

# Auto-Sealing New Home Leaks with Aerosols



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# Presentation Overview

- » Air Sealing Benefits
- » Basic Concept
- » Development Timeline
- » Building America Project
- » Path Forward
- » AeroBarrier Update





# Energy Benefits of Air Sealing

- » Heating and cooling is responsible for large fraction of energy use
  - 48% in residential
  - 35% in commercial
- » Infiltration is responsible for 30% of the heating and cooling load
- » Better insulated envelopes increase fraction of heating & cooling associated with infiltration/ventilation
- » Envelope tightness standards were fairly recently included in U.S. codes
- » Cost-effective approaches to sealing envelope leakage would improve and simplify adherence to code

# Health Benefits of Air Sealing

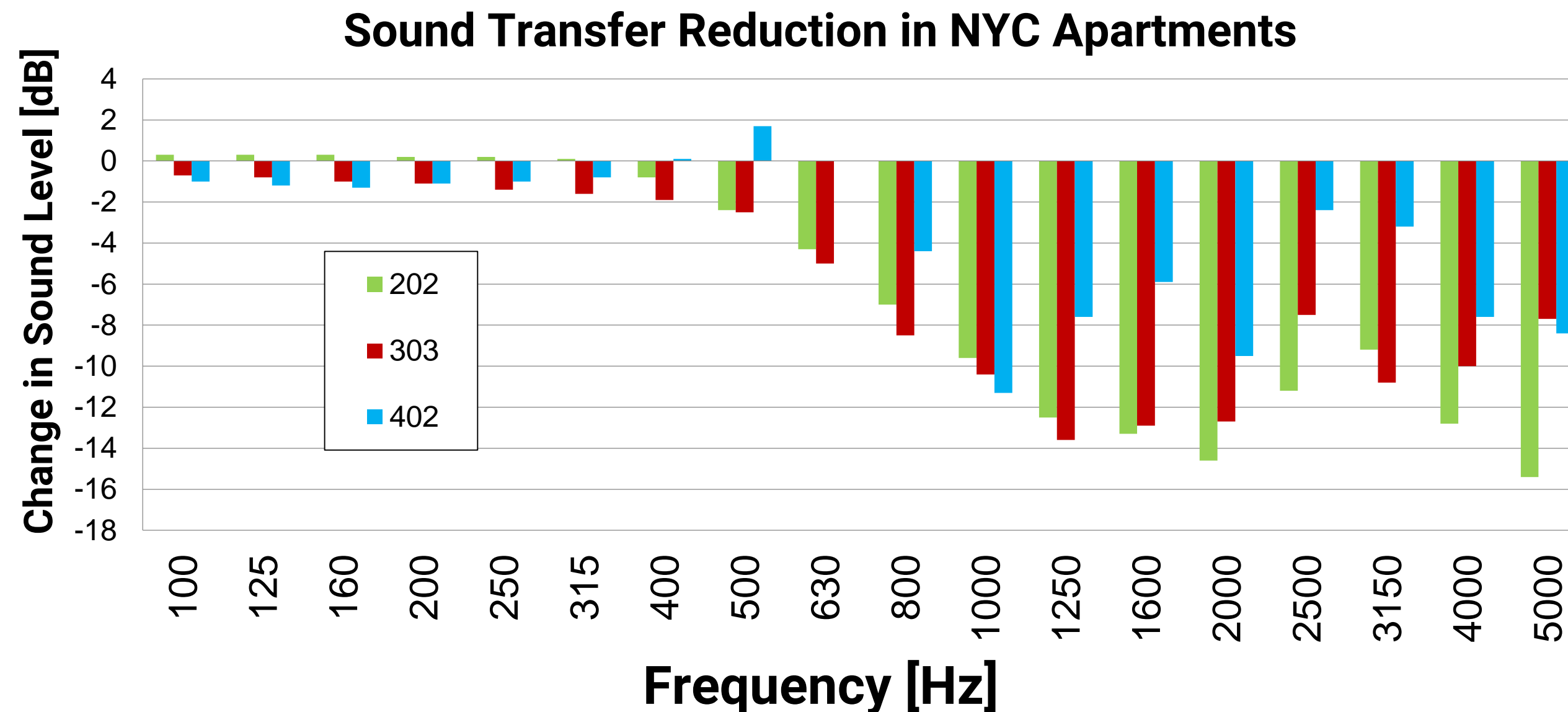
- » Better control of air flow and reduced infiltration of outdoor air and outdoor pollutants (e.g. PM 2.5 or Ozone)
- » Facilitates use of Mechanical Ventilation
  - HRV or ERV and filters
  - Putting HRV/ERV on leaky building doesn't save energy or reduce uncontrolled infiltration

# Health Benefits of Air Sealing (Large Buildings)

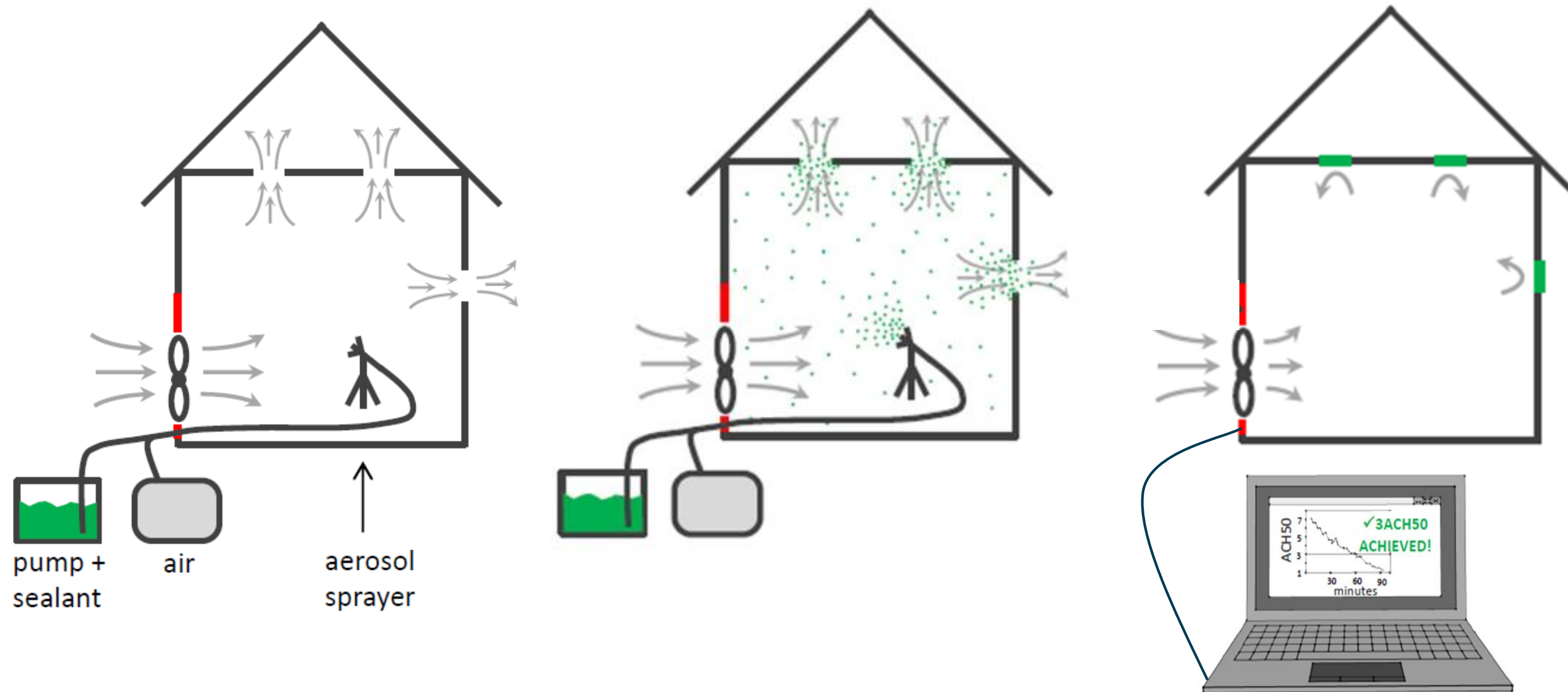
- » NIST measurements of large building leakage suggest that more air is needed for pressurization than for ventilation
- » Better and more efficient air flow control in sensitive spaces
  - Elimination of outdoor chemical infiltration
  - Contagious disease spaces
  - Clean rooms
  - Laboratories
  - **Schools in non-compliance areas (have current CEC project on HVAC and IAQ in schools)**

# Health Benefits of Air Sealing (Large Buildings)

- » Reduce noise transfer
- » Reduce smell transfer



# Basic Concept



*Blower door setup for pressurization*



*Seal formed between gap in foam*



# Building America Project Goals

Integrate aerosol sealing into building process

- » Determine appropriate time for applying
- » Measure performance relative to conventional methods
- » Determine existing sealing efforts that could be avoided
- » Determine cost-effectiveness



