Characterization of Air-Leakage in Unvented Attics

The Building Envelope Revisited

James Rinne

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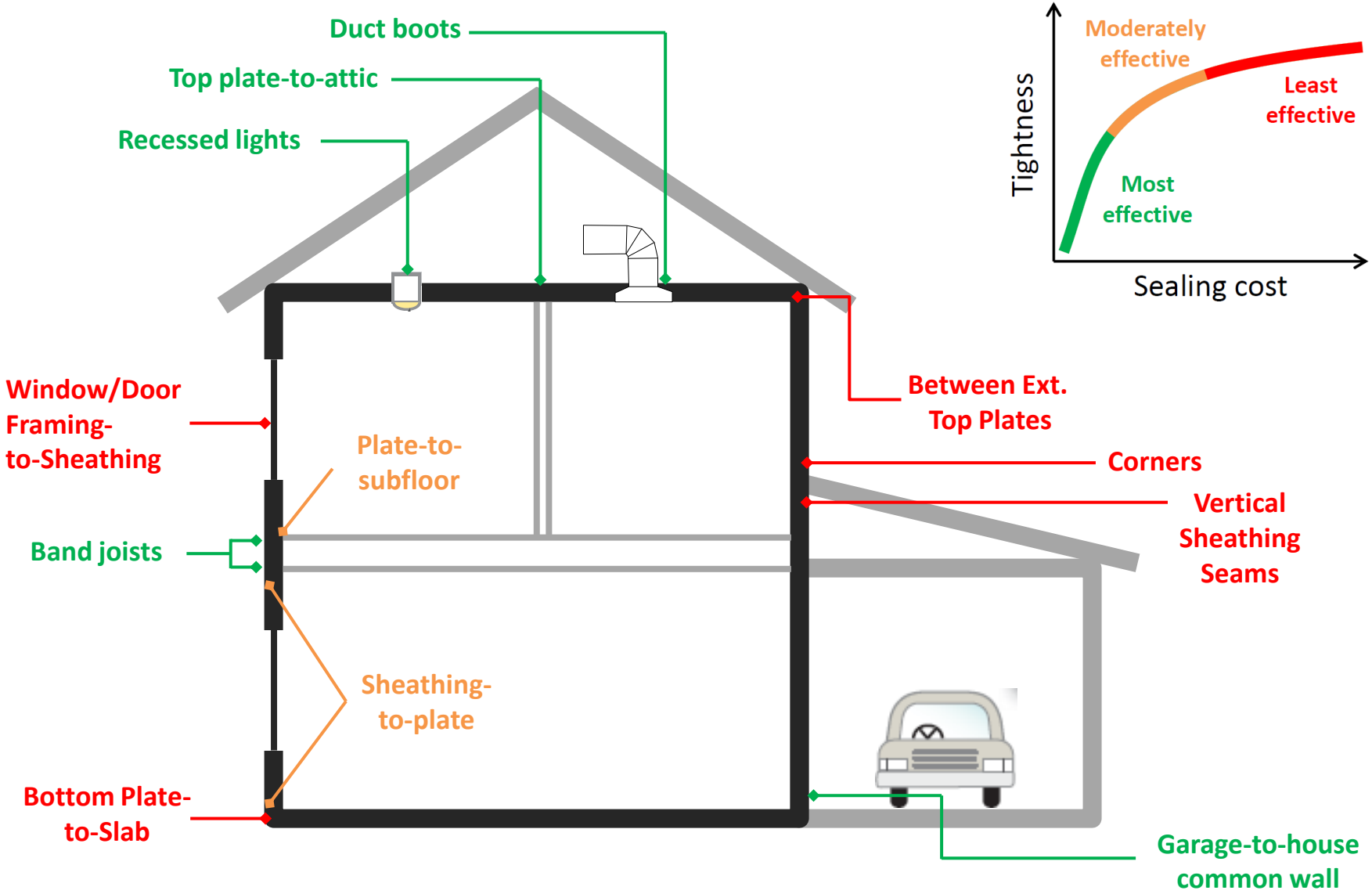
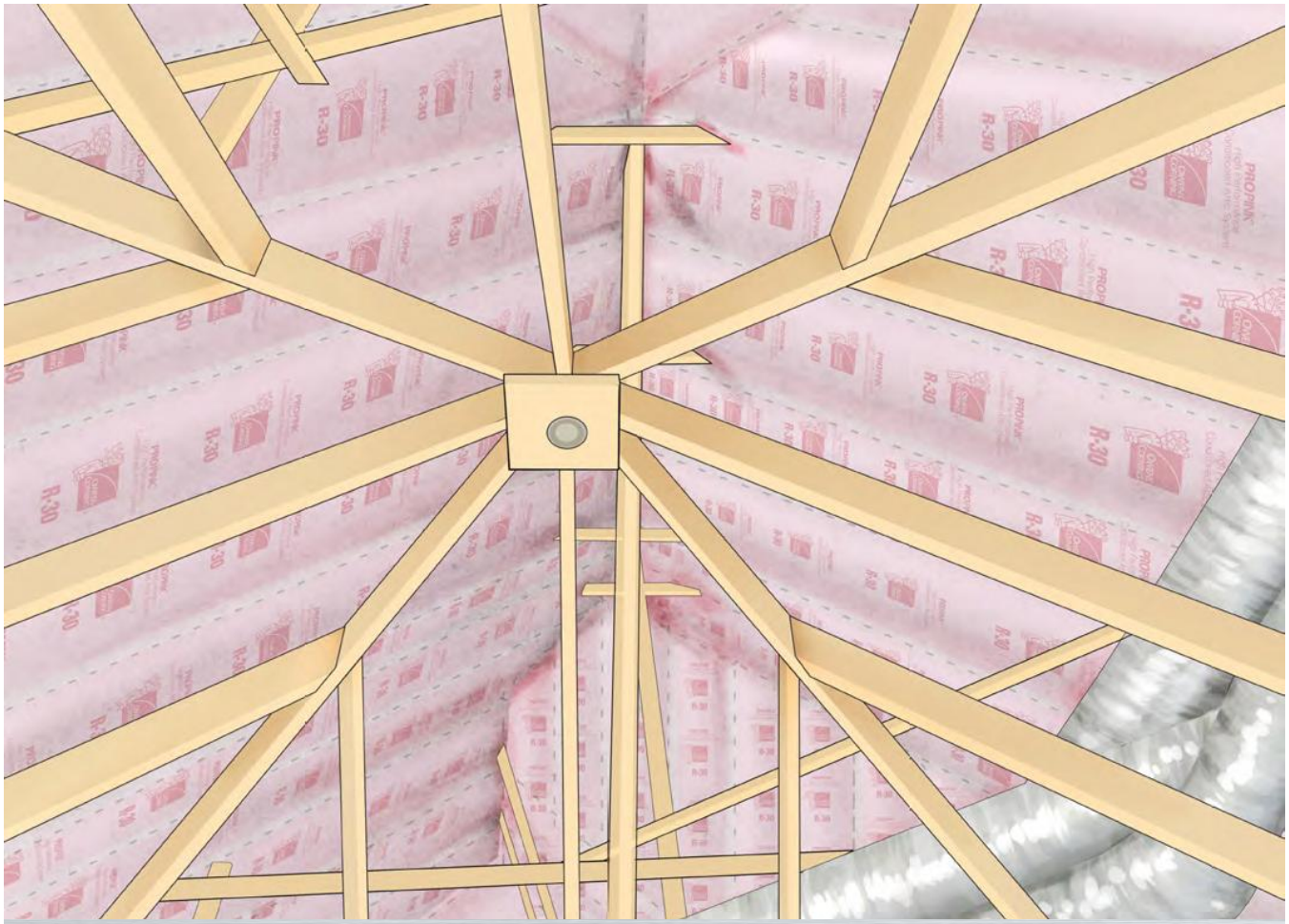
Denver, Colorado

