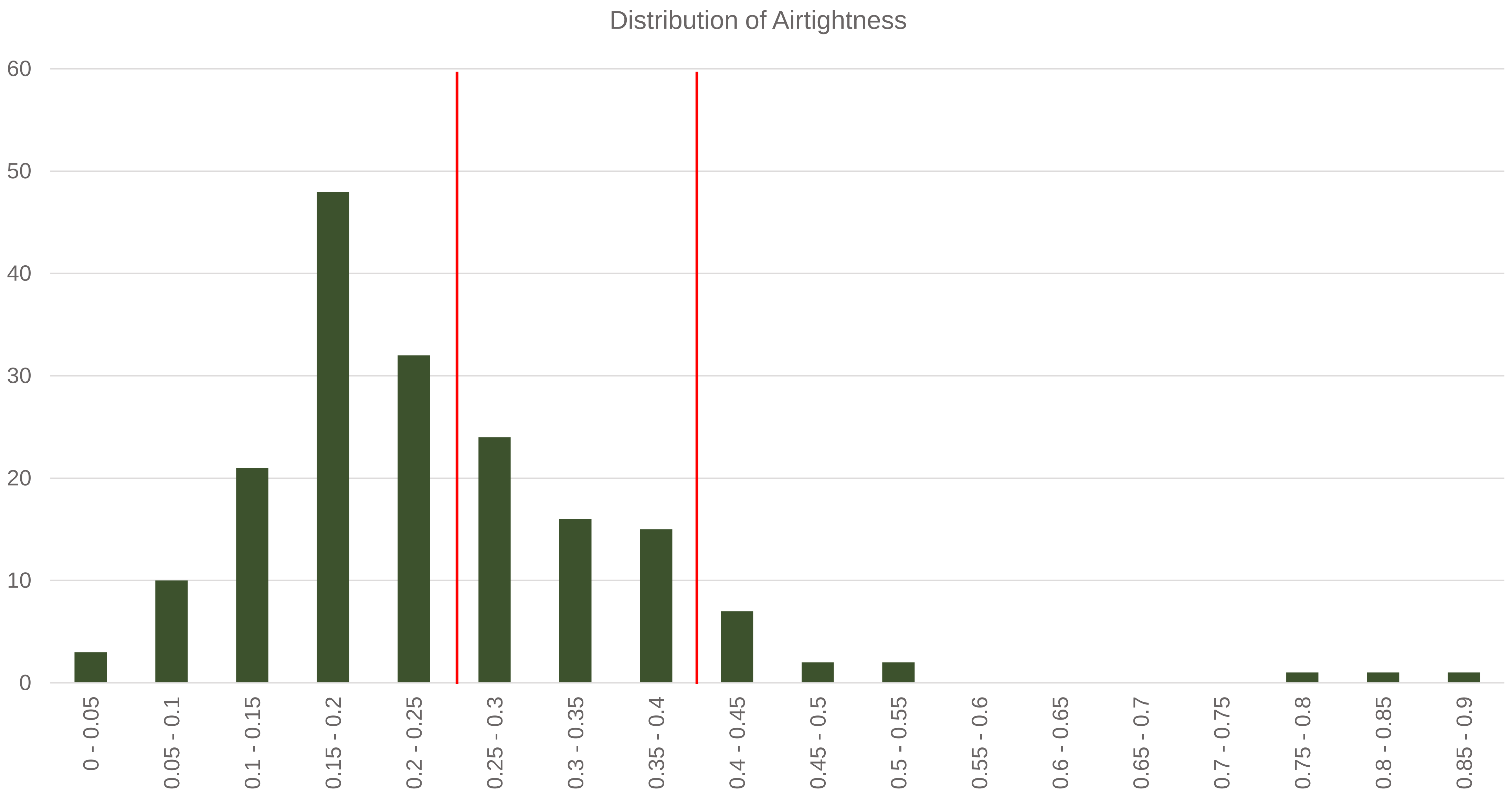

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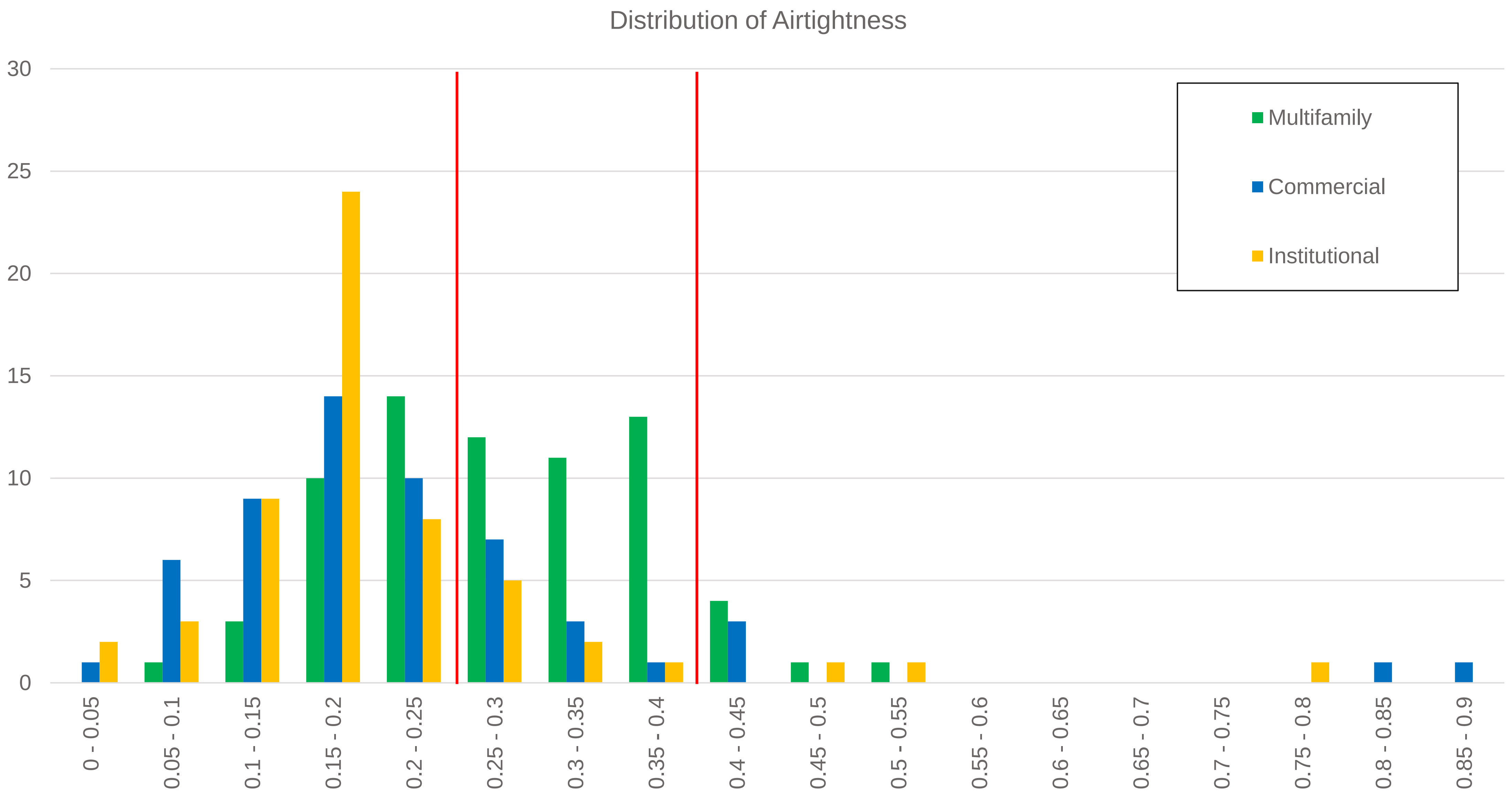
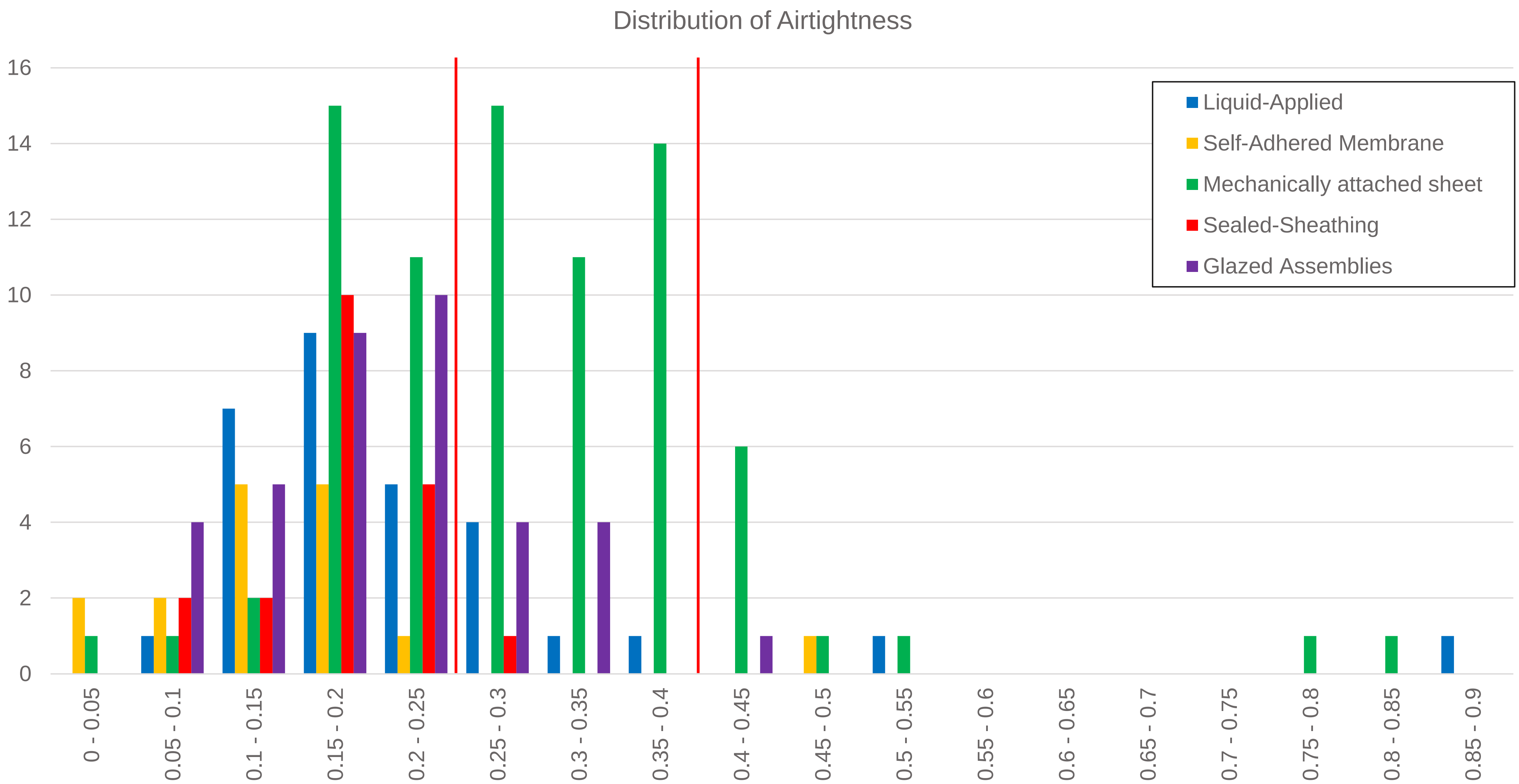

Distribution of Airtightness
30
25
20
15
10
5
0
Multifamily
Commercial
Institutional
0 - 0.05
0.05 - 0.1
0.1 - 0.15
0.15 - 0.2
0.2 - 0.25
0.25 - 0.3
0.3 - 0.35
0.35 - 0.4
0.4 - 0.45
0.45 - 0.5
0.5 - 0.55
0.55 - 0.6
0.6 - 0.65
0.65 - 0.7
0.7 - 0.75
0.75 - 0.8
0.8 - 0.85
0.85 - 0.9



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Takeaways

- Almost all buildings passing at 0.4 cfm/sf threshold
- Multifamily is generally leakier
- Mechanically attached sheet approach generally leakier

Do sheet applied systems appear leakier because they are mostly used on multifamily projects?

Or

Do multifamily projects appear leakier because most of them use sheet applied air barriers?