# Building America Project Team

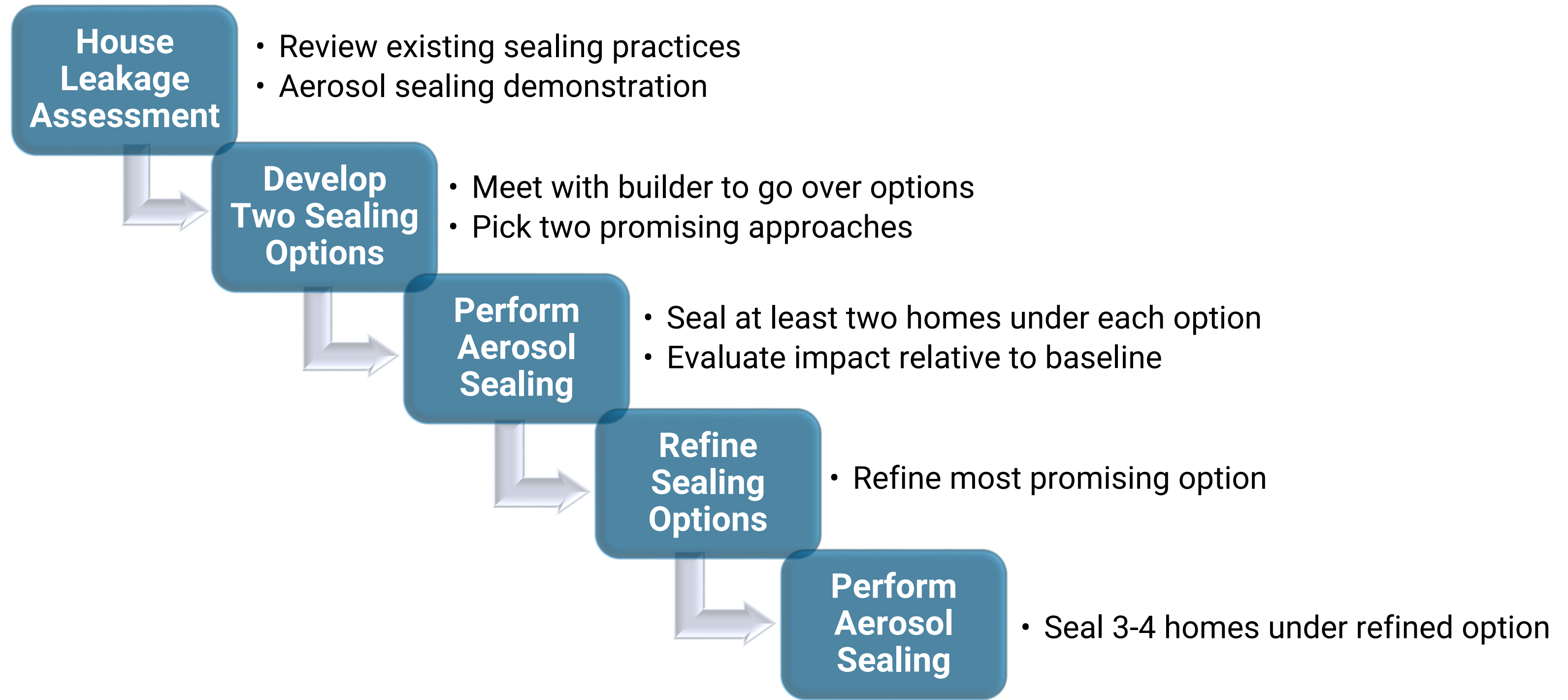
## » Project Partners:

- Center for Energy and Environment
- Building Knowledge Inc.
- University of Minnesota's Cold Climate Housing Program
- Aero seal LLC

## » Builders:

- Two in California
- Two in Minnesota

# Building America Project Approach

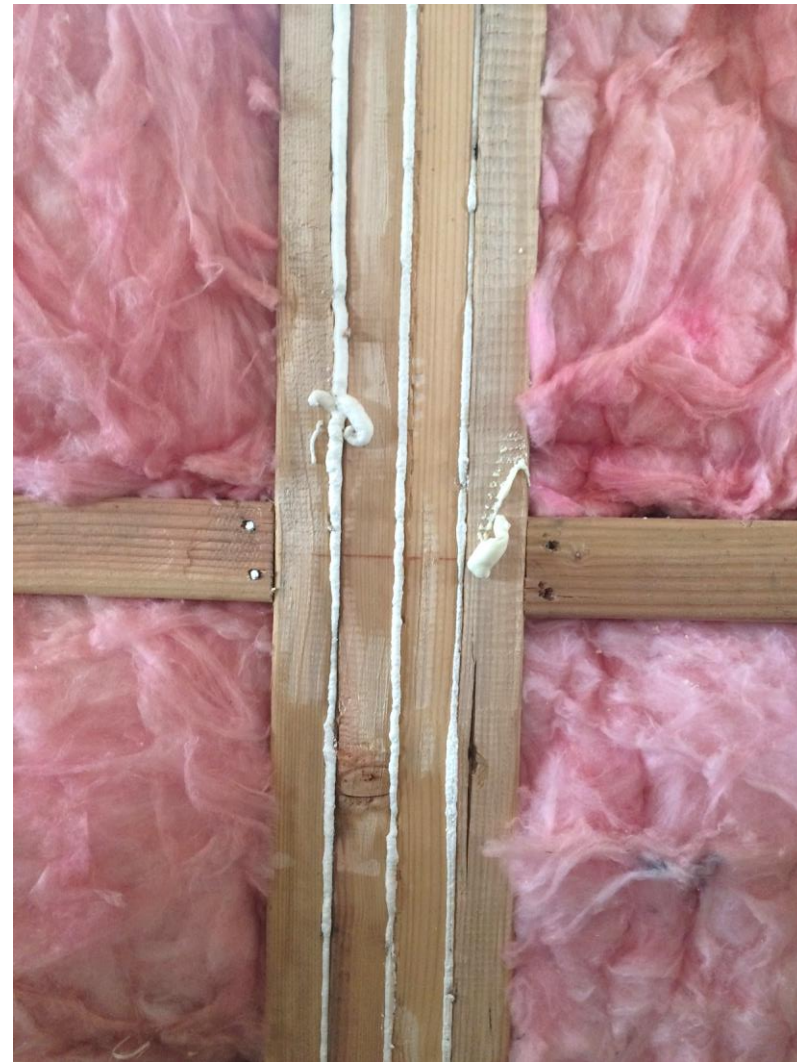


# Building America Interim Results (CA)

- » California Builder #1
- » Homes designed with sealed attics
- » Using open-cell spray foam
  - Under roof deck
  - At rim joist and other mechanical penetrations
- » Fiberglass/mineral wool in wall cavity
- » HRV integrated into central air handler
- » Target leakage of 800 CFM50 (2.1-2.4 ACH50)



# Conventional Sealing



*Can foam at seams  
where wood is joined*



*Can foam and gasket at sill plate*



*Foam gasket to seal drywall to top plate*



# Sealing Options

## » Sealing options

- Option 1: After open-cell spray foam
- Option 2: Before spray foam insulation

## » Advantage of sealing before drywall

- Addresses outer wall surface
- Seals less prone to damage in wall cavity
- Easier aerosol distribution



