Center for Energy and Environment

Using AeroBarrier in Existing Multifamily and Existing Homes

Mike Lubliner, CARES
Dave Bohac, CEE

Twenty-Seventh Westford Symposium on Building Science

AeroBarrier Case Studies Weatherization & "Gut Rehabs" Low-Rise Multifamily Dwellings Opportunities In Existing Public Housing

Mike Lubliner
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King County Housing Authority

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Exterior AeroBarrier: Air Sealing Attics and Crawlspaces of Occupied Residences

Dave Bohac
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Acknowledgements

- Mike Lyons & Mark Modera - Aeroseal™
- Dave Bohac - Center for Energy and Environment
- Collin Olson - The Energy Conservatory
- Chase Davis - Obrien 360
- Chase Counts - Arrow Insulation
- Andre Dejarlais -Oak Ridge National Laboratory
- Joe & Betsy – Building Science Corporation

Weatherization & "Gut Rehabs" Low-Rise Multifamily Dwellings

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KCHA is a key leader in affordable public/private housing partnerships with; Puget Sound Energy, Washington State Department of Commerce, Bonneville Power Administration, Northwest Energy Efficiency Alliance, with state & national support!

- Washington's largest landlord - https://www.kcha.org/
- Affordable rental housing & assistance to more than 50,000 people
- Low-rise multi-family are "woody walkups/corridor 50%/50%"
- Typical individual mechanical & utility metering
- Deep energy retrofits in LRMF, SF & buys/operates MH "parks"

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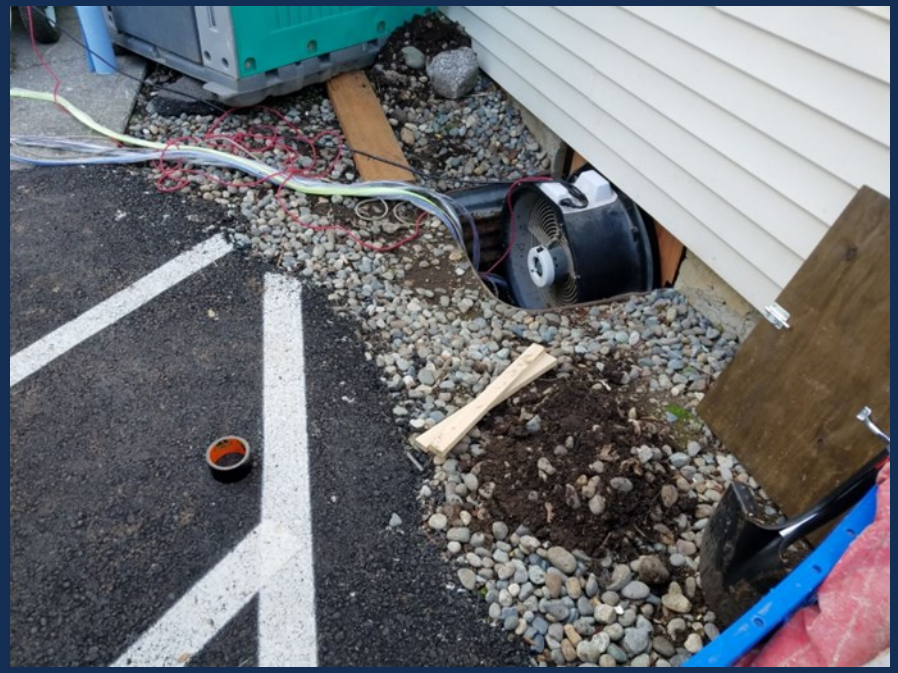
Windsor Heights Seattle

Gut Rehab “car decking” over vented crawlspace



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Windsor Hts: Gut Rehab "car decking" over vented crawlspace

Results With & Without AeroBarrier

- Old "rat-piss and falling down" R-19 batt insulation removed (W&V)
- All crawlspace vents were sealed & BD used to pressurize crawl (V)
- AeroBarrier was injected Building V crawlspace
- All crawlspace vents were then unsealed (V)
- New R-30 floor batts installed (V)
- No AeroBarrier for Building W

Building	# Units	Test In Date	Test In	Test Out Date	Test Out	Reduction
V	10	9/19/2016	5774	11/20/2019	3203	44.53%
W	10	9/19/2016	5123	11/20/2019	3899	23.89%

Windsor Hts: Whole building exterior envelope leakage test results (TECLOG 4)

Building W: Without AeroBarrier

Windsor Hts: Whole building exterior envelope leakage test results (TECLOG 4)

Building V: With AeroBarrier

Evergreen Terrace Renton WA

Gut Rehab “car decking” over vented attic

Total Leakage Reduction

20 ACH50 to under 2 ACH50

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Renton: Gut Rehab “car decking” over vented attic

Results

- 14 buildings, 50 units, 1963’s w/upgrades
- AeroBarrier - pressurized injection “unit by unit” each unit to seal; attic and walls
- Un-insulated slab on grade
- Attic loose fill R19 - R49
- Build tight ventilate RIGHT – Ducted HRV
- Ductless Heat Pumps – Got AC!

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Renton: Gut Rehab "car decking" over vented attic

AeroBarrier Reports

AEROBARRIER
Air Sealing Technology from Aeroseal

ENVELOPE SEALING REPORT

Envelope Sealing Performed For:

King County, Housing Authority
3030 B
NE 15th St, WA 98056

AEROBARRIER CASE ID: 8013

HARDWARE: AeroBarrier

DATE: 6/5/2020

BUILDING TYPE: Apartment

Envelope Sealing Results:

BEFORE SERVICE

1435.3 CFM of Leakage, equivalent to a
172.8 Square Inch Hole or
20.40 Air Changes per Hour

(for your 508 square-foot structure enclosing a volume of 4221 cubic feet)

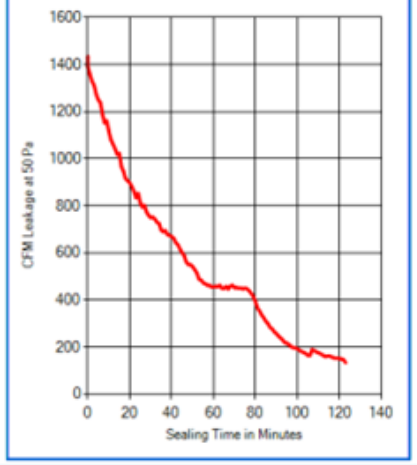
AFTER SERVICE

133.3 CFM of Leakage, equivalent to a
16.0 Square Inch Hole or
1.89 Air Changes per Hour

This corresponds to a
90.7% Reduction in Envelope Leakage

NOTE: Envelope leakage and air-change results are calculated at a standard pressure of 50 Pa.