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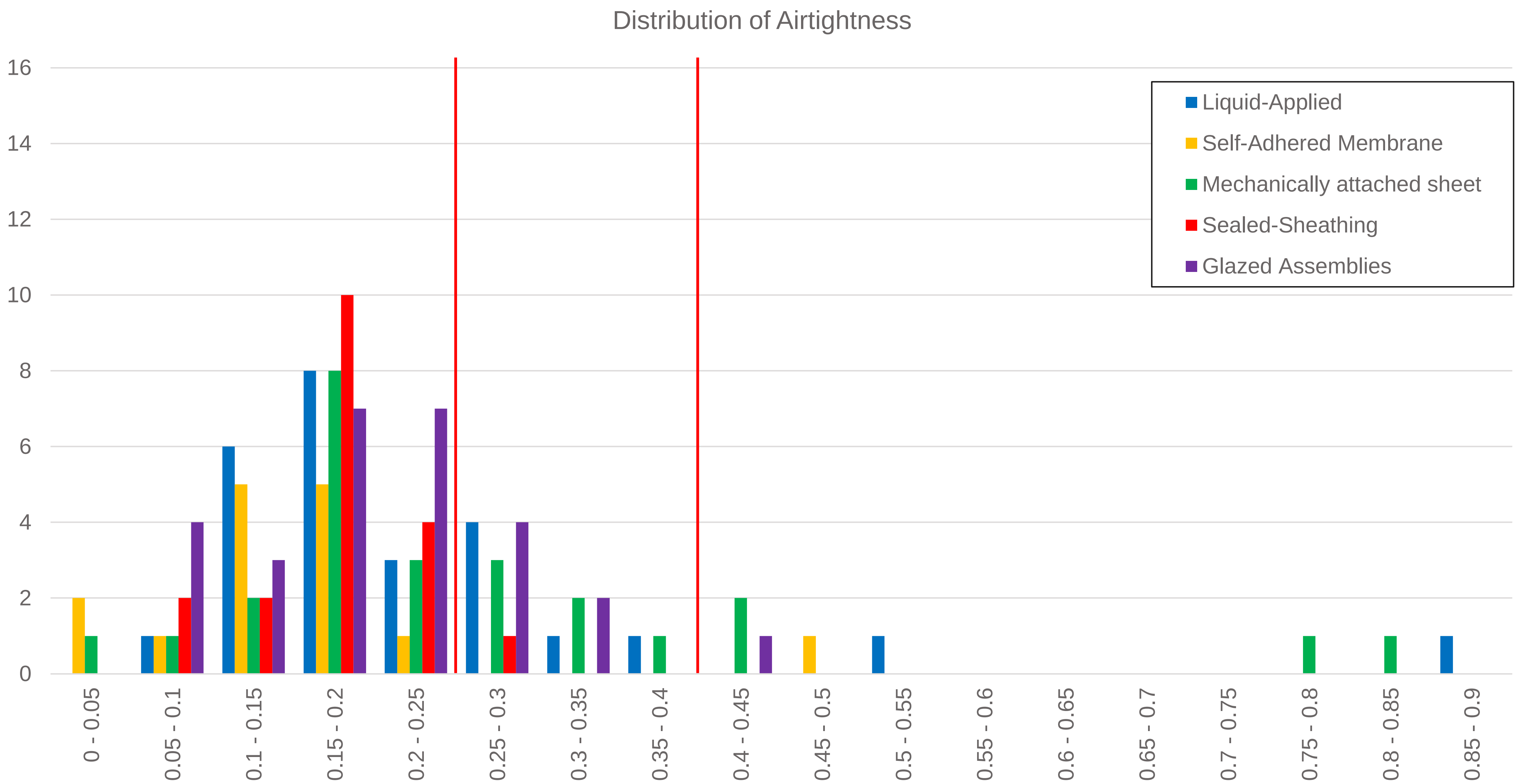

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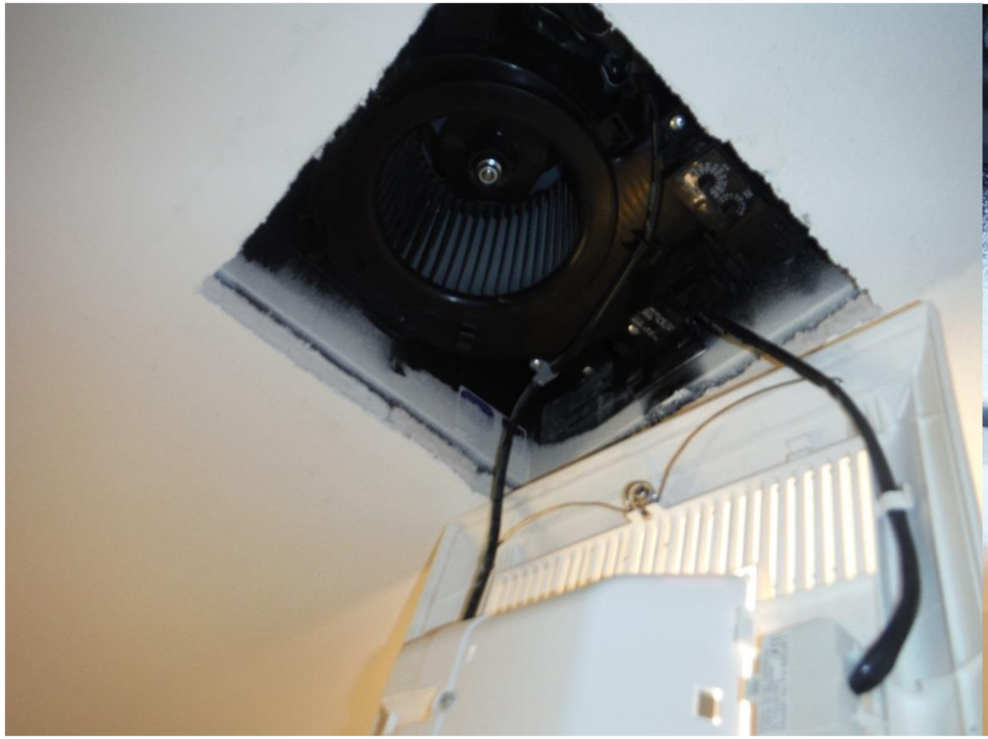
Challenges with multifamily testing

- Intent: measure unintended leakage through air barrier systems, while isolating intentional openings (HVAC) from the test
- Reality: exhaust vents are almost always the largest single source of leakage
- Can only be sealed effectively from outside
- Difficult to access