Chapter 1 – *"Bang per Air-Sealing Buck"*



Dave Wolf, "Characterization of Air Leakage in Residential Structures", EEBA 2012



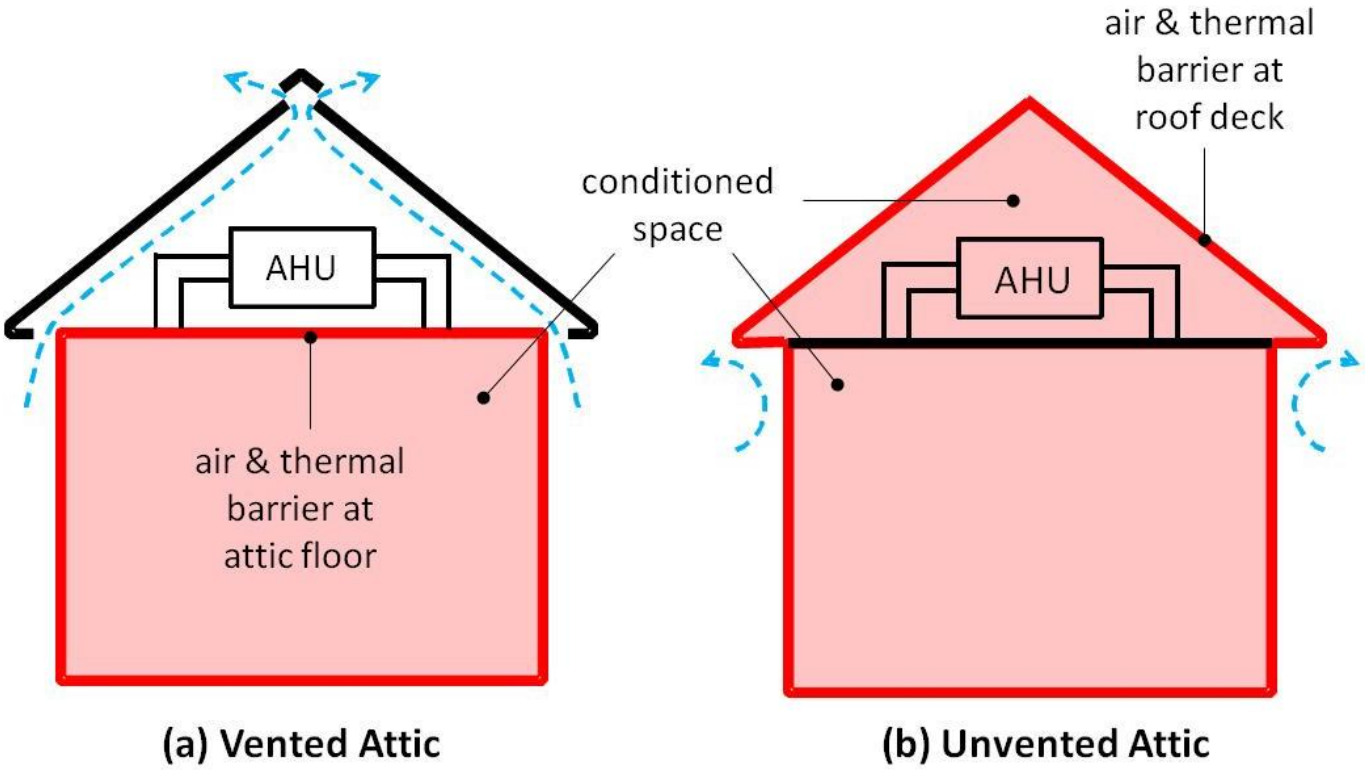
High Performance Conditioned Attic
(an unvented attic with fiberglass)

Outline

1. Primer on unvented attics (UVAs)
2. Understanding how UVAs leak
   - *A different air-barrier*
   - *Testing joints*
3. Air-Sealing

Primer on Unvented Attics

What is an Unvented Attic?



(a) Vented Attic

(b) Unvented Attic

If your ducts are located in the attic,
insulating the roof and sealing the attic saves a lot of energy.