Envelope Sealing Progress:



Envelope Sealing Performed By:

EKOVATE AIR

Ekovate Air, LLC
502 Rainier Ave S
Suite 206
Seattle, WA 98144
Phone: (206) 491-7111

DATE: 6/4/2020

BUILDING TYPE: Apartment

Envelope Sealing Results:

BEFORE SERVICE

686.2 CFM of Leakage, equivalent to a
82.6 Square Inch Hole or
11.93 Air Changes per Hour

(for your 370 square-foot structure enclosing a volume of 3452 cubic feet)

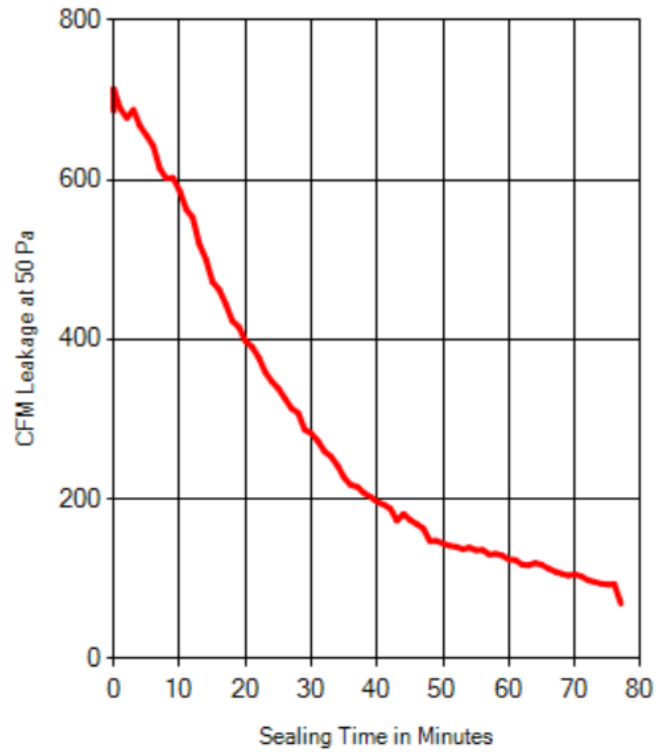
AFTER SERVICE

68.8 CFM of Leakage, equivalent to a
8.3 Square Inch Hole or
1.20 Air Changes per Hour

This corresponds to a
90.0% Reduction in Envelope Leakage

NOTE: Envelope leakage and air-change results are calculated at a standard pressure of 50 Pa.

Envelope Sealing Progress:



Kirkland Heights Kirkland

New Construction w/100% AeroBarrier (woody walkup)

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Kirkland Heights: New Construction w/100% AeroBarrier (woody walkup)

Results

- 27 buildings, 325 units, 80% completed
- Slab on grade, three-stories
- Non guarded test (total leakage) w/windows open in adjacent units
- Built to WA - WSEC “tighter with HRV - energy credits” for compliance w/ER heat
- CO2 central HPWH – New emerging technology (Ecotope – Mechanical-DHW)
- HRV in each unit to each room, ER heat, No Cooling
- PV - on site

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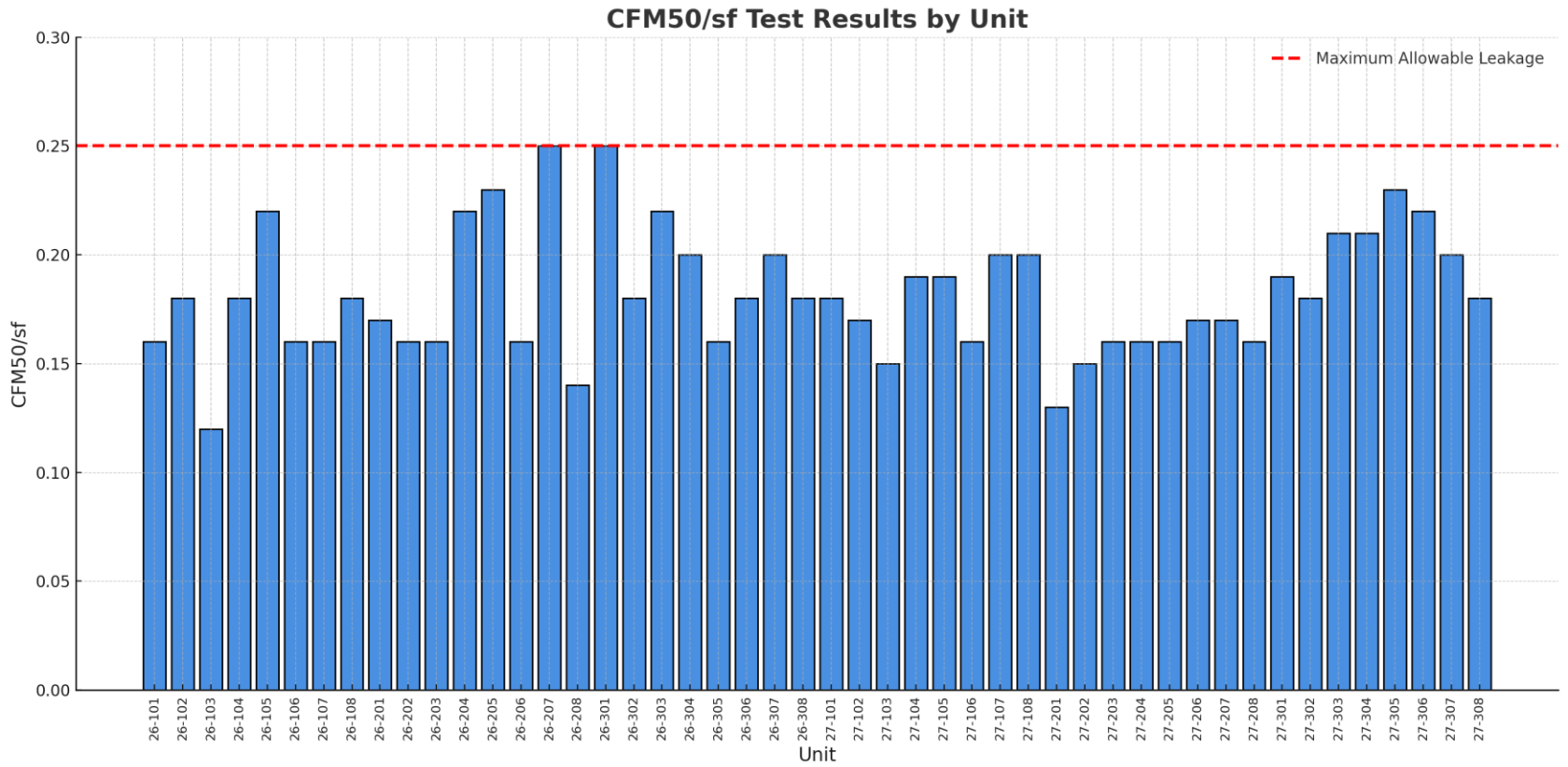
Kirkland Heights: New Construction w/100% AeroBarrier (woody walkup)