Challenges with multifamily testing



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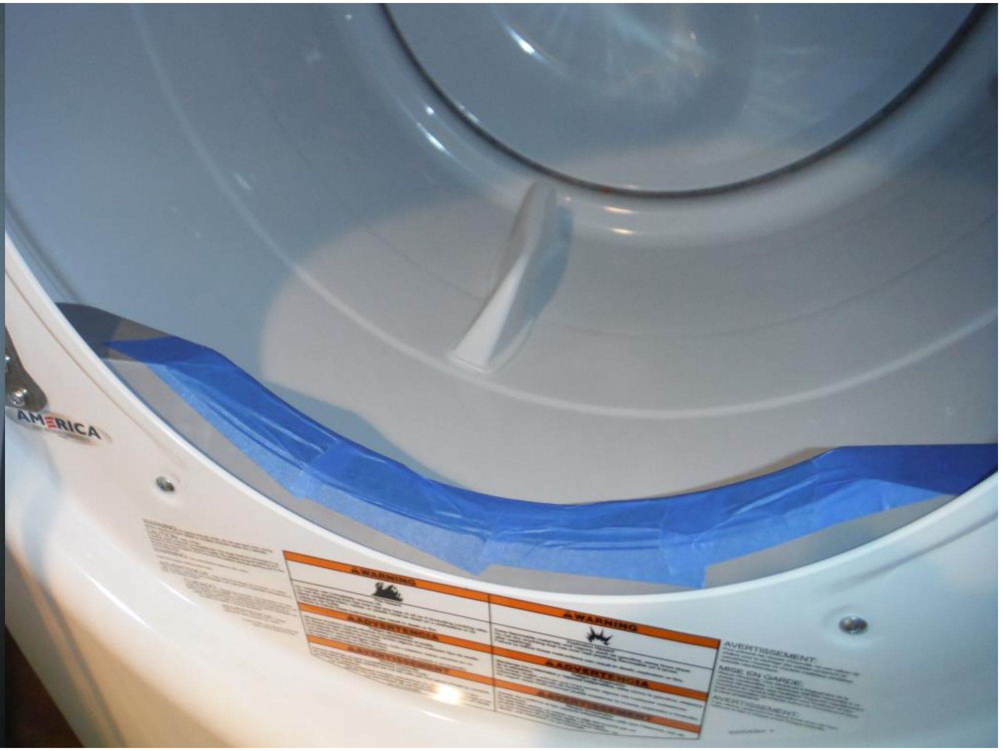
Challenges with multifamily testing



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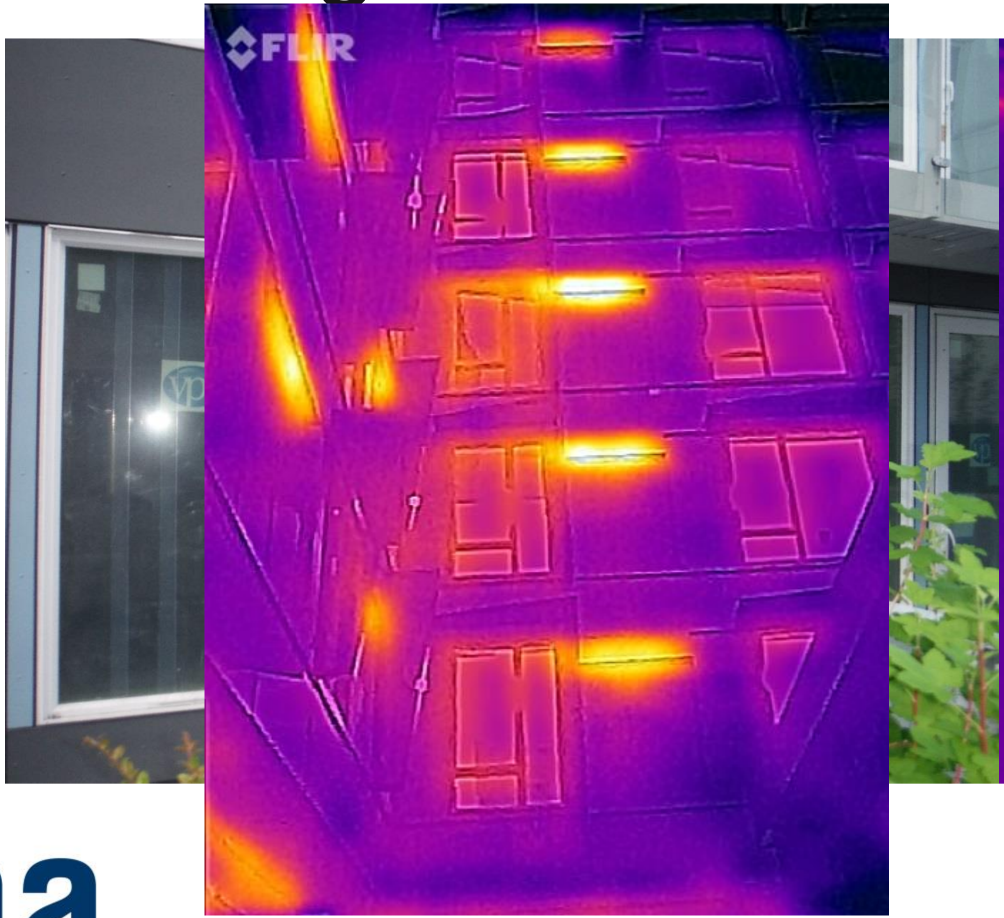
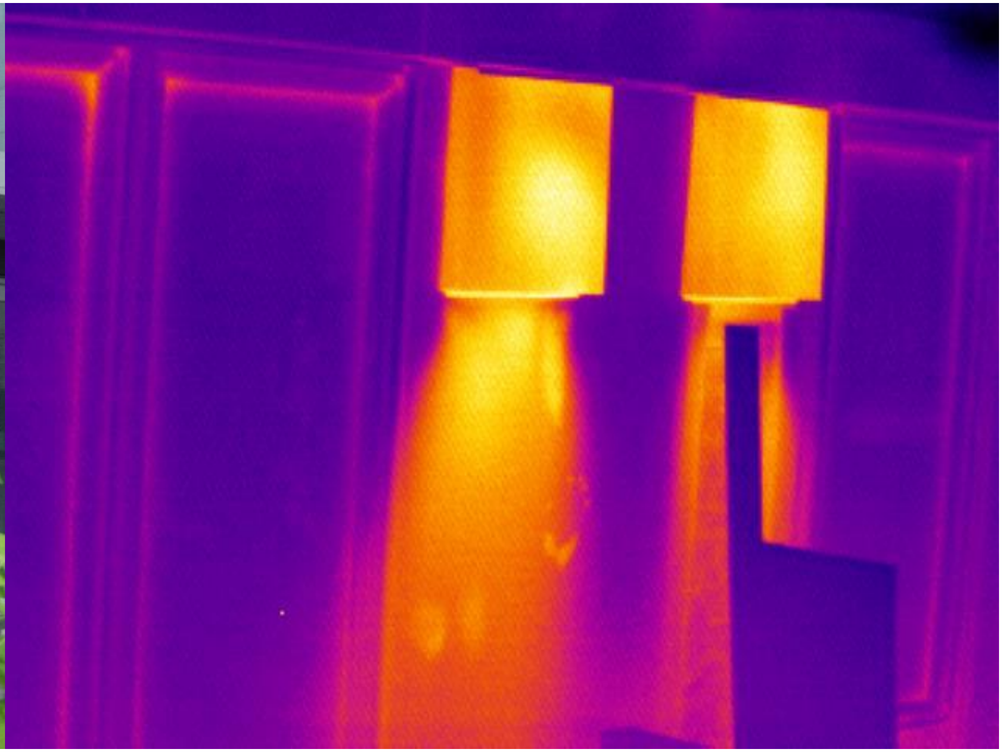
Challenges with multifamily testing