Unvented Attics with Air-Impermeable Insulation

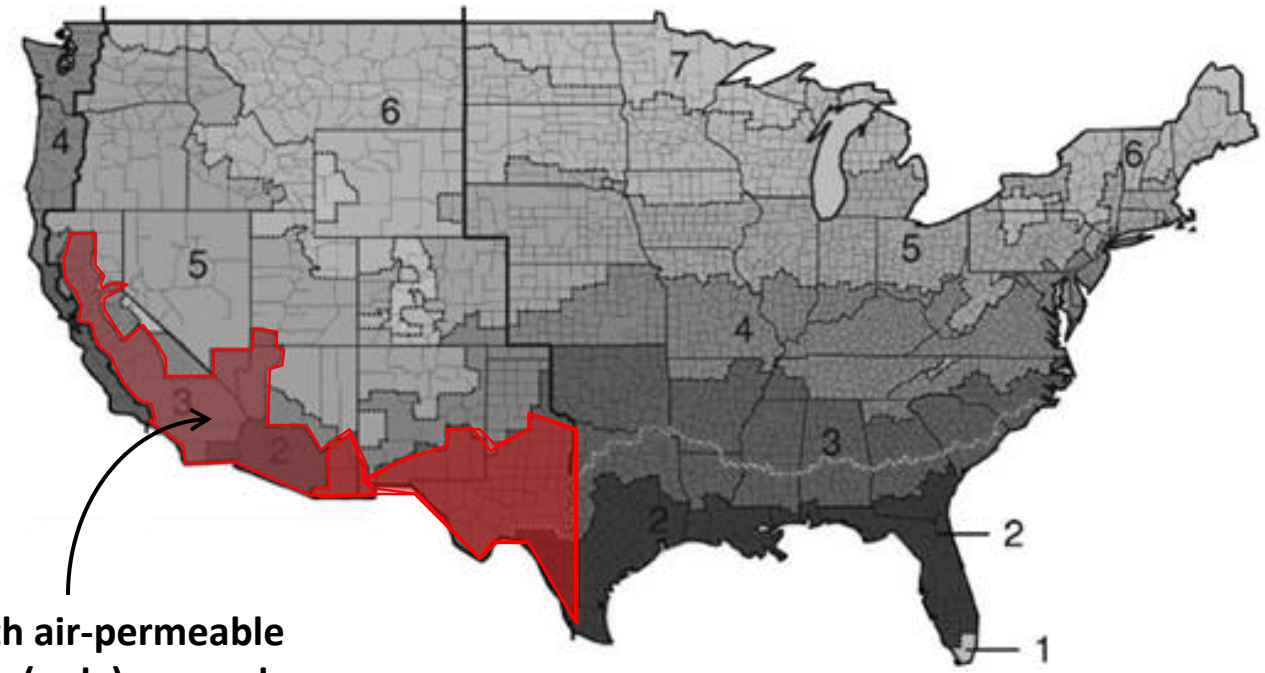
Open Cell Spray Foam

Unvented Attics with *Air-Permeable* Insulation

Cellulose

Blown Fiberglass

Air-Permeable UVA - *Limited by Condensation & Code*



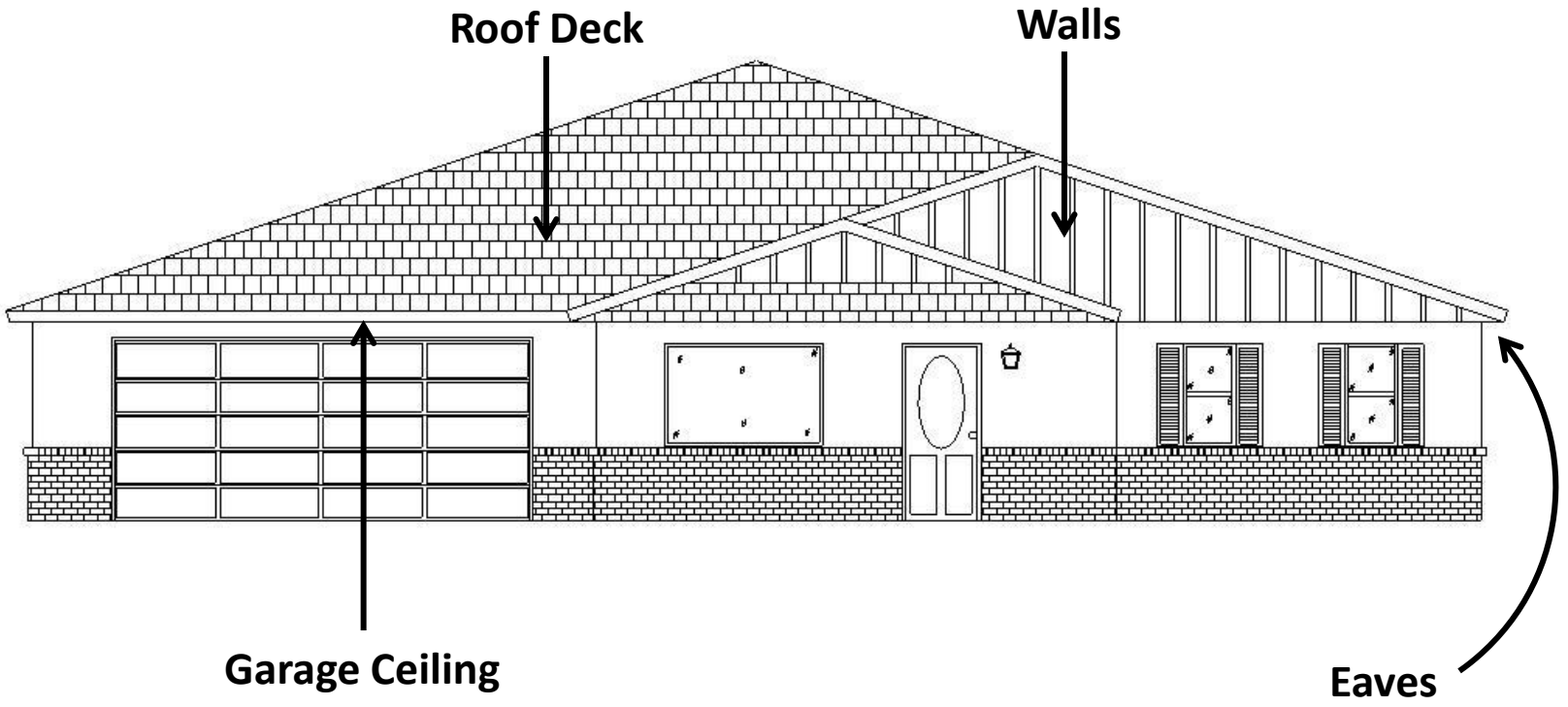
UVAs with air-permeable insulation (only), are only allowed by code in climate zones 2B & 3B, with a tile roof.