Results



The units in the newly constructed buildings averaged 27% below the 0.25 CFM50/sf target

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Kirkland Heights: New Construction w/100% AeroBarrier (woody walkup)

Results

Building 10 example

June 12-14, 2024

All units passed WSEC Option 2.2

Target: 0.25 CMF50/sf (unit SA)

521 cfm50 vs. 698 cfm50

Average 25% below code

Unit	Test Results (CFM_{50}) Depressurization	Single-Point Test Results (110% Result)	R406.3, Option 2.2 Target (0.25 CFM_{50}/sqft)	Unit Enclosure Area (sqft)	Unit Conditioned Floor Area (sqft)
10 A	336	370	648	2,590	785
10 B	431	474	748	2,990	926
10 C	546	601	748	2,990	926
10 D	355	391	648	2,590	785
10 E	339	373	648	2,590	785
10 F	460	506	748	2,990	926
10 G	508	559	748	2,990	926
10 H	374	411	648	2,590	785
10 I	555	611	648	2,590	785
10 J	602	662	748	2,990	926
10 K	642	706	748	2,990	926
10 L	530	583	648	2,590	785

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Kirkland Heights: New Construction w/100% AeroBarrier (woody walkup)

Results

- Arrow bid $1.85/sq ft to remove batt insulation in an attic.
- Arrow bid $1.60/sq ft to remove loose fill insulation in an attic.

- Air seal specifications requires air sealing all joints in the attic floor:

- Air seal attic w/existing insulation = $0.60 - $0.65/sq ft
- Air seal attic w/o insulation = $0.55 - $0.60/sq ft

$2.15 - $2.50/sq ft – Remove old and air seal w/o AB

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Future Research?

Deep energy retrofits case studies at gut-rehab:

- Conduct Survey to Identify Stakeholder Value Proposition(s)
- Conduct (SIR) Cost/Benefits Parametric Analysis

Research to Assess:

Tenant, building owners, contractors, utilities & WX crews, KCHA contactors feedback:

- Odor Control
- Sound Control
- Thermal Comfort
- Indoor Air Quality
- Utility Bills impacts (energy and demand)
- Savings to Investment Ratio
- Other Non-energy Benefits

Your thoughts are appreciated!

Dwellings Resilience Improvements

- Air sealing “big-leaks”, Blower door guided pre/post whole building and each unit tests
- Dense-pack 2x4 walls, added to existing R2- R11 to R15 (insulates & air seals)
- Continuous wall insulation often added when re-siding
- Energy Star or better; window, door, appliances, lighting replacements
- Vented attic old insulation removed or moved & air seal big holes, insulate to R38-49
- Vented crawl floor insulation moved & air seal, & replaced, insulate to R30-38
- Insulating uninsulated slab at grade at perimeter
- Replace HVAC electric/gas heaters with DHP’s & EPCHOA “DDPTAC”
- Upgraded ventilation system to 62.2 and install H/ERV’s, if & when appropriate
- Upgraded electric/gas DHW to Heat Pump Water Heaters when appropriate
- PV on roof when reroofing and appropriate

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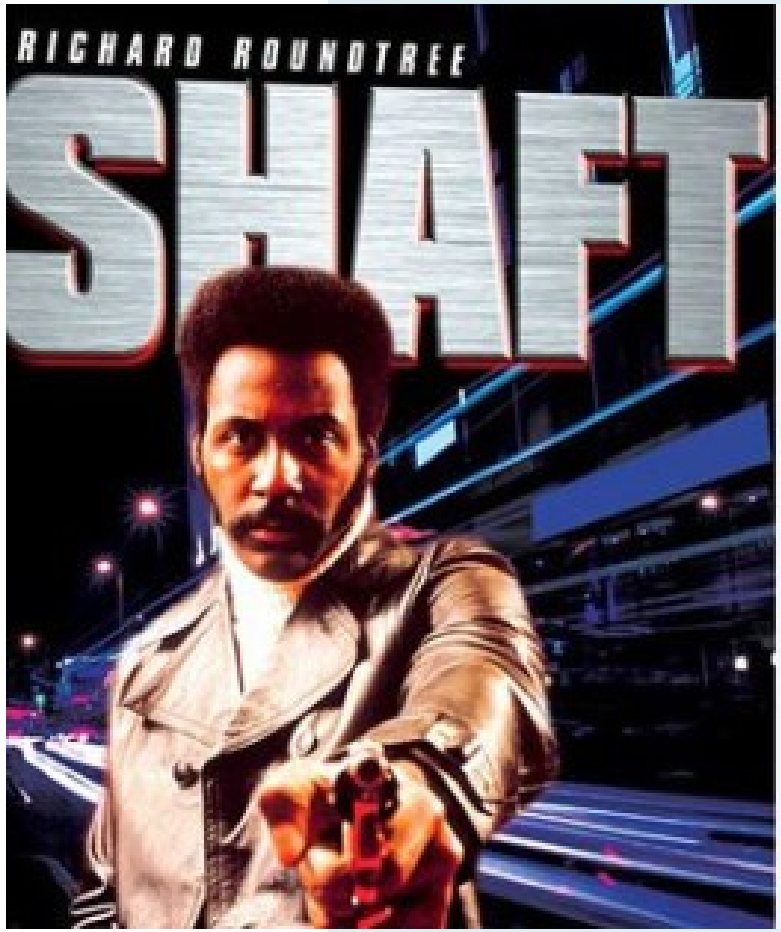
Where are the leaks that are bigger than the other leaks? Right-On!