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Case Study:

- 6 over 3
- Wood Frame
- Market Rate Apartments
- Mechanically attached air barrier
- Low-slope Roof
- Individual Unit Kitchen/Bath/Dryer Venting

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RANGE HOOD VENTING

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BLOWER DOOR TEST RESULTS & DIAGNOSTICS

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Final test results for the building:

Negative pressure – 0.162 cfm/sq ft - Equiv. leakage area = 12.9 SF @75Pa
Positive pressure – 0.308 cfm/sq ft - Equiv. leakage area = 24.6 SF @75Pa
Average – 0.235 cfm/sq ft - Delta = 11.7 SF @75Pa

For the unit 222 testing:

Microwave sealed, vent shroud not sealed – 83 sq in leakage area
Microwave not sealed, vent shroud not sealed – 83 sq in leakage area
Microwave not sealed, vent shroud sealed – 76 sq in leakage area (delta of roughly 7 sq in)

7 sq in per unit extrapolated out over 171 units equals 8.3 SF Equiv. leakage area, which could potentially account for **70%** of the difference in air leakage between the negative and positive numbers.

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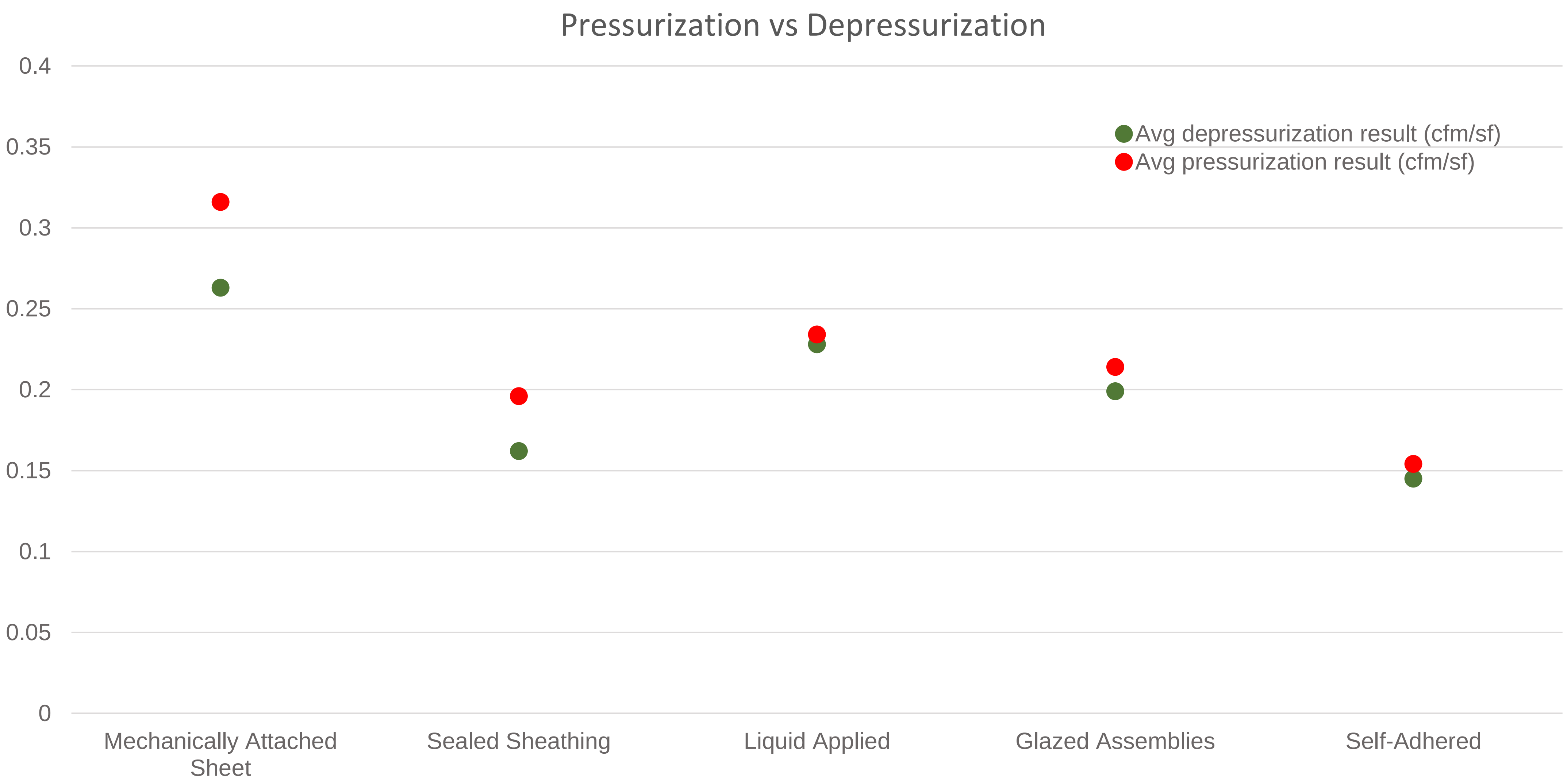