# Option 1: After Foam



*Foam at roof deck*

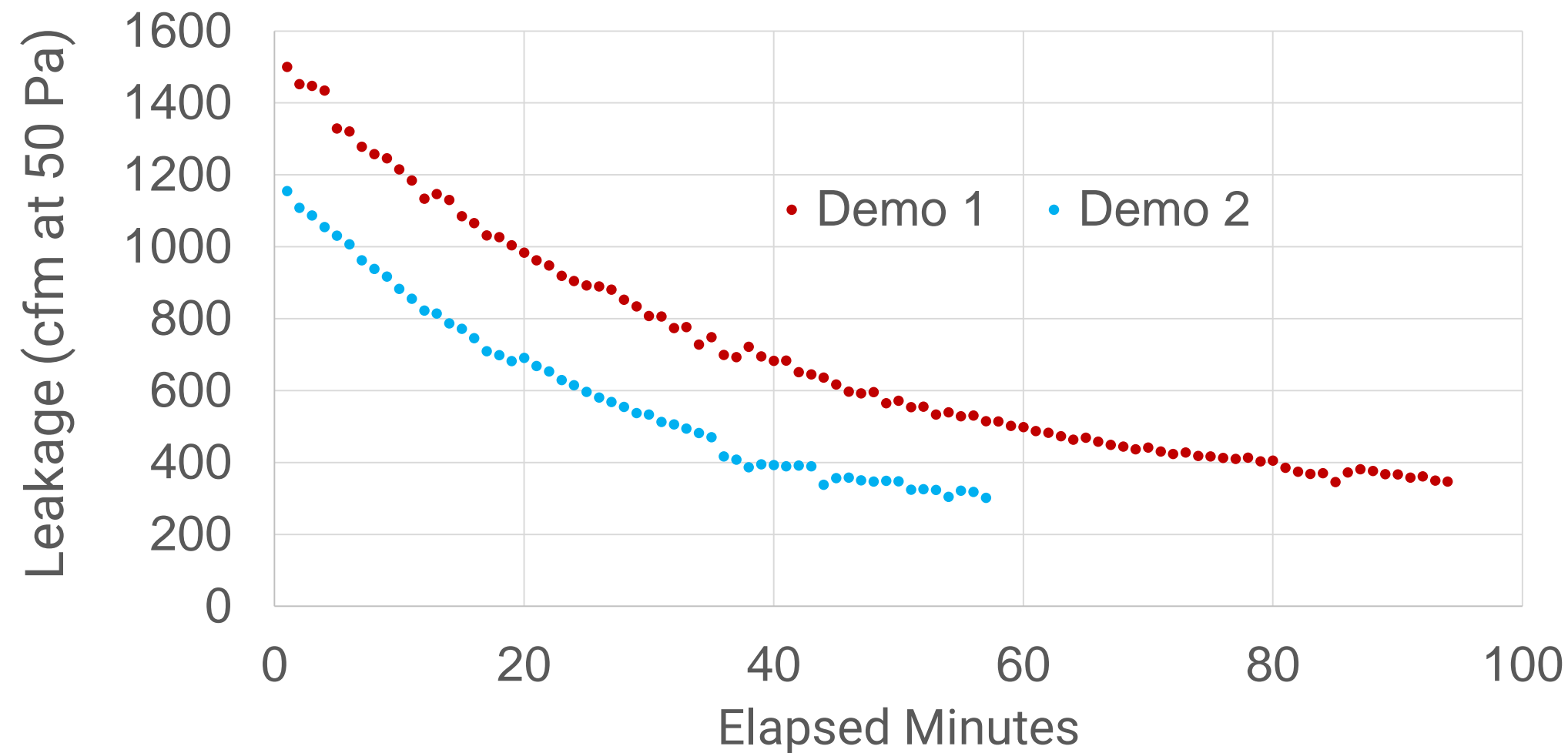


*Foam at rim joist*

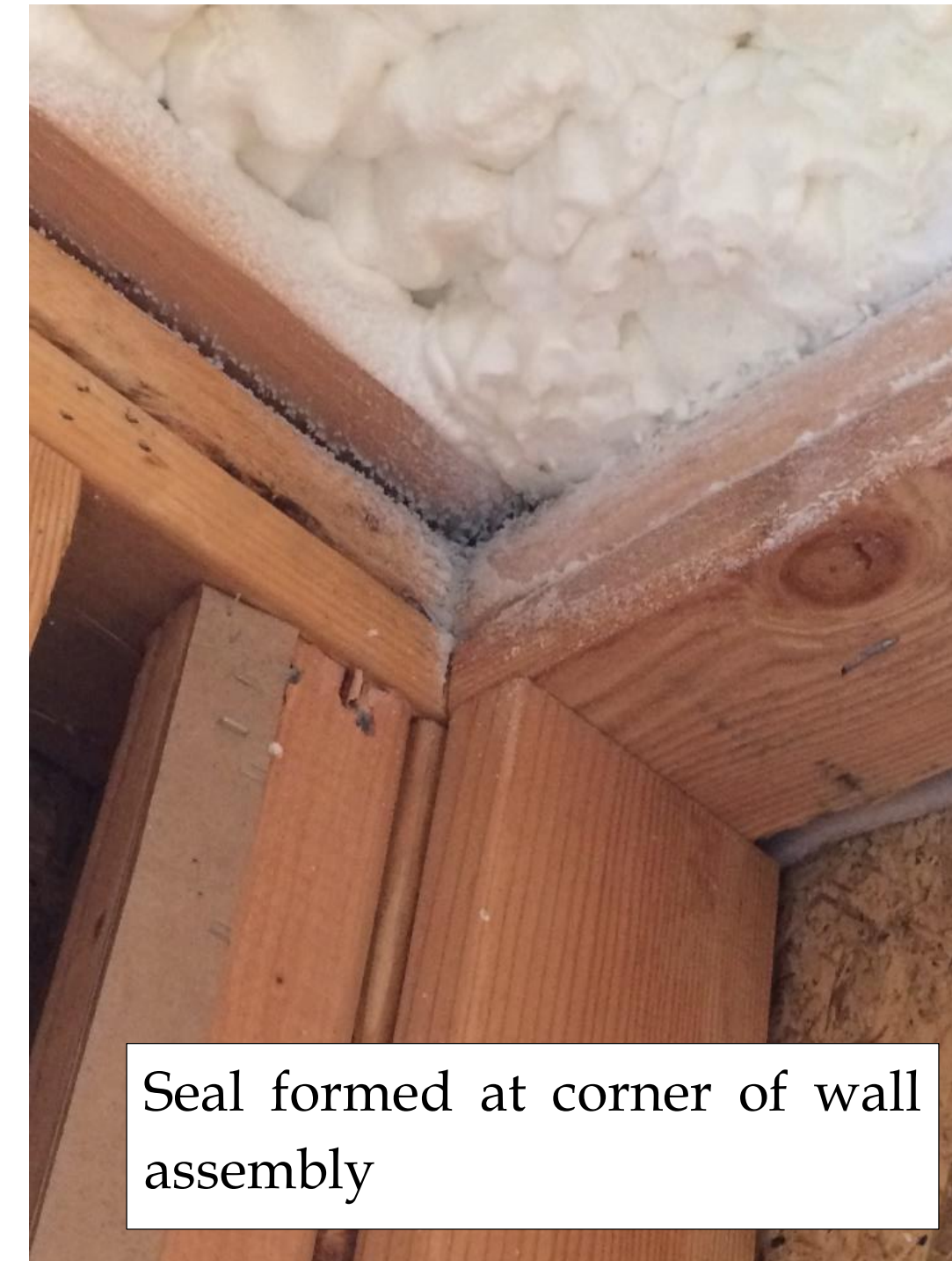
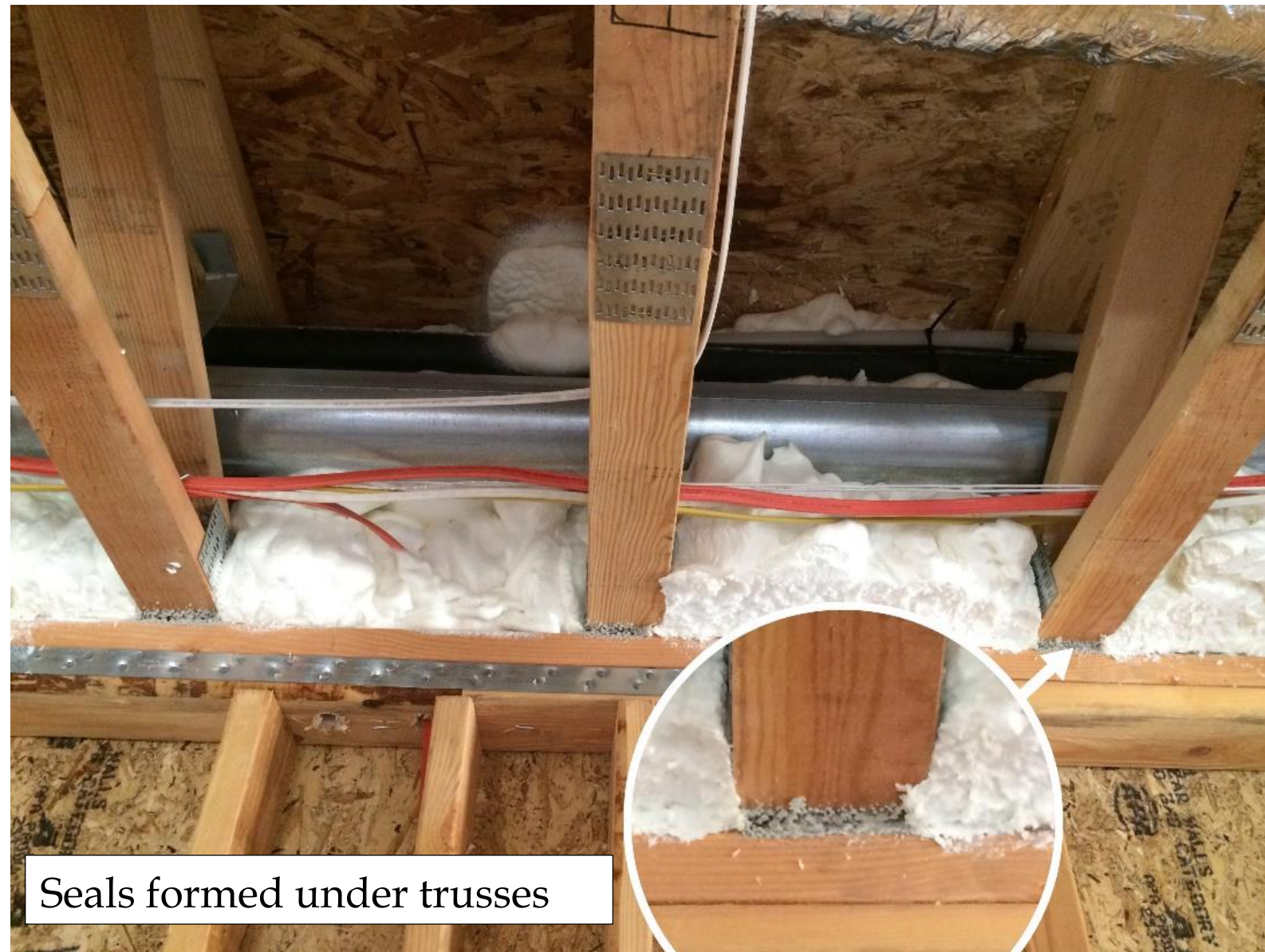