Deep energy retrofits case studies at gut-rehab:

- Chat with Dan & Jesse
- Chat with Dave & Luby
- Chat with Dr. Mark Modera & Emily

- Build tight & ventilate right!



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Acknowledgements

Mike Lyon

Lead Application Engineer

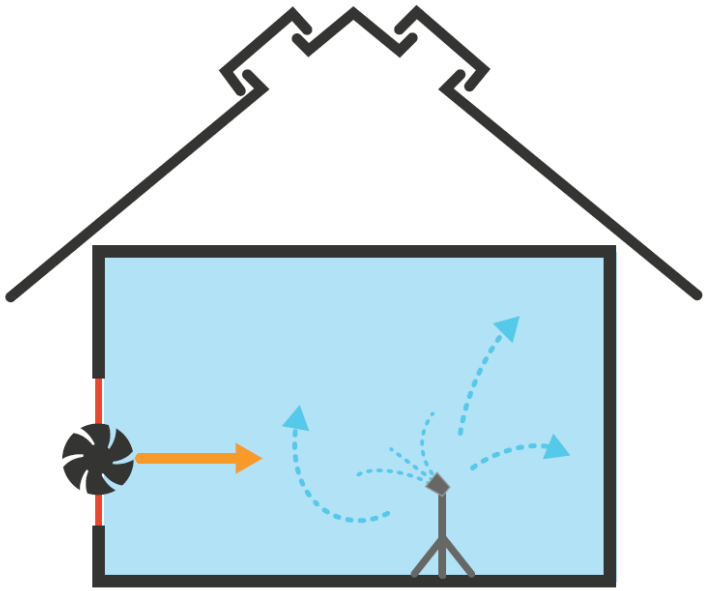
Aeroseal

Curtis Harrington

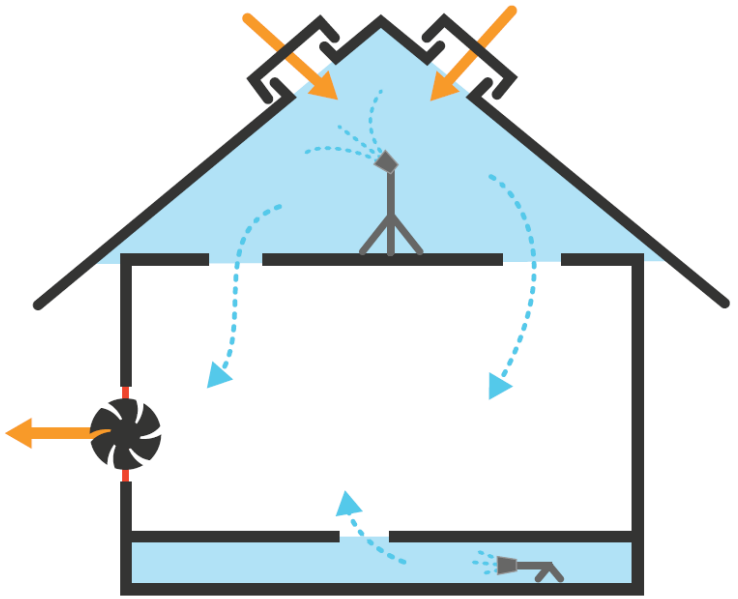
Co-Director of Engineering

UC Davis, WCEC

Traditional Inside – Out Method



New Exterior Outside – In Method



Equipment Development - ongoing

AeroBarrier Select

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Attic Sealing Process

- Less invasive
- No surface preparation required
- Requires removal of attic insulation
- Depressurize living space while injecting in attic
- Occupants leave for ~1-2 hours

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DOE BENEFIT Project

Test process in a realistic product delivery environment in SF & MF homes and evaluate; field performance, experience needed to refine the process and validate the value proposition to stakeholders. Research tasks include:

- Stakeholder outreach (HPC, SME meeting etc.)
- Market structure scenario(s) research
- Identify barriers/opportunities in (WAP) & (HPC) for low-income clients
- Energy/economics - Savings to Investment Ratio (SIR) analysis
- Inform moisture durability, and (IAQ) non energy benefits.

On Hold

Exterior AeroBarrier

CalNEXT Demonstration Project

Goal – Develop and demonstrate less invasive approach for aerosol sealing of existing homes

- Adapt existing aerosol sealing methods to address occupied homes
- Measure performance of sealing approach in different building types
- Develop and document installation protocols
- Provide recommendations for sealing equipment