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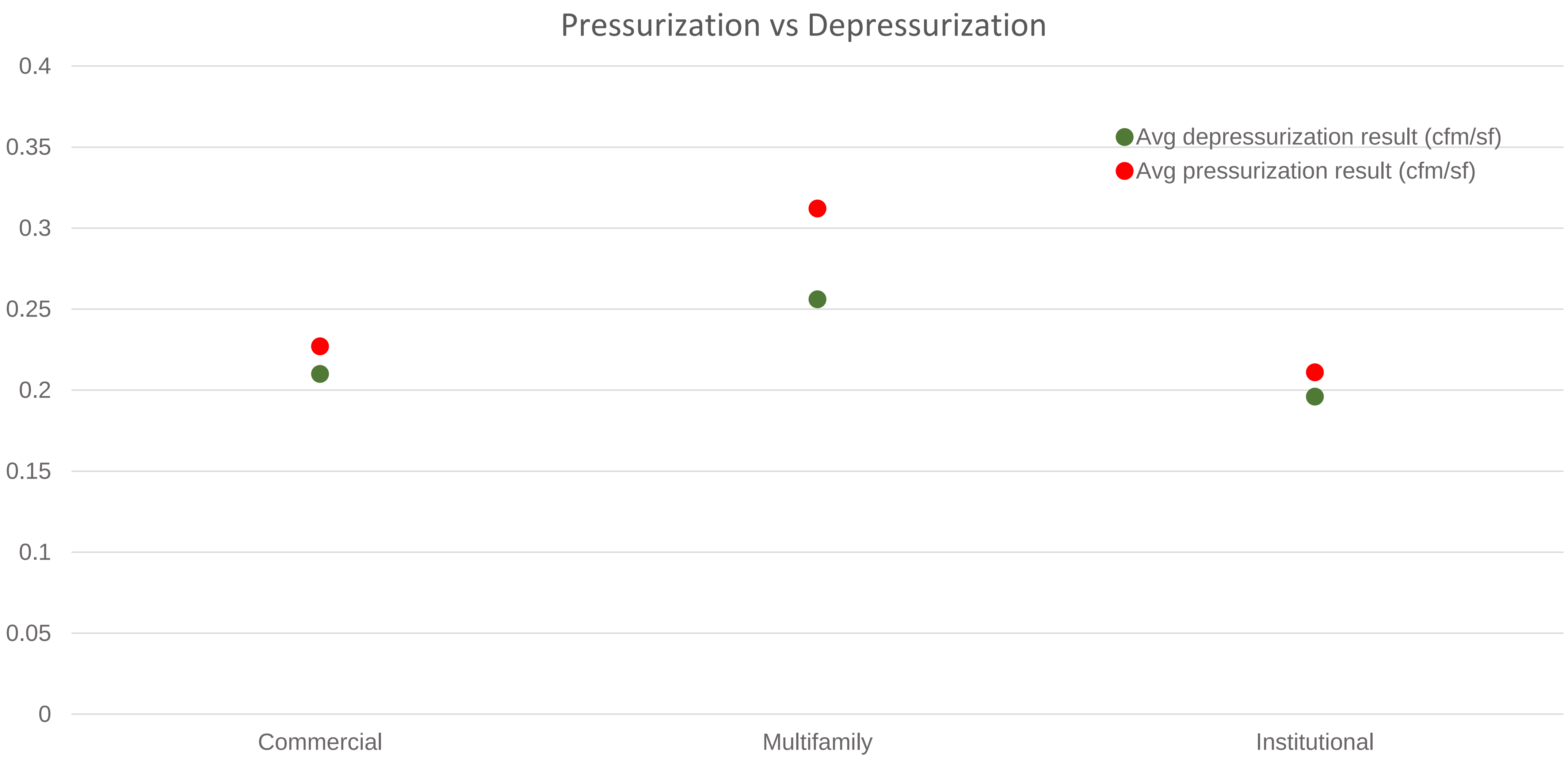