Why Study Air-Leakage in UVAs with Air-Permeable Insulation?

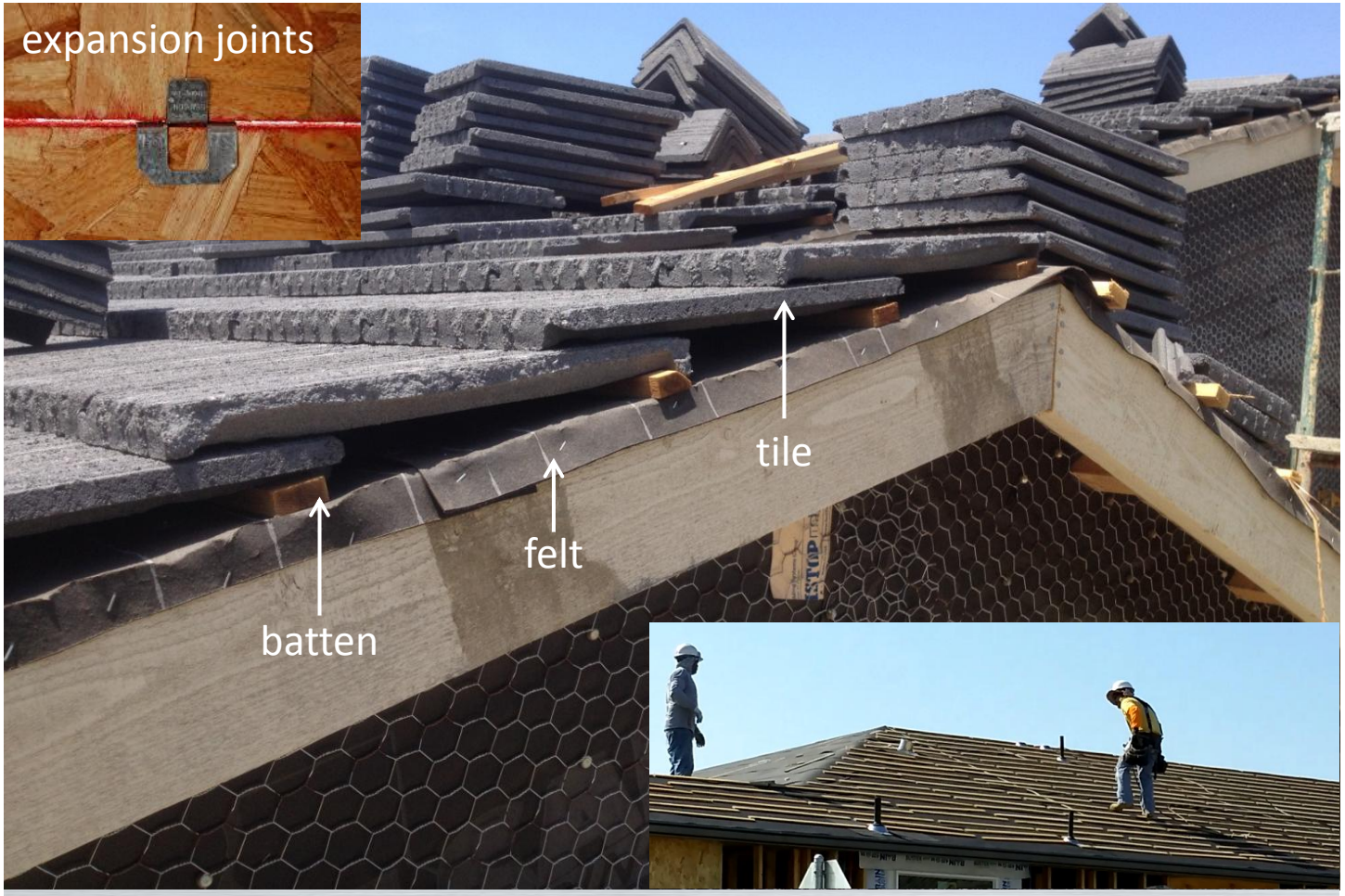
Understanding Air-Leakage in Unvented Attics