Curtis Harrington

Co-Director of Engineering

UC Davis, WCEC

WCEC Western Cooling Efficiency Center

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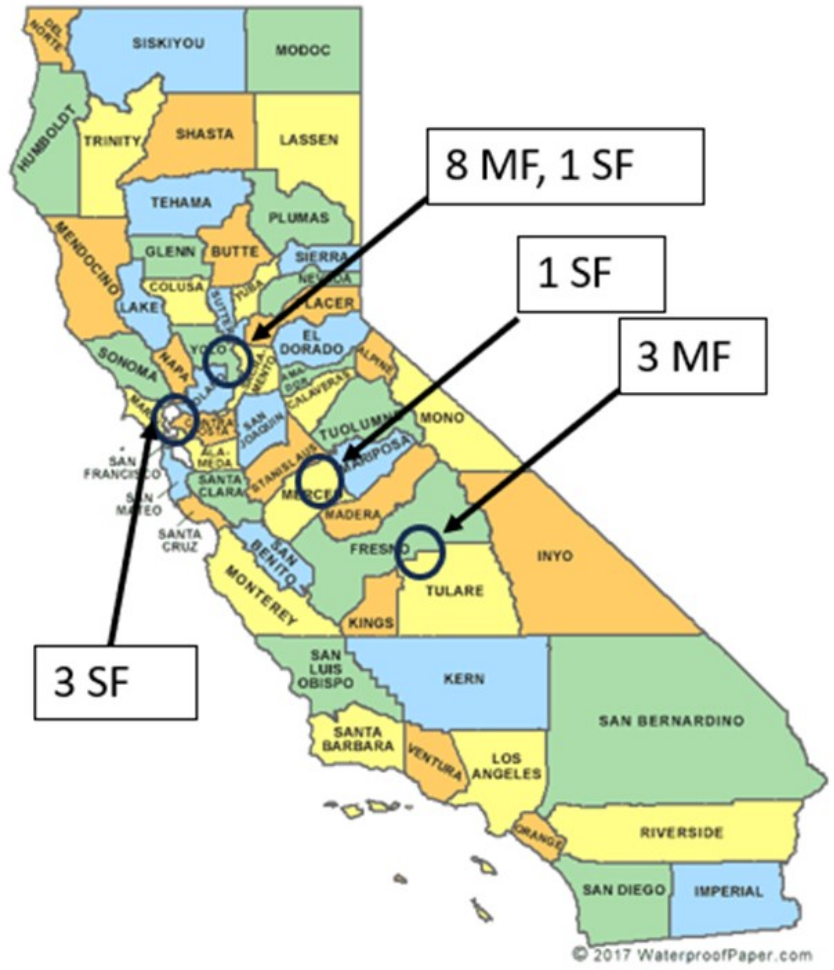
CalNEXT Demonstration Project

5 single-family
- 1 attic only
- 2 crawlspace only
- 2 attic and crawlspace

11 multifamily
- all 11 attic only



Compare to other sealing methods
- Manual applied canned foam
- Spray-on elastomeric

WCEC Western Cooling Efficiency Center

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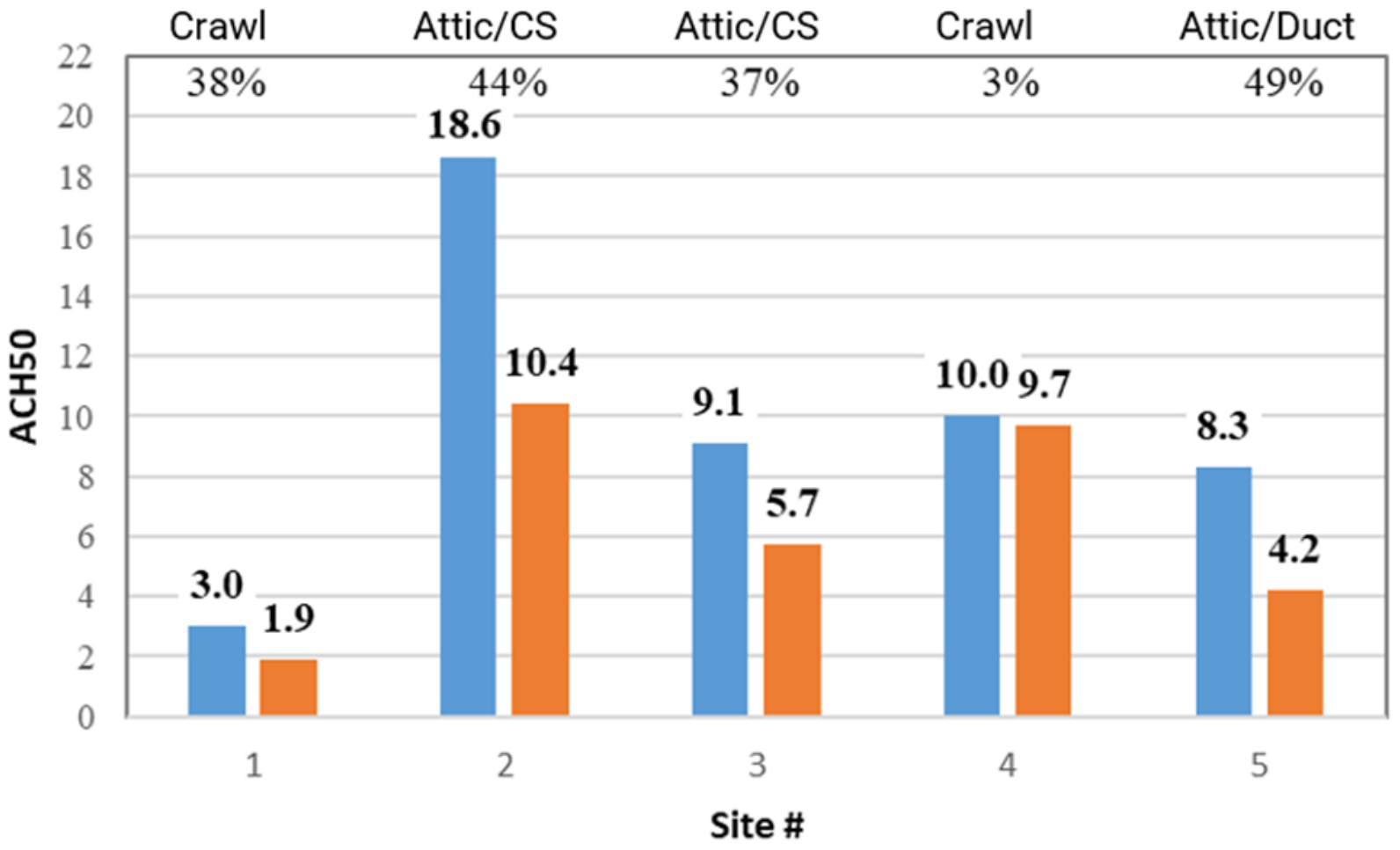
Single Family Homes



Vintage: 1900-1972

Size: 1,191-2,491 ft2

Starting leakage:

3-18.6 ACH50

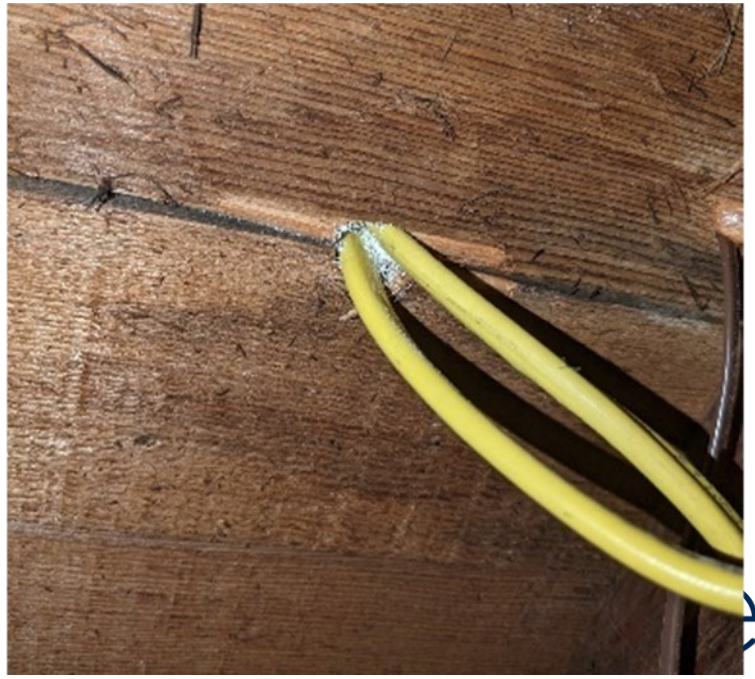
Average = 34%

42% w/o site 4

Exterior AeroBarrier: Single Family Homes

Site 1

- Early 1900s, gut rehab, 1,420 sf
- Crawlspace sealing only (conditioned attic)
- 3.0 >> 1.9 ACH50 (**38%**)
- 87% of 283 CFM50 CS to house leakage was sealed



Site 4

- 1961, 2-story, 2,491 sf
- Partial crawlspace and slab-on-grade
- Crawlspace sealing only – difficult attic insulation removal
- 10.0 >> 9.1 ACH50 (**3%**)
- 60F and raining (100% RH), depressurization ~ 70Pa
- Opened a patio door to reduce sealing in living space

Exterior AeroBarrier: Single Family Homes

Site 5

- 1972, 1-story, 2,136 sf
- Attic sealing only, ducts in attic
- 12.7 >> 8.5 >> 4.2 ACH50 (**49%**)
- sealed 133 CFM25 or 34% of the total duct leakage
- Sealing occurred at exposed joints, better sealing w/removed insulation