# Results Sealing After Foam

	Stage/Option	Lot	Plan	Floor Area (ft <sup>2</sup> )	Volume (ft <sup>3</sup> )	Pre-Seal		Post-Seal		
						CFM50	ACH50	CFM50	ACH50	% Reduction
Demo 1	After Foam	7	3	2569	23121	1690	4.39	429	1.11	75%
Demo 2	After Foam	8	1	2032	22215	1286	3.47	351	0.95	73%



# Example Seals After Foam





# Option 2: Before Foam



*Exposed roof deck*



*Rim joist penetrations*



# Option 2 Pre sealing work

- » Large penetrations needed to be sealed prior to aerosol sealing
- » Time/materials for pre-sealing was tracked





# Prepare for unexpected!





# Pre-Sealing Time/Materials

	Sealing Penetrations		Sealing Gap at Eaves	
Stage/Option	Time for Manual Sealing (person-hours)	Cans of Foam Used	Time for Manual Sealing (person-hours)	Cans of Foam Used
Before Foam	1.5	3	1.5	4
After Foam	4.5	6	1	4

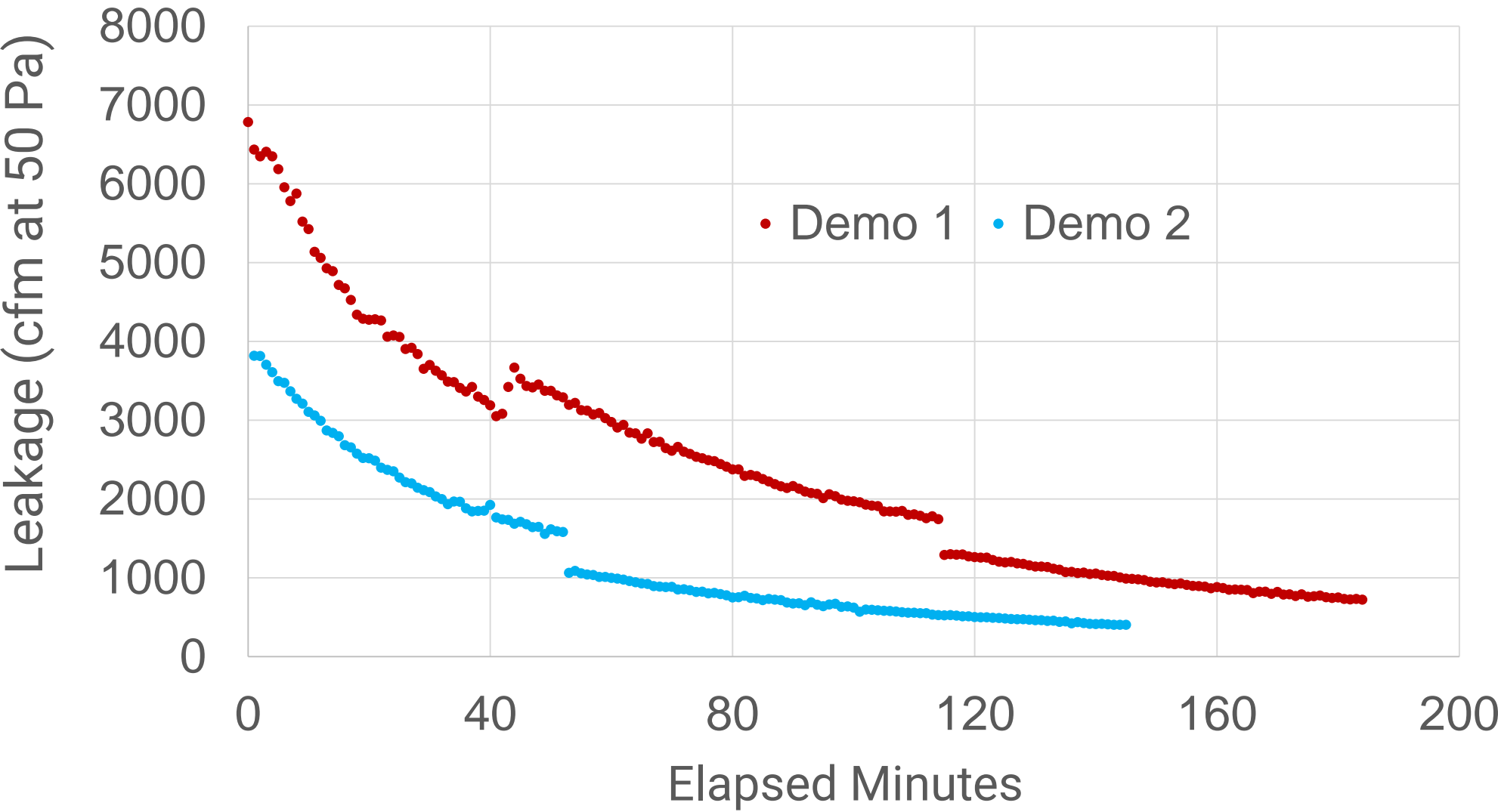
\*Note: Pre-sealing work performed by inexperienced staff





# Option 2 Results

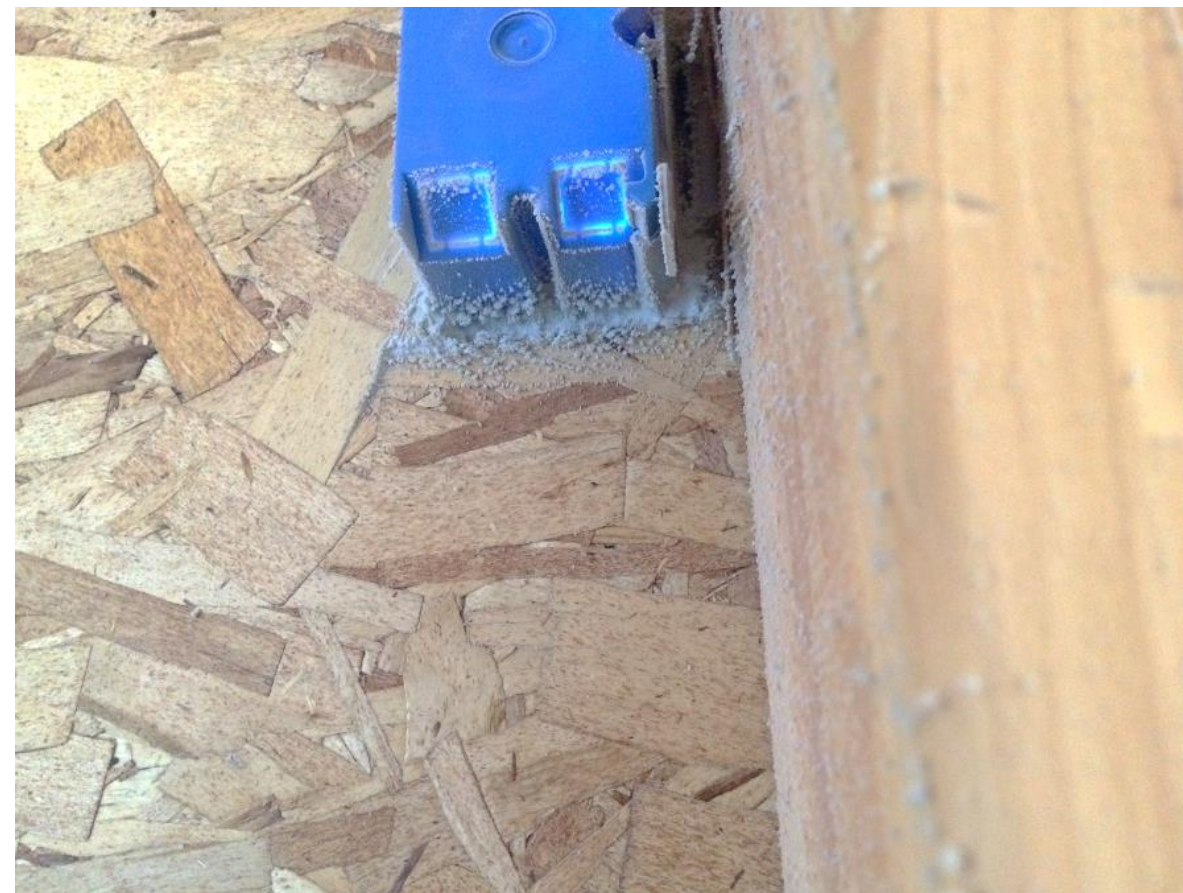
	Stage/Option	Lot	Plan	Floor Area (ft <sup>2</sup> )	Volume (ft <sup>3</sup> )	Pre-Seal		Post-Seal		
						CFM50	ACH50	CFM50	ACH50	% Reduction
Demo 1	Before Foam	23	3	2569	23121	5836	15.14	828	2.15	86%
Demo 2	Before Foam	24	2	2223	20007	3005	9.01	477	1.43	84%