A different air barrier

Areas to Consider

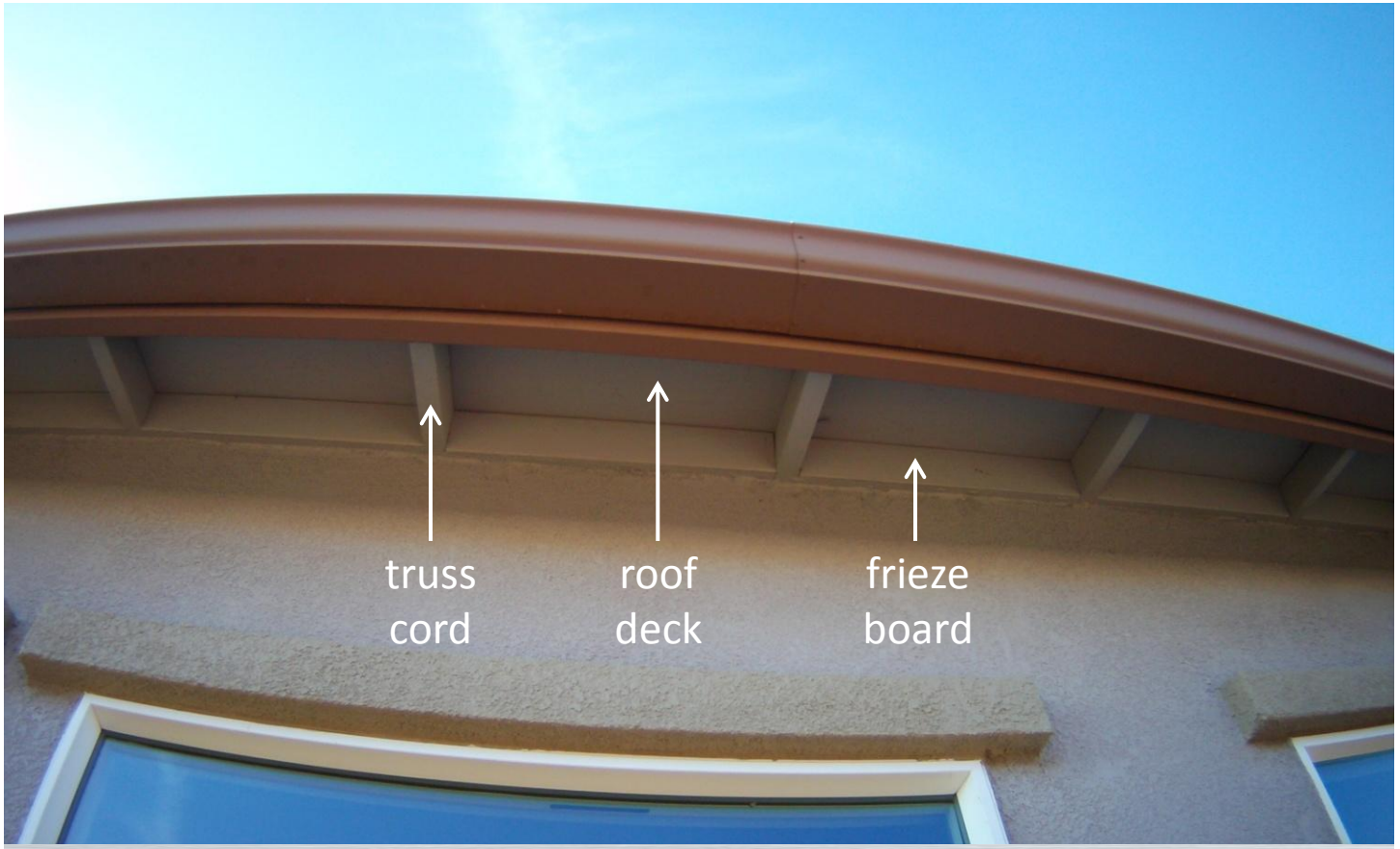


Tile Roof Construction



Is this a good air-barrier?

Eave Construction



Complicated geometry
A lot of joint length

Walls

Gables

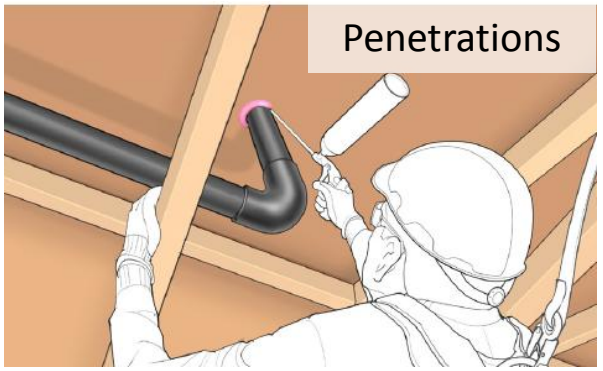
Attic Partitions

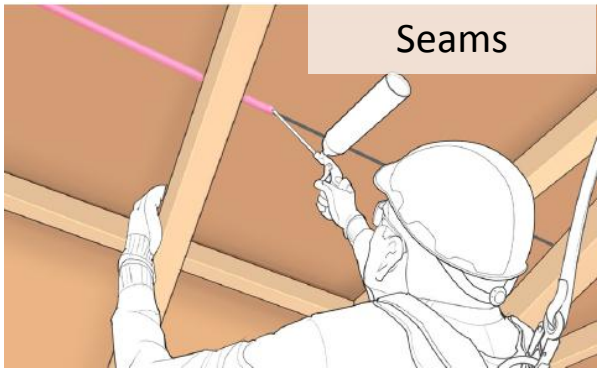
Garage Ceiling (and Walls)

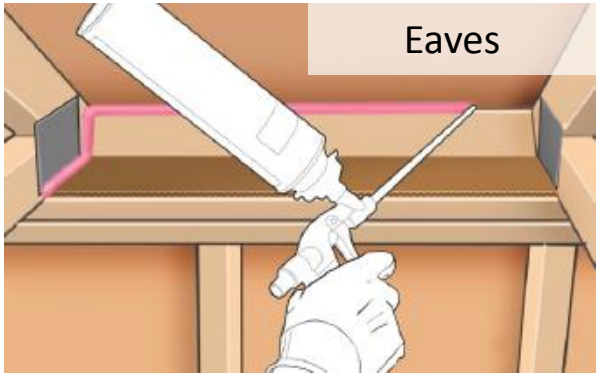
Fewer ceiling penetrations.
Garage walls communicate with attic.

Current Air-Sealing Recommendations

Seal <u>all joints</u> along the roof deck and eaves using <u>gun foam</u>.