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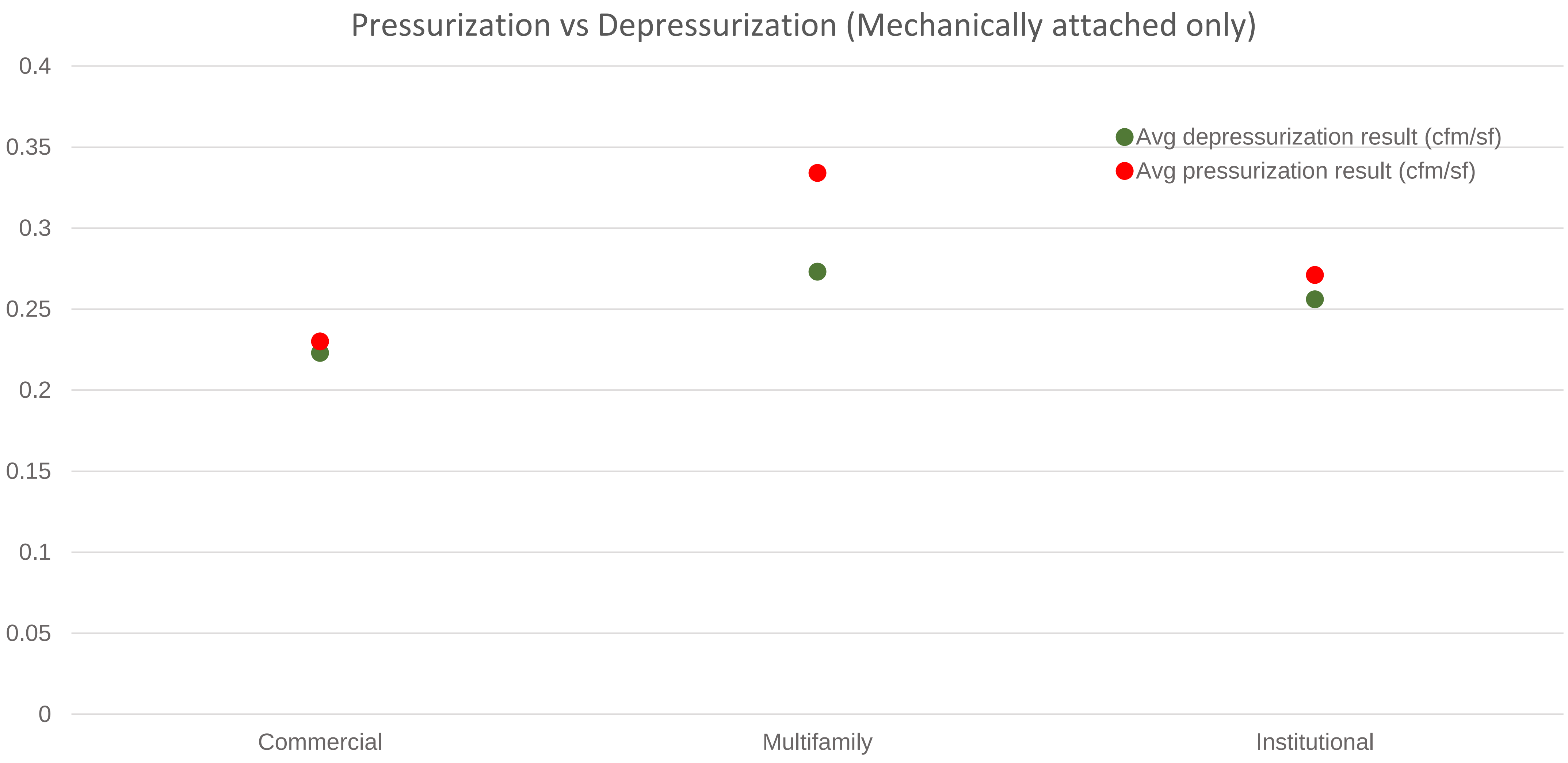
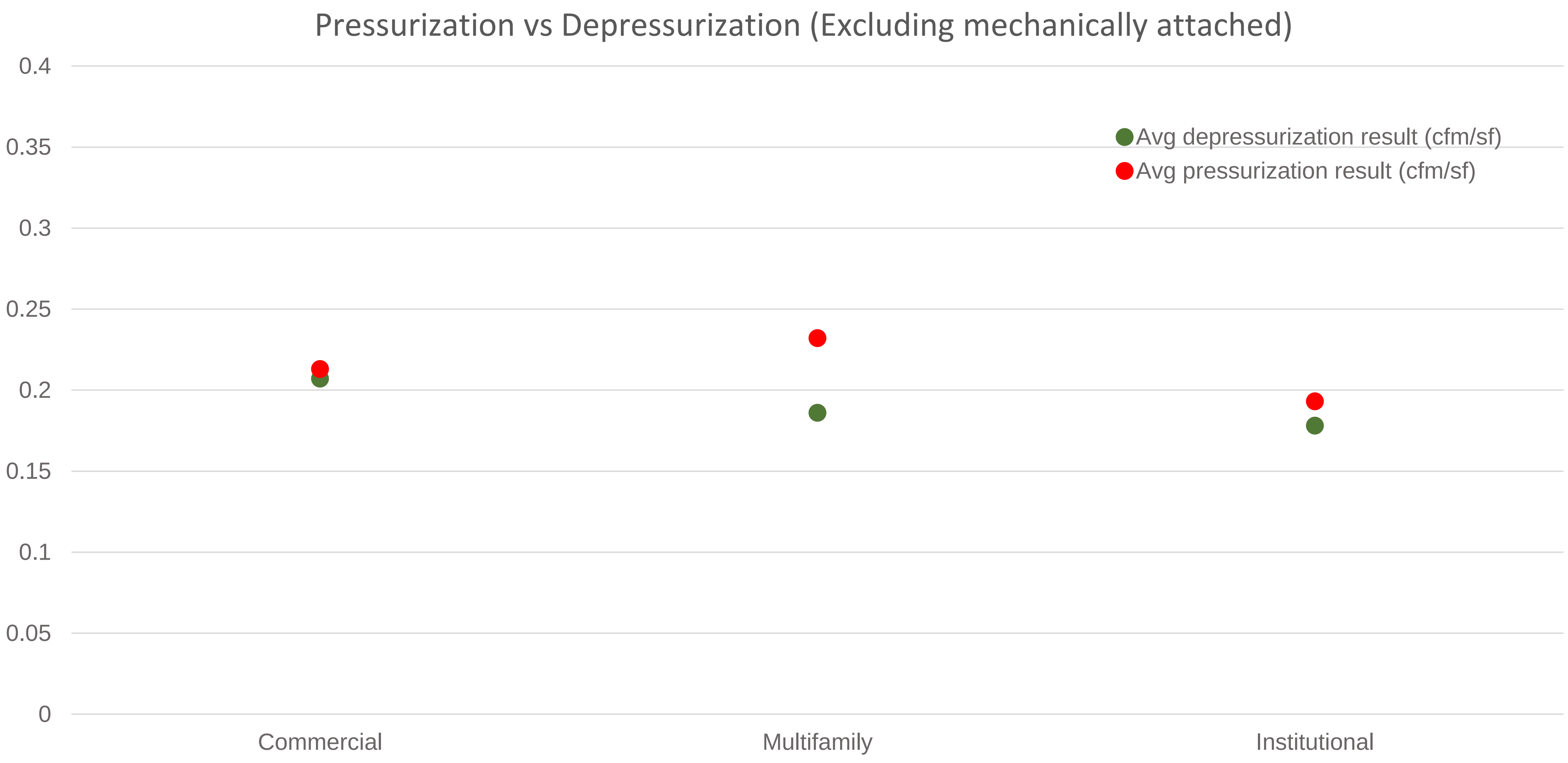


Pressurization vs Depressurization (Mechanically attached only)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Avg depressurization result (cfm/sf)
Avg pressurization result (cfm/sf)
Commercial
Multifamily
Institutional



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Takeaways

- Main cause of larger positive leakage than negative is exhaust strategy (multifamily)
- Mechanically attached sheet approach is not inherently leakier under positive pressure
- Best approach for multifamily testing – seal everything from the exterior
- Other factors with multifamily
  - Often lower budget
  - Often lower oversight
  - More variability in quality of trades & GCs

Case Study

Catalyst, Spokane WA by Katerra, Designed by MGA

Net Zero Energy Performance Goal, Passive House Building Enclosure & Airtightness Goal (PHIUS 0.08 cfm/ft^2@75 Pa)