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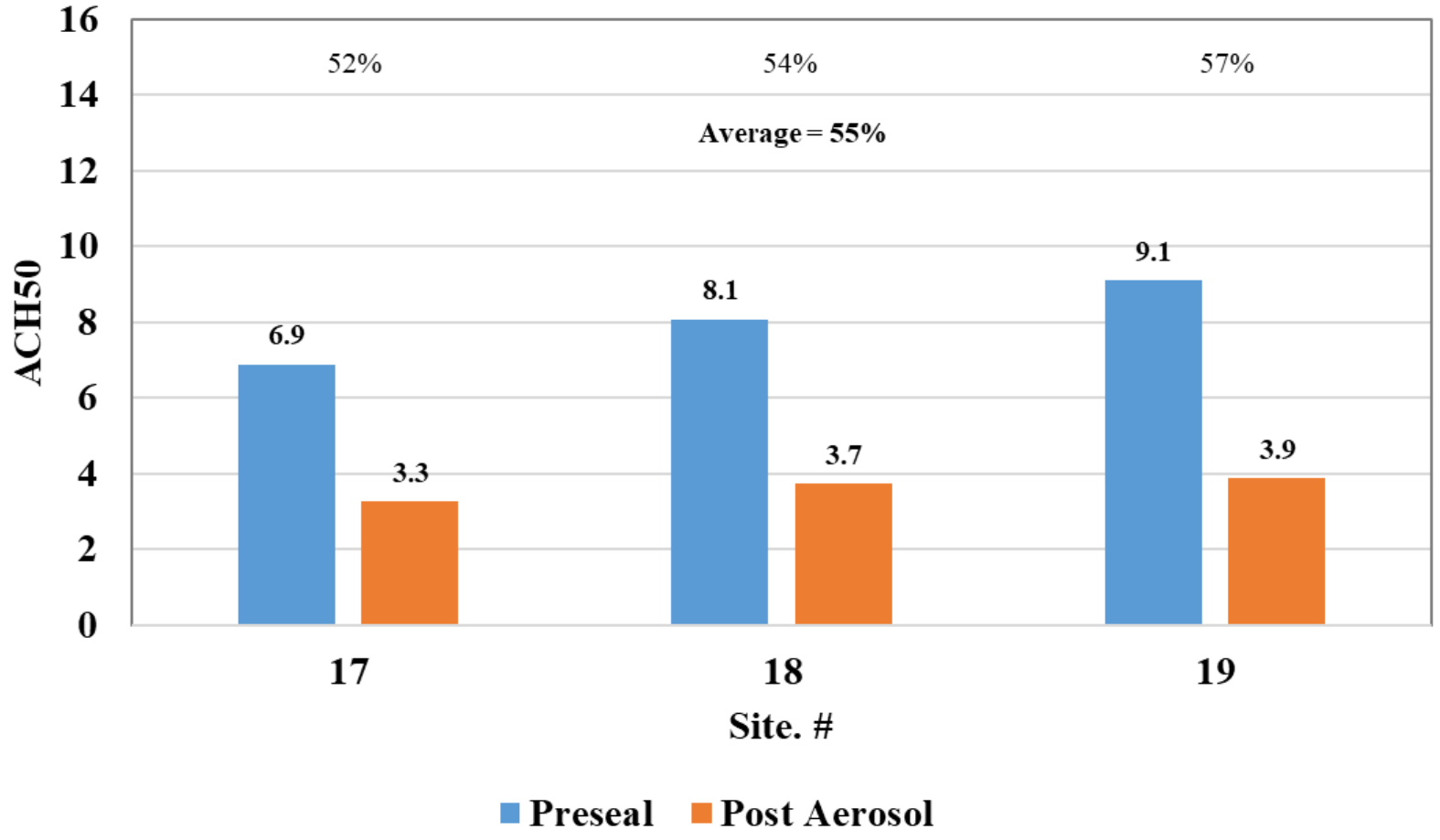
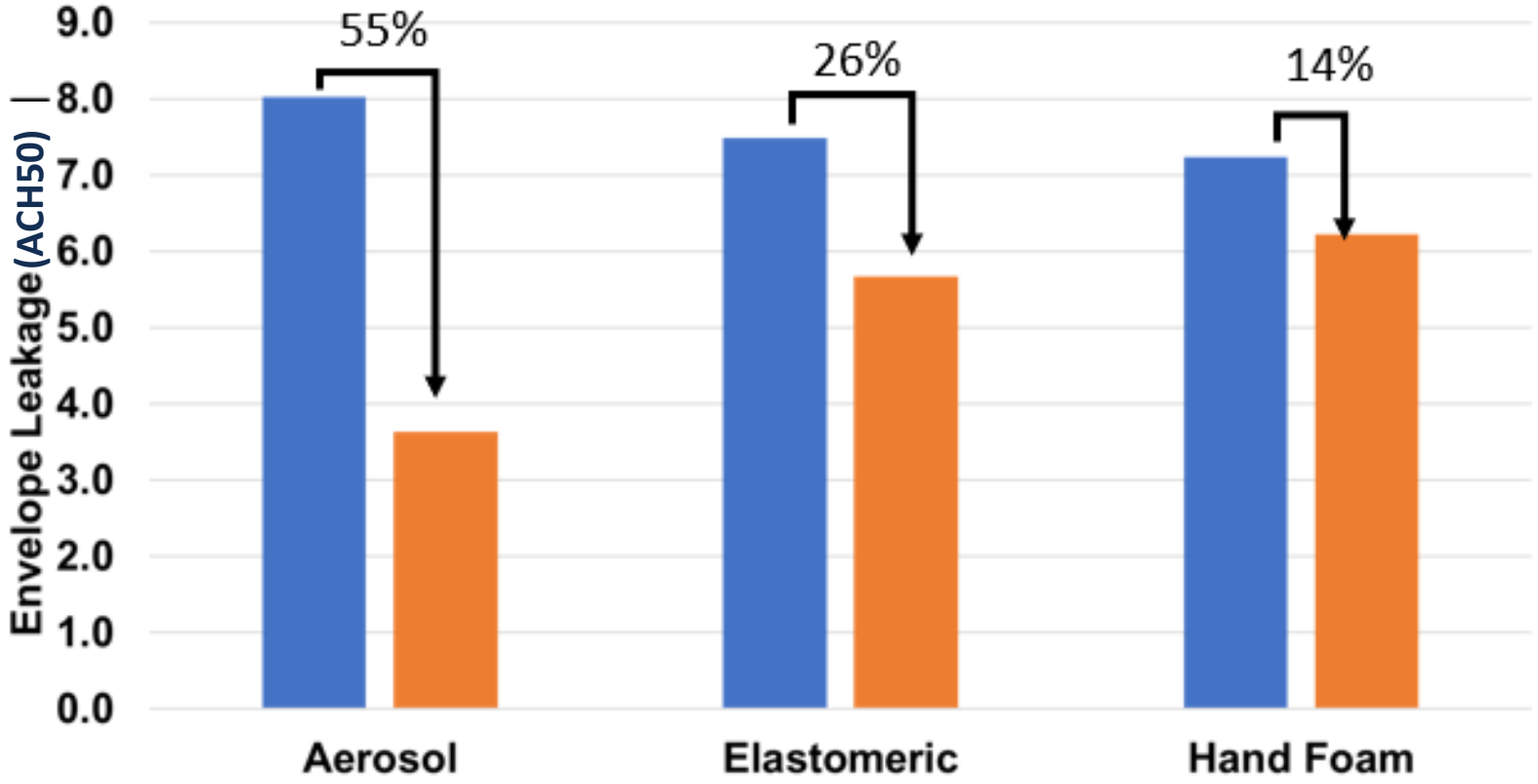
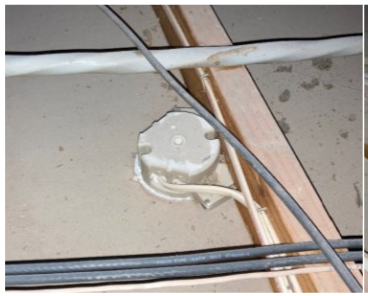
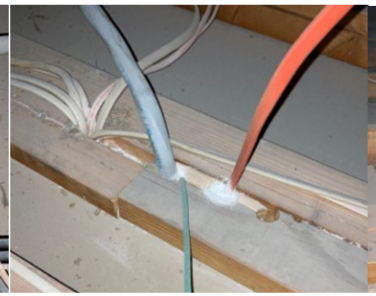
First Multifamily Sealing



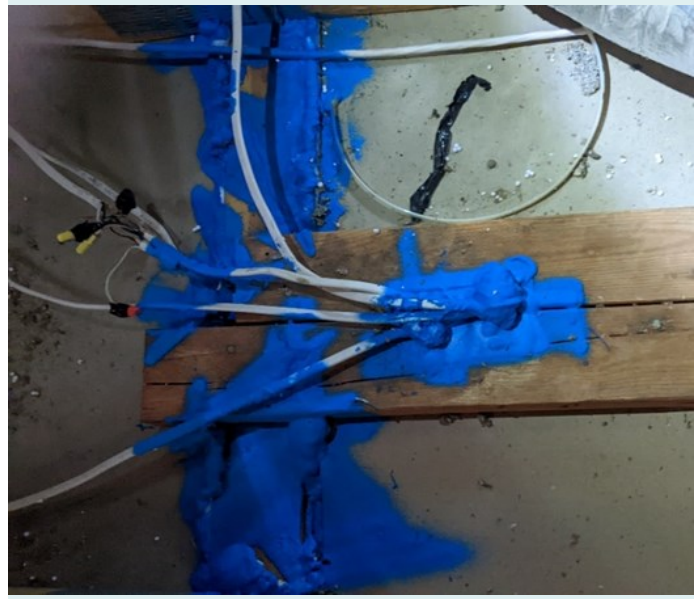
Sealed 3 apartments with each of the methods