Understanding Air-Leakage in Unvented Attics

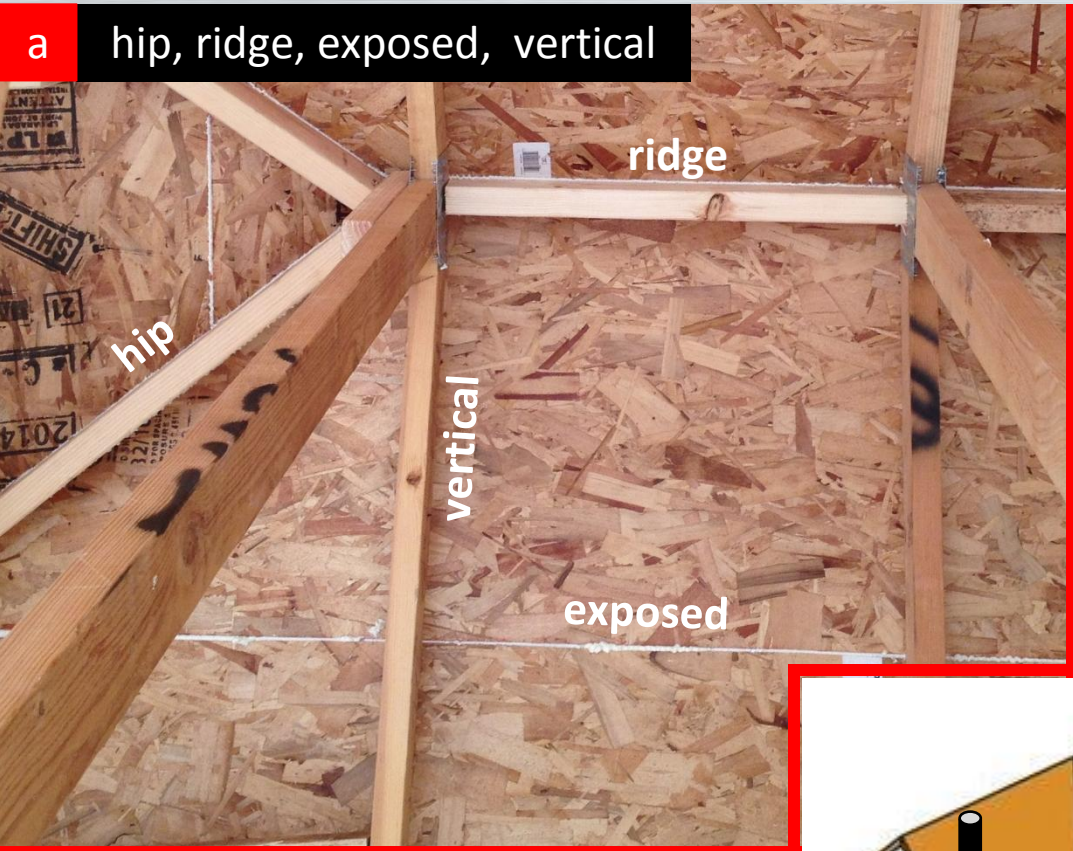
Testing Joints

Some Questions to Answer

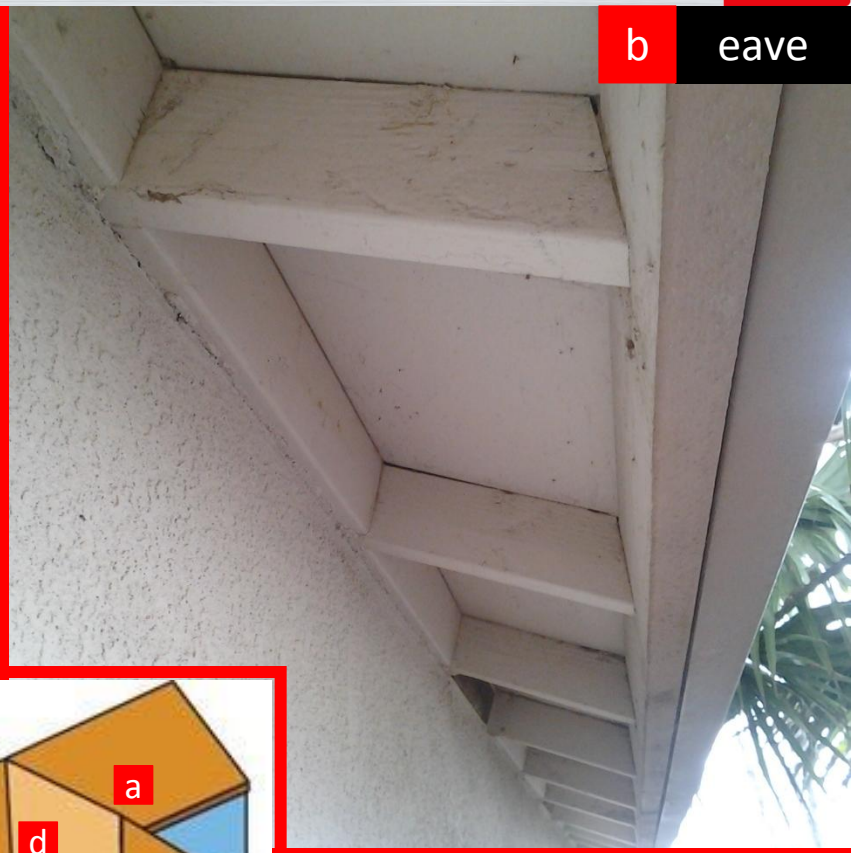
- *What are the joints?*
- *How much do different joints leak?*
- *How does the roofing membrane affect air-leakage?*
- *How much can we reduce air-leakage?*