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Mass Timber (CLT) Structure

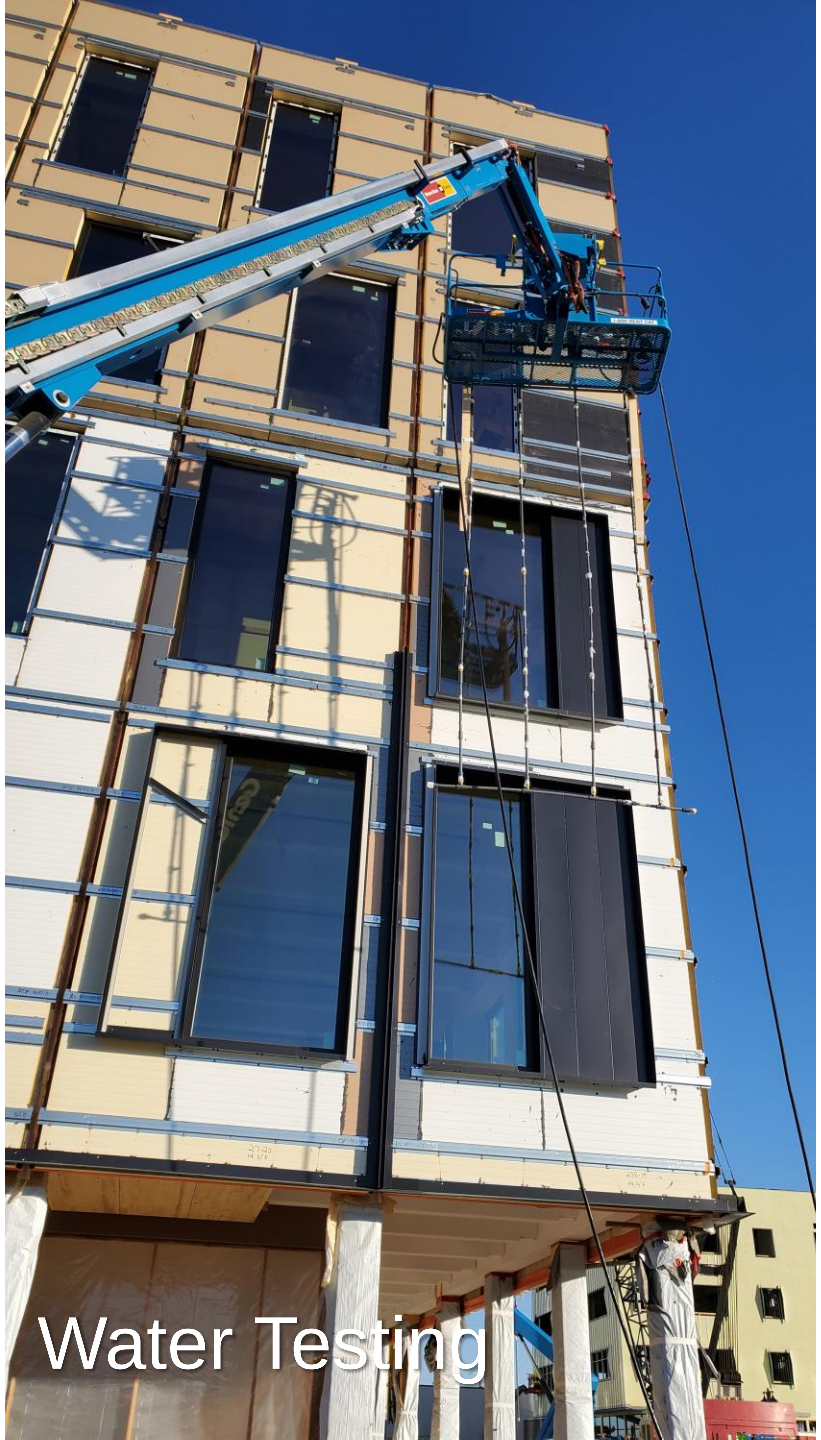
Prefabricated Façade Panels –
Self-Adhered Vapor Permeable AB System

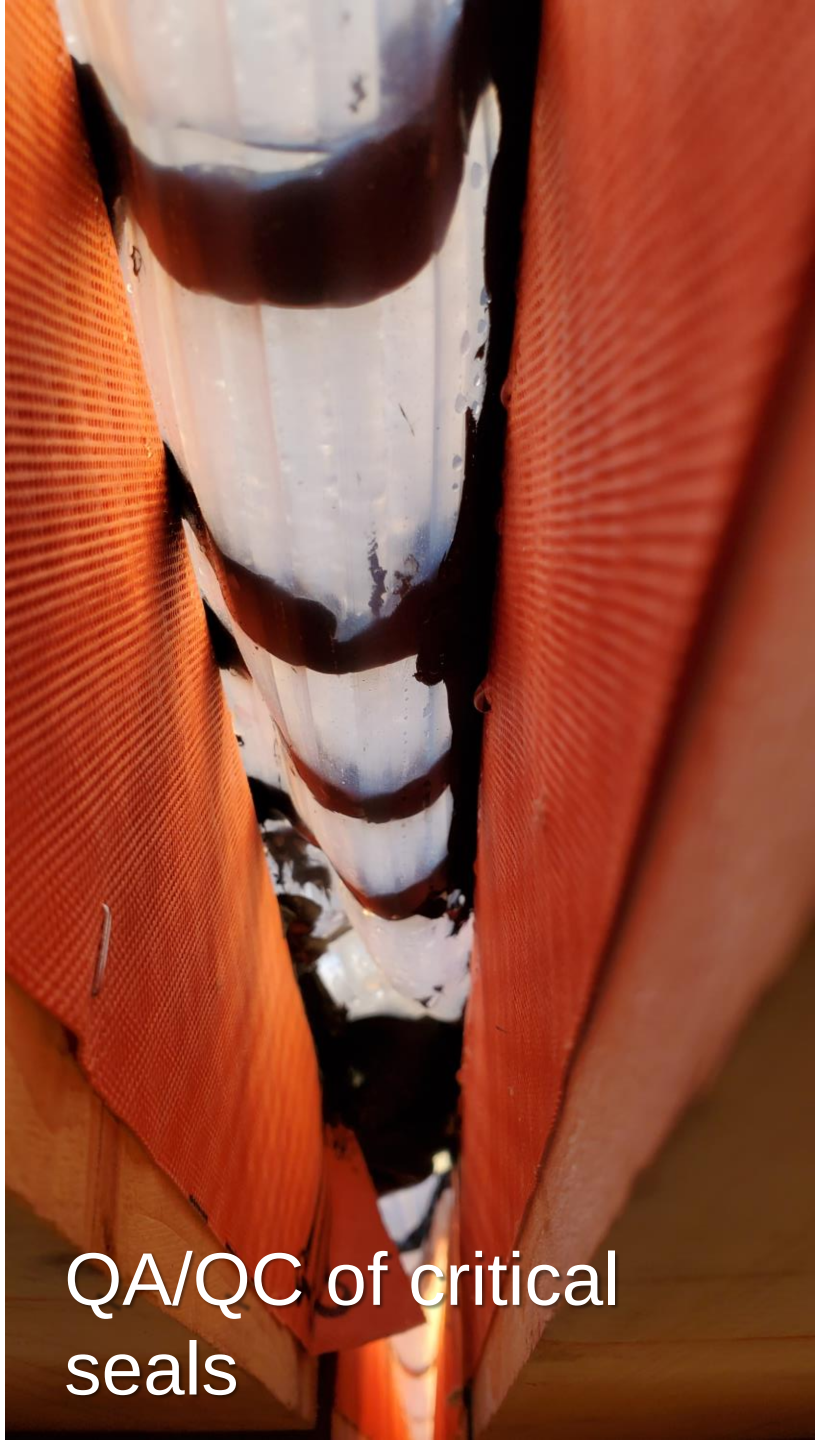
Site Installation


Flexible AB Joint Sealing

Field Testing & Commissioning


Air Testing


Water Testing


QA/QC of critical seals


More Field Testing & Commissioning

Final Result: 0.034 cfm/sf

Looking ahead

- Whole-building test requirements are resulting in tighter buildings in WA
- QA plan is essential for any project aiming for high performance – must include mockups and site visits
- 0.4 cfm is not difficult for any building type or air barrier approach – we can and should do better with even a basic quality assurance plan
- Training & certification of testing technicians eliminates roadblocks to widespread testing requirements
- Multifamily remains the most difficult to get very tight due to common exhaust only ventilation approach – moving toward a Passive House approach will be the next big leap

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