Compare to Manual Methods



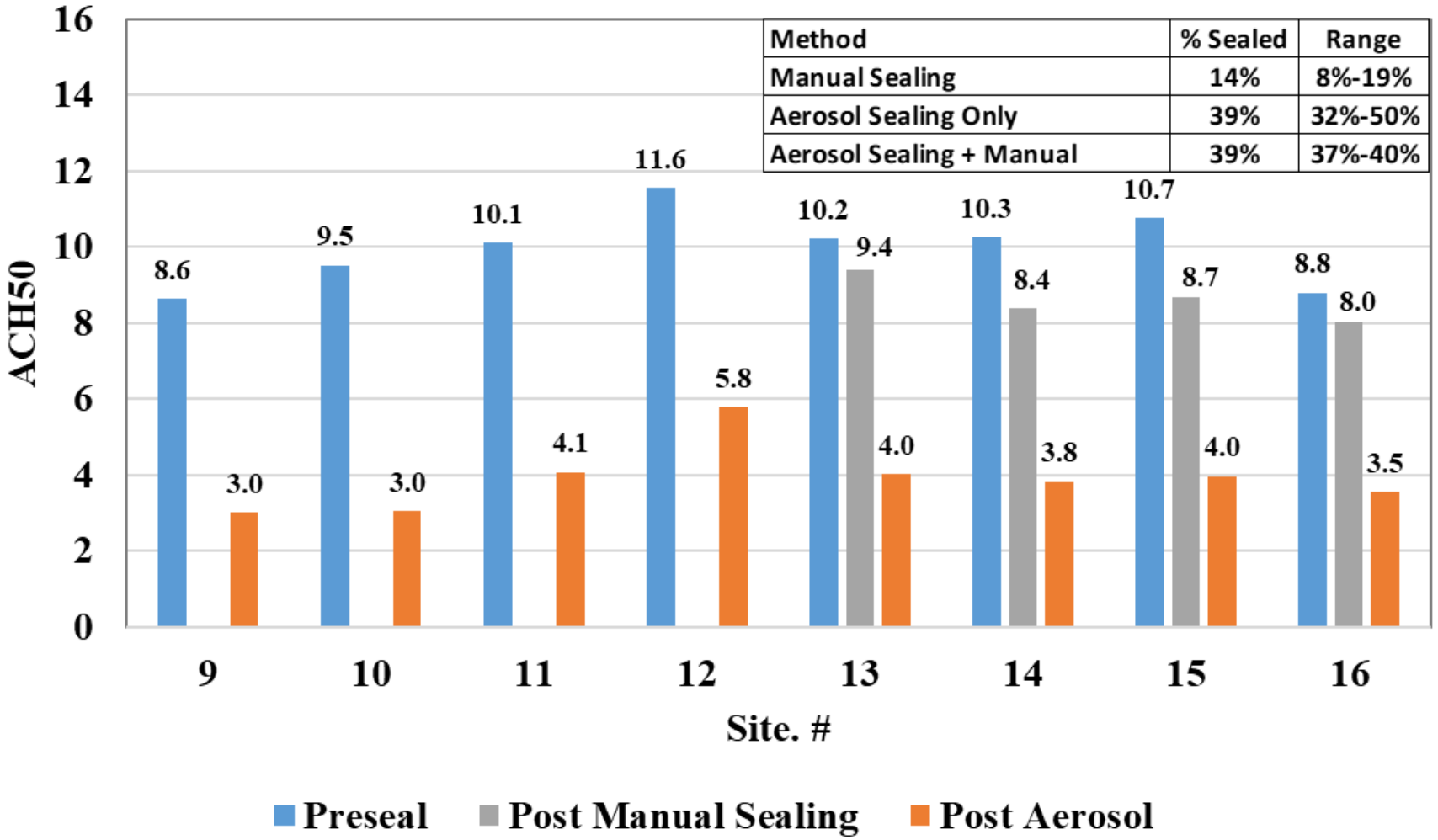
Elastomeric



Hand Foam

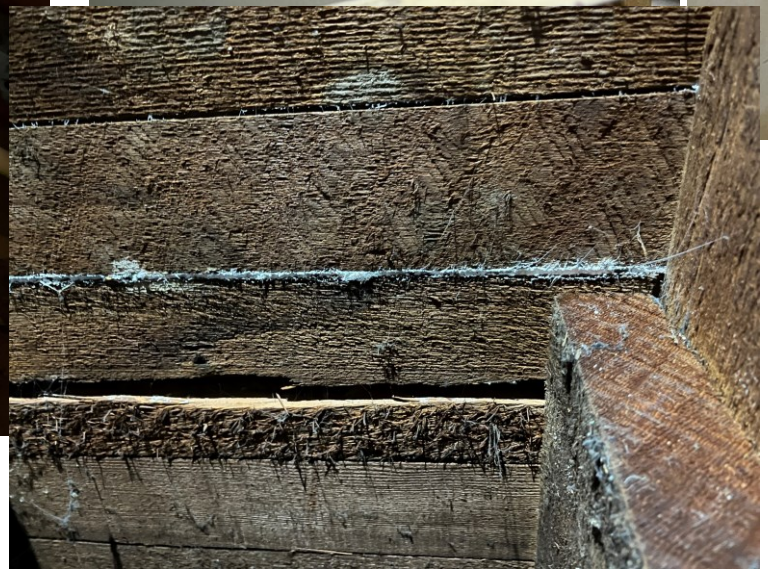
4 AeroBarrier Only and 4 Manual + AeroBarrier

8 Multifamily Sites – Attic Sealing



Method	% Sealed	Range
Manual Sealing	14%	8%-19%
Aerosol Sealing Only	39%	32%-50%
Aerosol Sealing + Manual	39%	37%-40%

Sample Seals



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Barriers to Adoption

- Requires removal of insulation
- Manually seal gaps > 3/8”
- Requires tenants to leave for 1-2 hours
- Higher cost than manual sealing
- Still on the pathway to commercialization

Exterior AeroBarrier

Opportunity

- Air sealing responsible for single largest natural gas reductions in WAP (20% - 30%)
- Outperforms conventional attic air sealing
  - 42% SF average leakage reduction (37% - 49%)
  - 39% MF average leakage reduction (32% - 50%)
  - Manual: 14% can foam, 26% elastomeric
- Greater reduction with other WX measures
- Little or no prep to occupied space
- Process can seal ducts at the same time
- New equipment > save labor and reduce invasiveness

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THANK YOU

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