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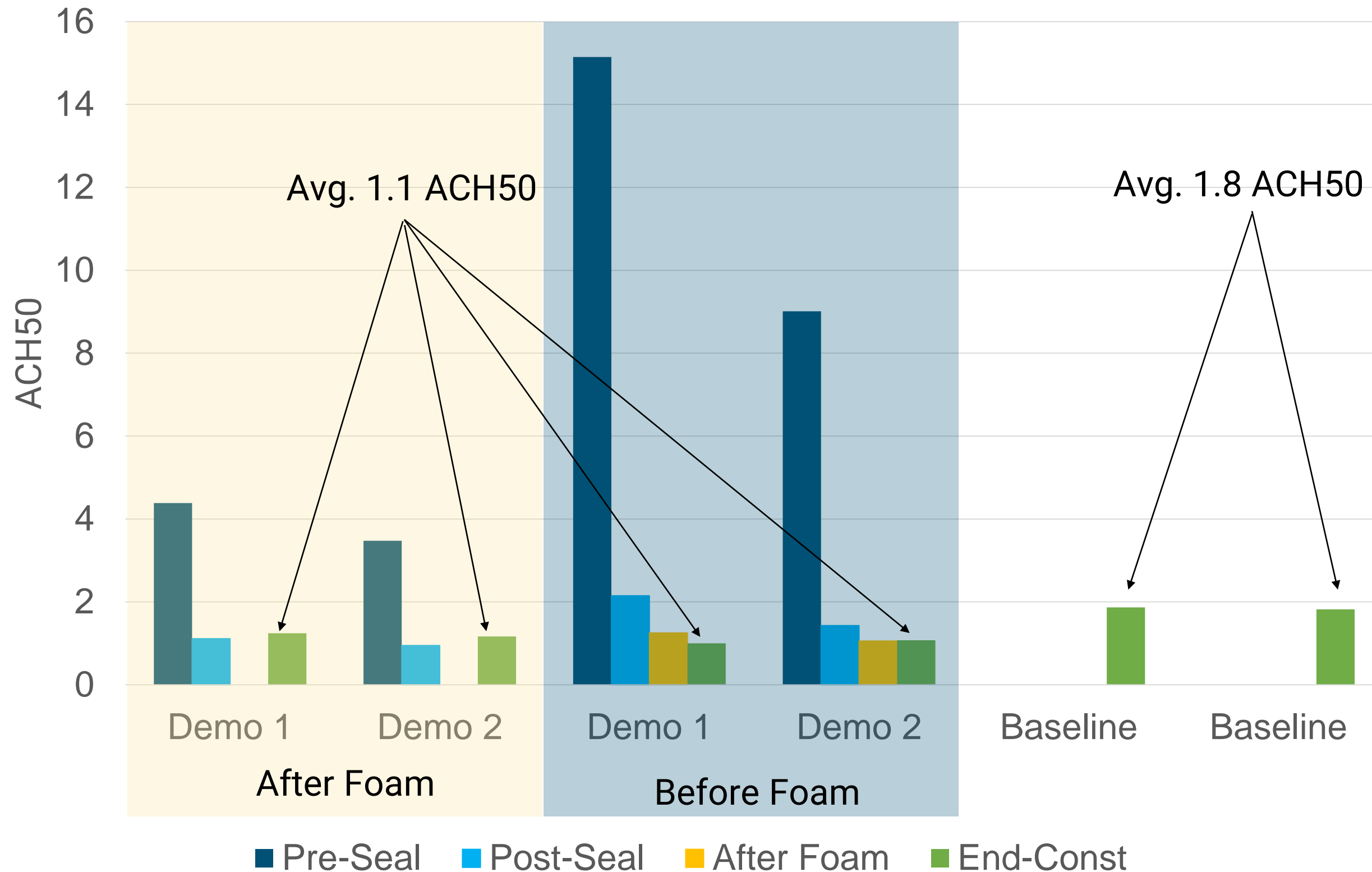
After Foam		
CFM50	ACH50	% Reduction
483	1.25	6%
352	1.06	4%

# Option 2 Example Seals





# CA Builder #1 Results Summary



» 39% tighter than two control houses

» 55% tighter than Zero Energy Ready requirement of 2.5 ACH50

# Further Testing In Sealed Attics

- » California Builder #2
- » Homes designed with sealed attics
- » Using netting and blown-in cellulose insulation at roof deck
- » Fiberglass/mineral wool in wall cavity
- » HRV integrated into central air handler



# Conventional Sealing



*Gasketed light fixtures*



*Can foam in expansion joint at roof deck and HVAC penetrations*



*Foam gasket at sill plate*



# CA Builder #2 – Before Insulation





# Challenges

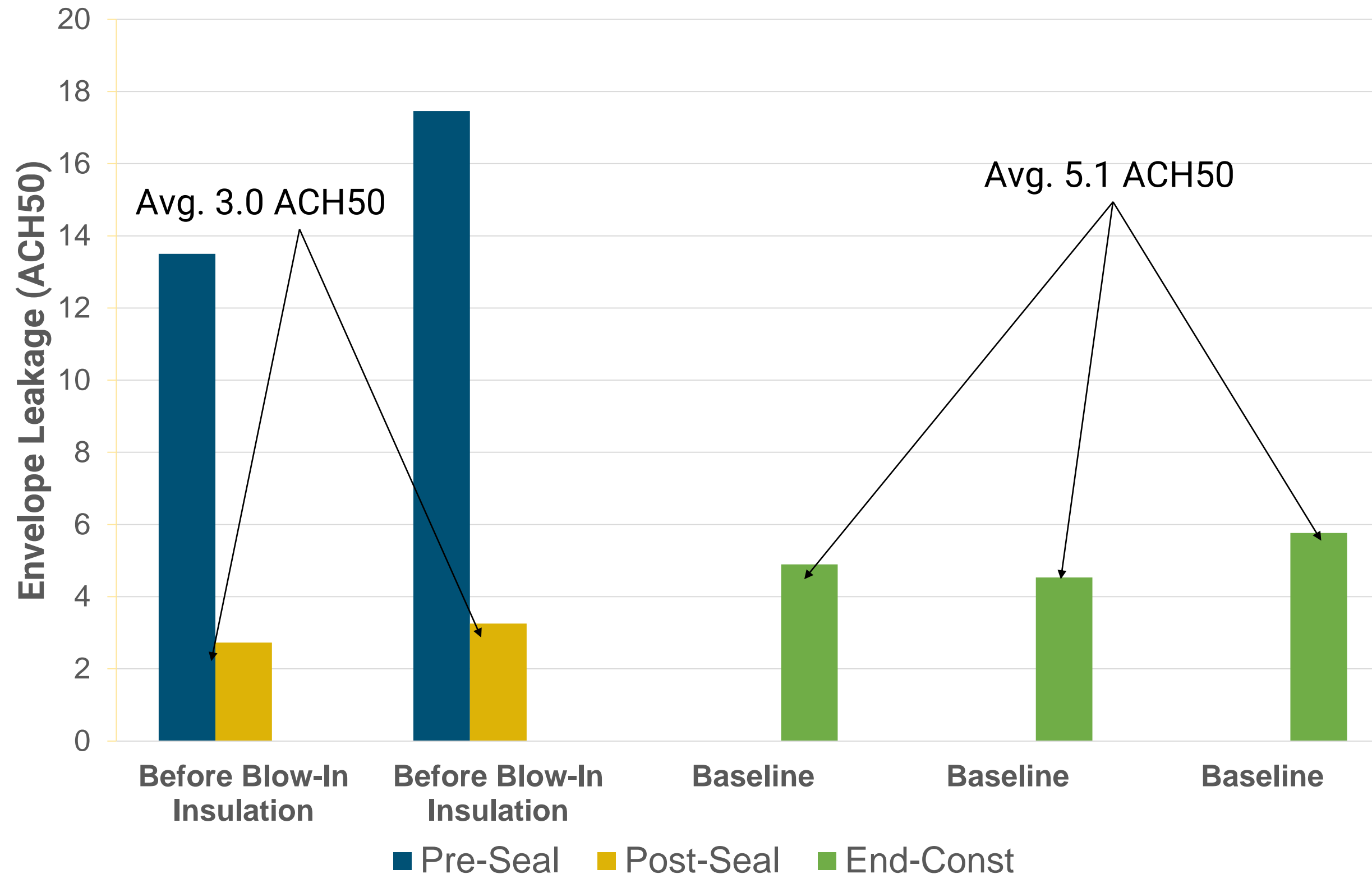


Air barrier installed to block garage attic from house attic



Gap between exterior foam and roof

# CA Builder #2 Results Summary



- » 41% tighter than two control houses (before drywall)
- » Final end of construction testing planned this week



# Testing In Vented Attics

- » California Builder #1
- » Vented attic with blow-in insulation on ceiling
- » Fiberglass/mineral wool in wall cavity
- » HRV integrated into central air handler

## Sealing Strategy

- » Sealed after drywall, mud and tape
- » Temporarily covered fire sprinklers



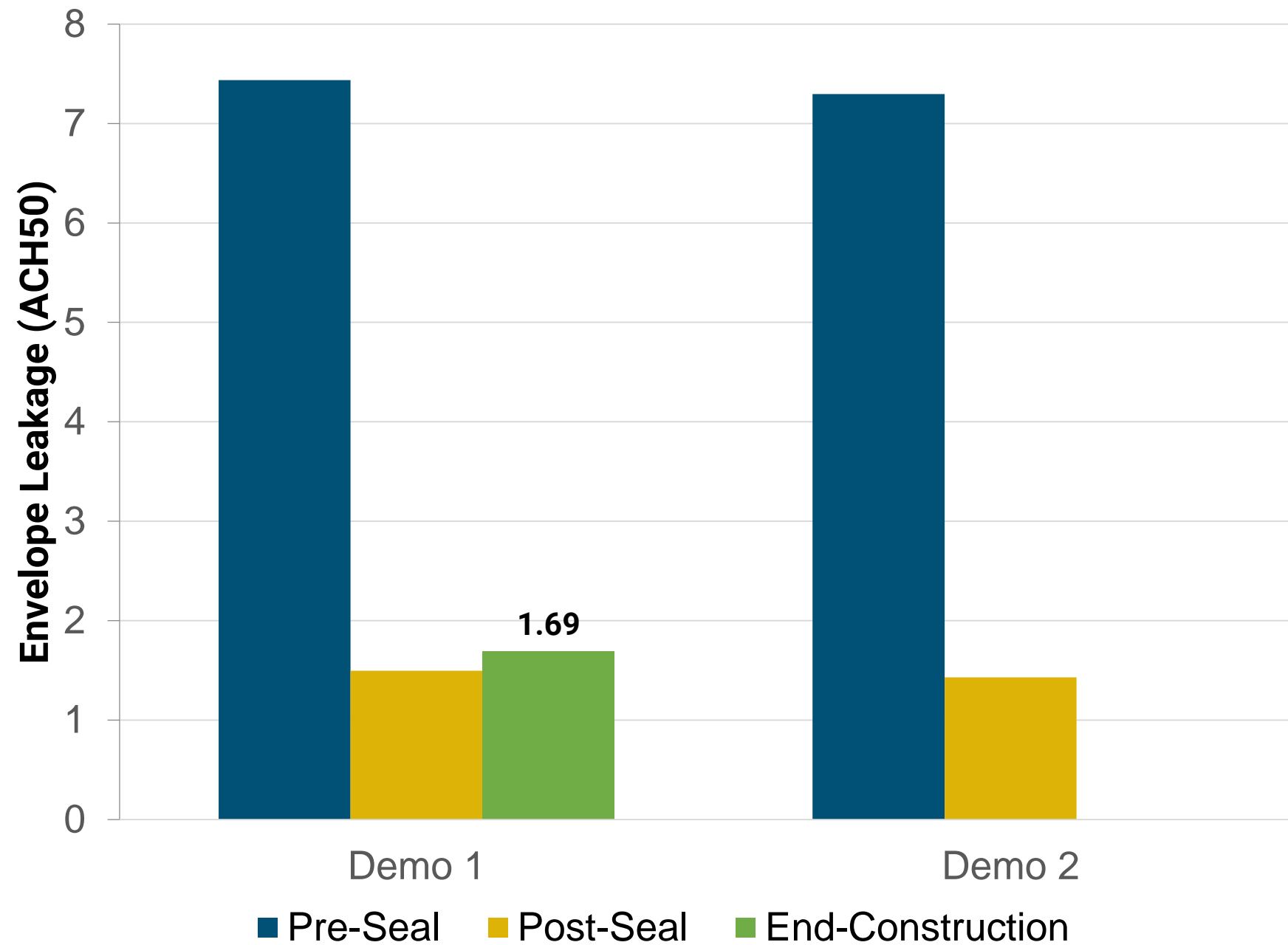


# Conventional Sealing

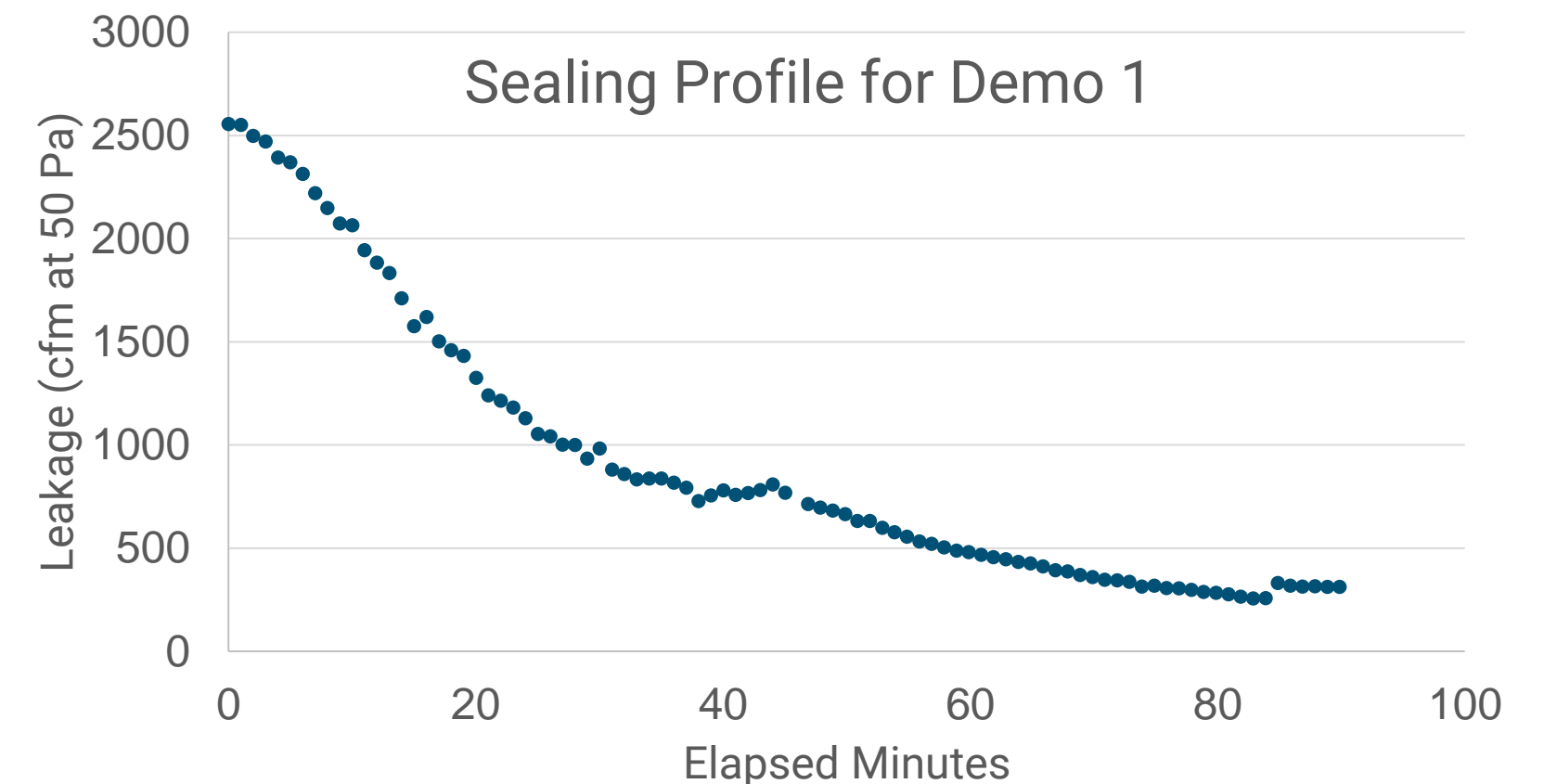




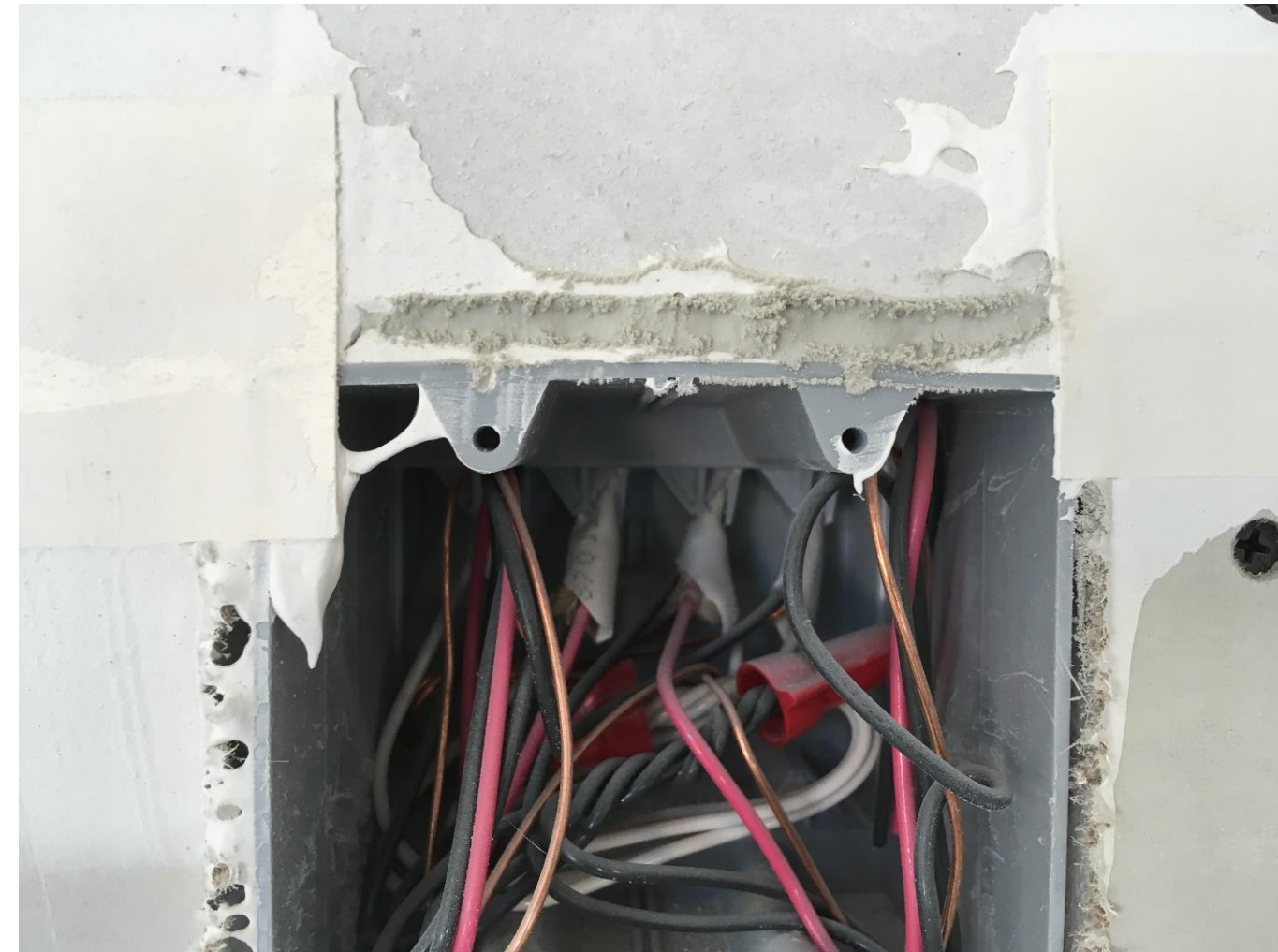
# Sealing Results



- » 80% reduction in leakage
- » 90 minutes of sealant injection
- » 65% below Title 24 code



# Example Seals





# Building America Interim Results (MN)

- » Minnesota Builder #1
- » Homes designed with ventilated attics
- » Closed-cell spray foam at rim joist
- » Interior poly wrap
- » Fiberglass/mineral wool in wall cavity
- » ERV integrated into central air handler

# Conventional Sealing



*Caulk at seams where wood is joined*



*Can foam at wire penetrations*



*Caulk at sill plate*



# Proposed Sealing Options

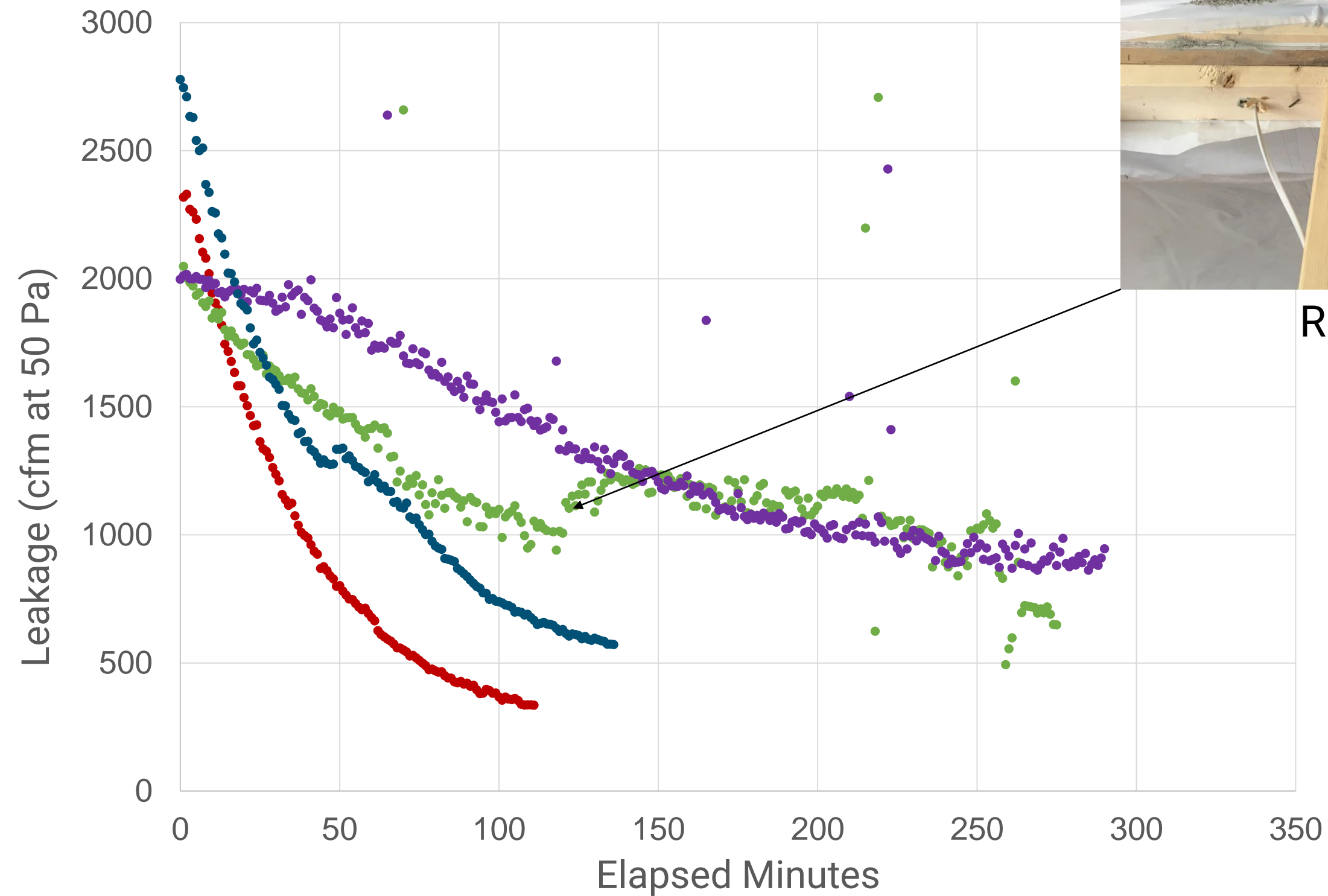
## » Option 1:

- Seal home after spray foam at rim joist
- Reinforced poly at ceiling-attic interface
- Maintain conventional sealing

## » Option 2 (Ultimately not implemented):

- Seal home after spray foam at rim joist
- Reinforced poly at ceiling-attic interface
- Do not install:
  - Airtight electrical boxes
  - Interior poly

# Sealing Results



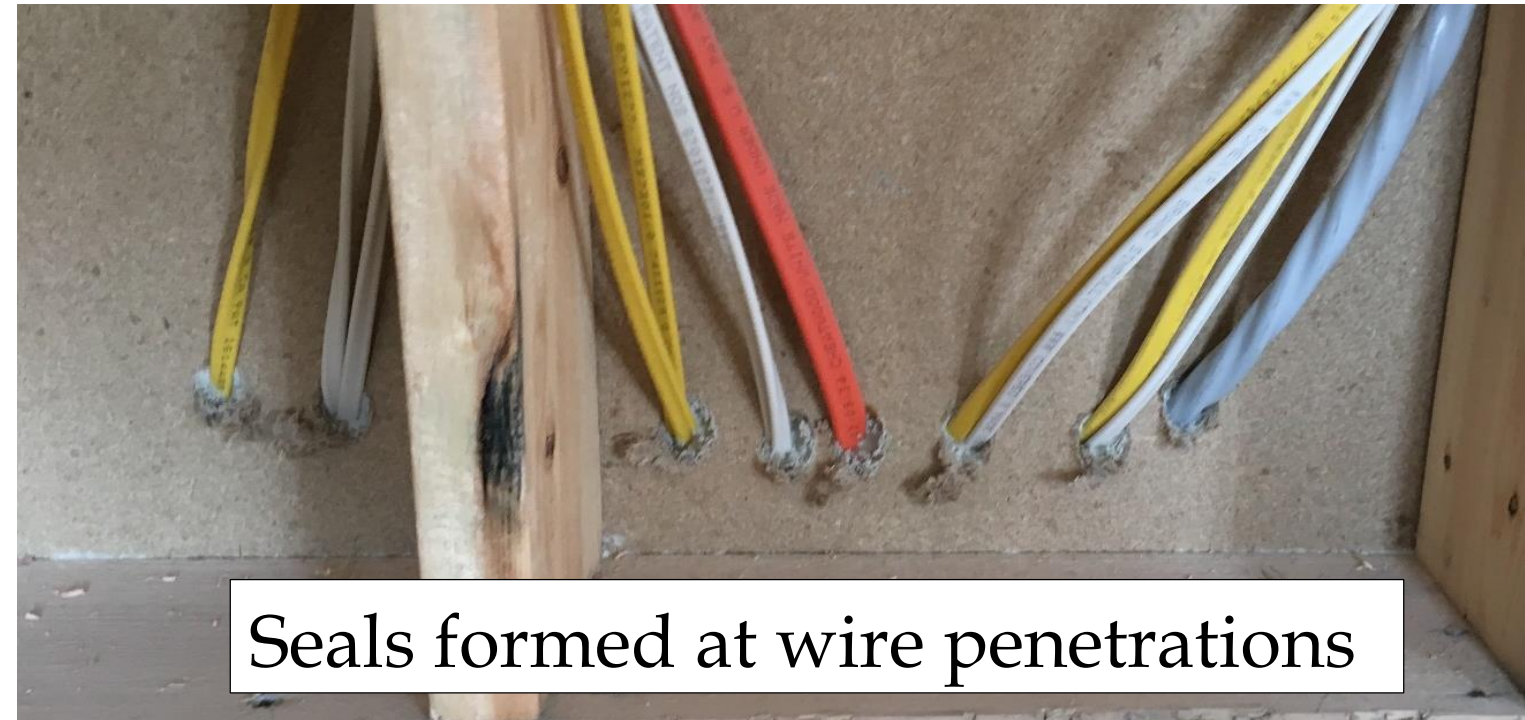
Reinforced poly failed



# Example Seals



Seal formed between studs



Seals formed at wire penetrations

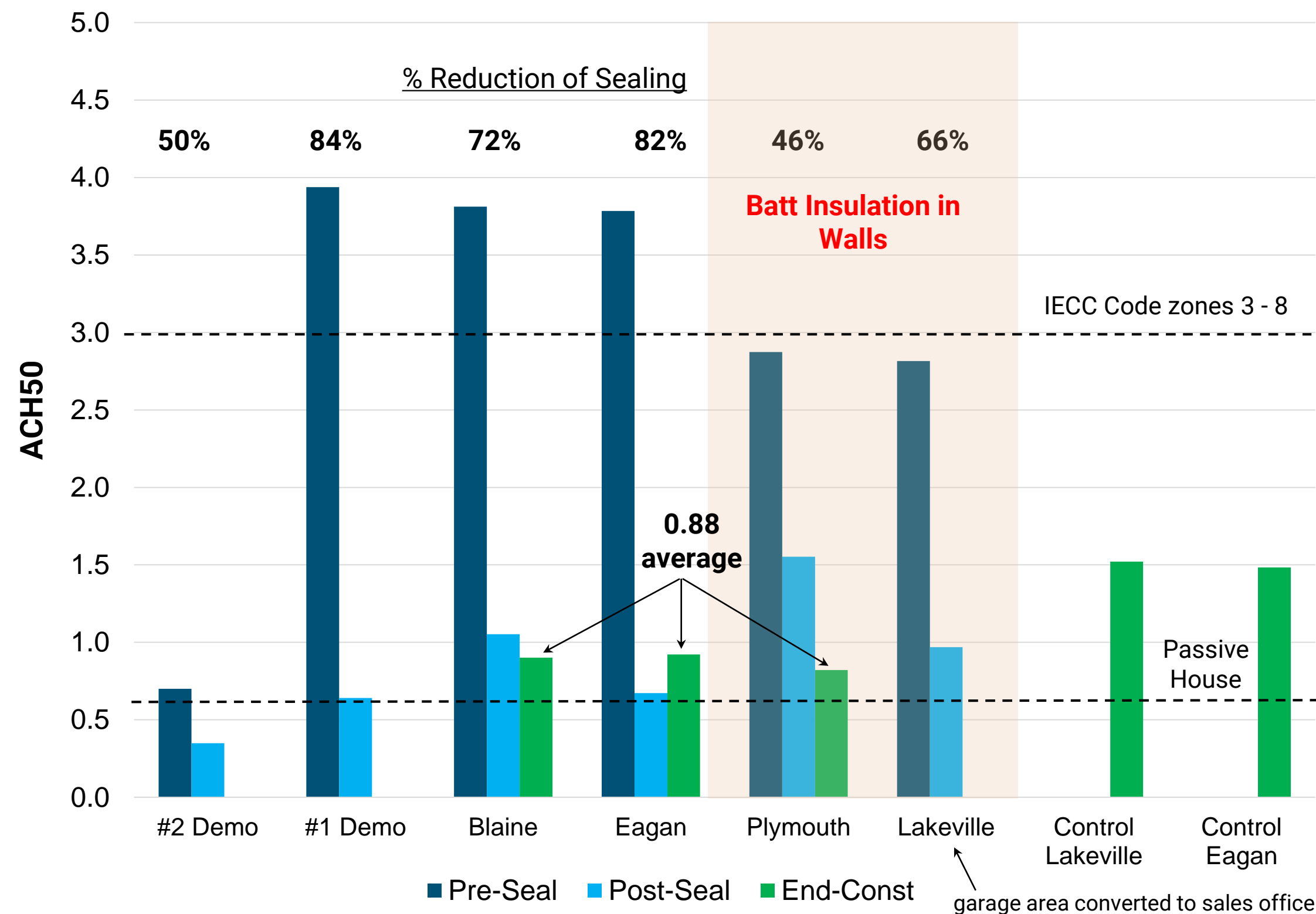


Seal formed at electrical box



Seals formed at plumbing penetrations

# MN Builder #1 Results Summary



- » 41% tighter than two control houses
- » 56% tighter than Zero Energy Ready requirement of 2.0 ACH50



# Final Takeaways

- » Aerosol sealing was very effective
  - Reduced air leakage by 75-80%
  - Achieved leakage rates well below codes
- » Only 1-3 hours of total injection time
- » Can replace many conventional sealing tasks
- » Assures leakage targets are met
  - Provides verification

# Project Path Forward

- » Complete testing with vented attics
- » Complete end of construction tests
- » Determine cost effectiveness:
  - Gather cost data from builders
  - Compare costs and performance to conventional sealing approaches



# Research Path Forward

- » Application in commercial buildings
  - Completed a project for DoD on non-res retrofits
  - Commercial buildings present challenges
    - Roof-to-wall connection
    - Supplemental manual sealing sometimes required
- » Application in existing homes
  - Existing homes are leakier
  - Apply at time of tenant change

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