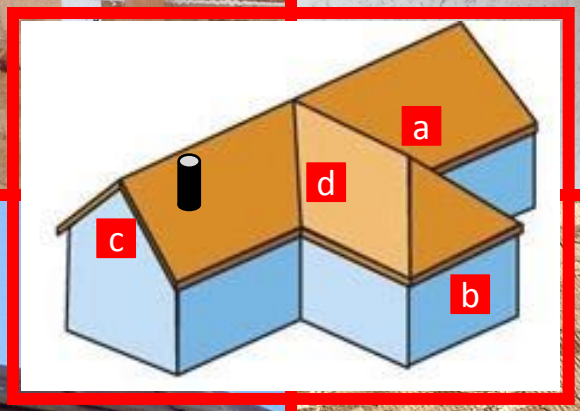
Joints Investigated

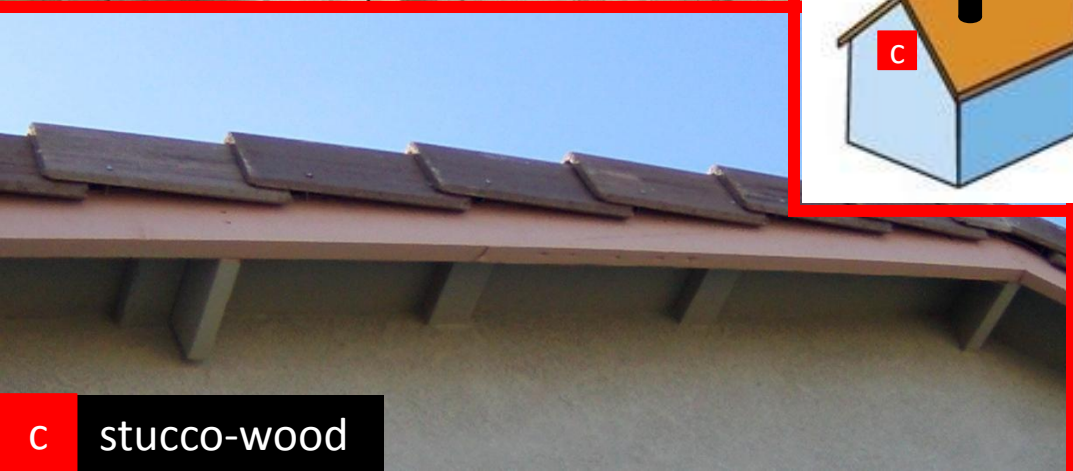
a hip, ridge, exposed, vertical



b eave







c stucco-wood

d valley

Mimicking Air-Leakage on Lab Scale

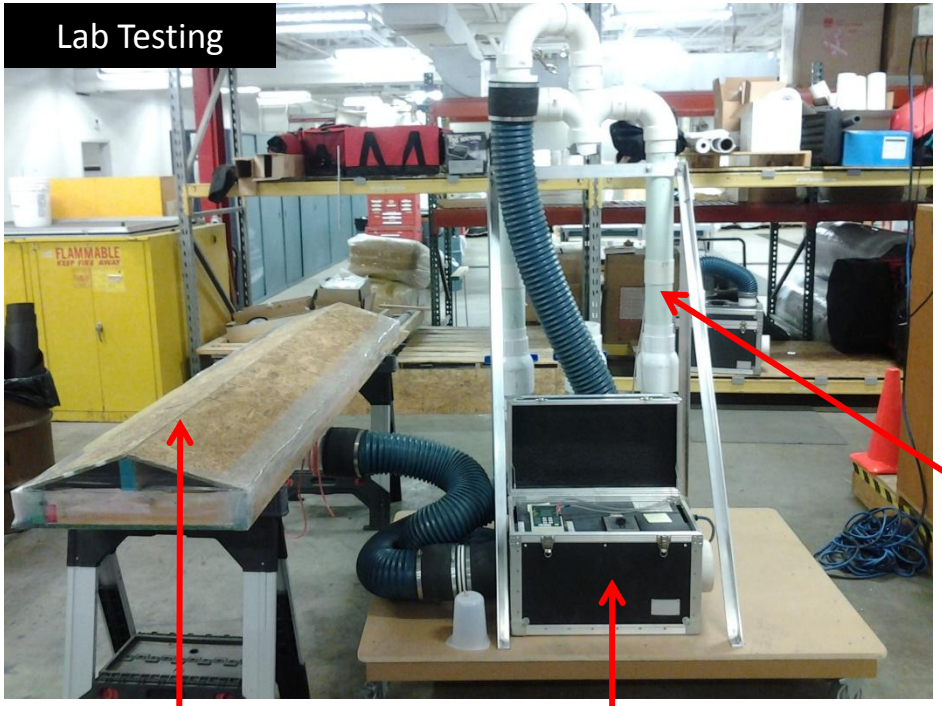
valley

exposed

stucco-wood

hip

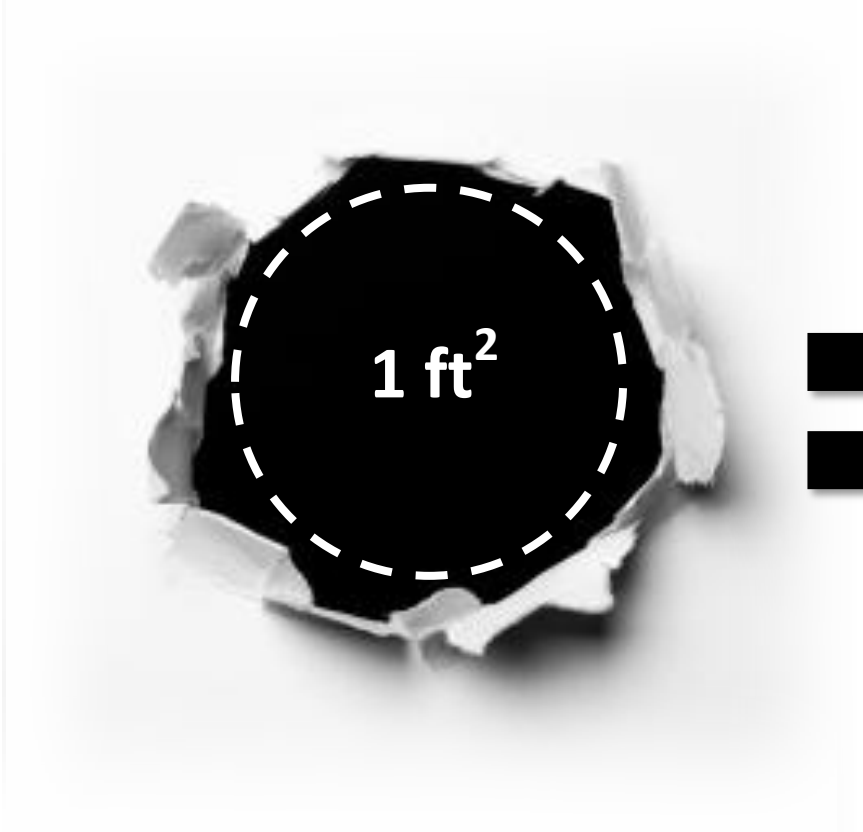
Testing Joint Mimics



Quantifying Joint Air-Leakage:

- Build sealed plenum & joint
- Apply ΔP to joint
- Measure CFM across orifice

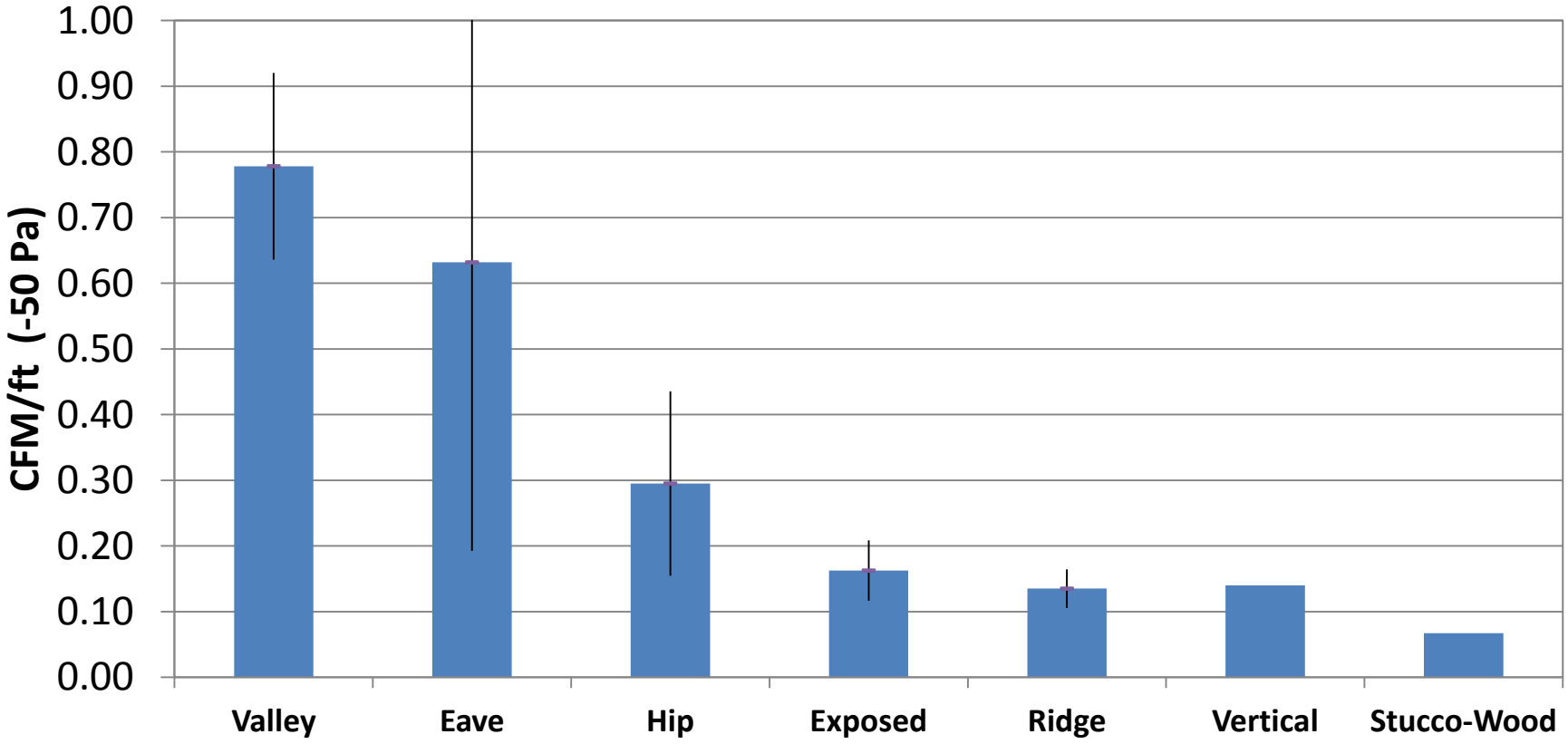
Let's Not Forget About Big Holes……. *They Matter!!*



1101 CFM
(50 Pa)

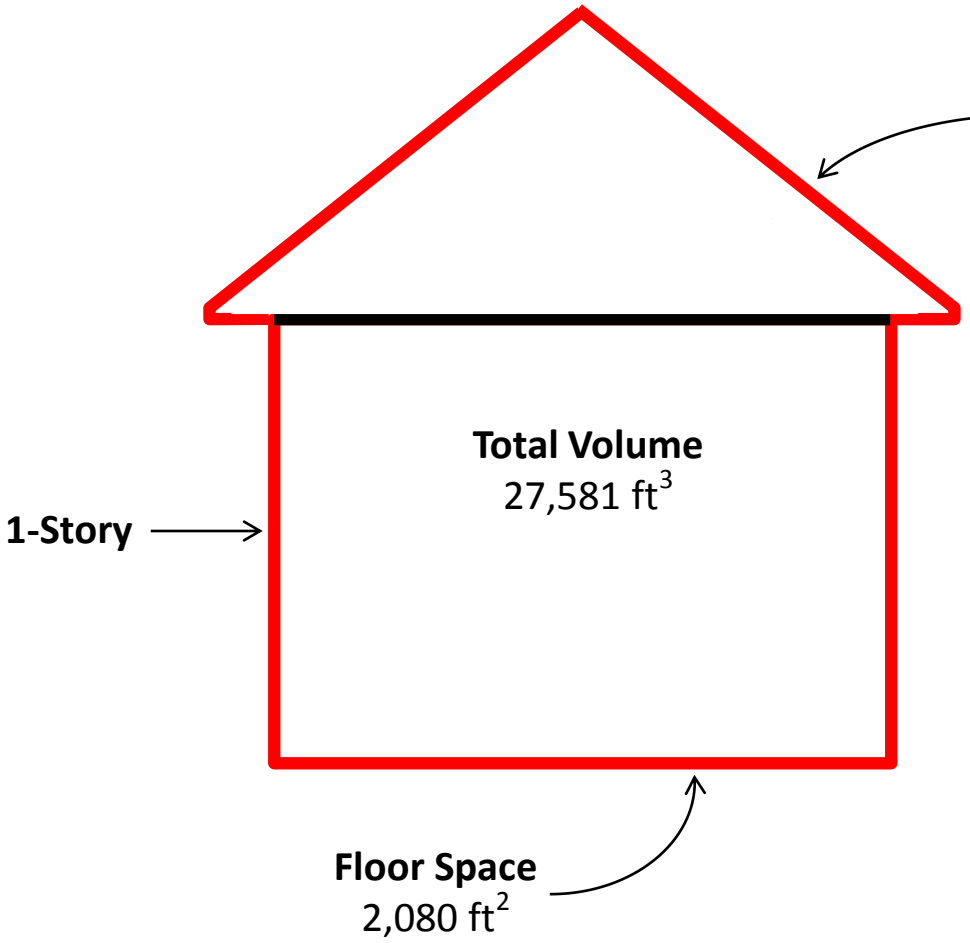
Big Hole Example

Joint Leakage Results (-50 Pa)



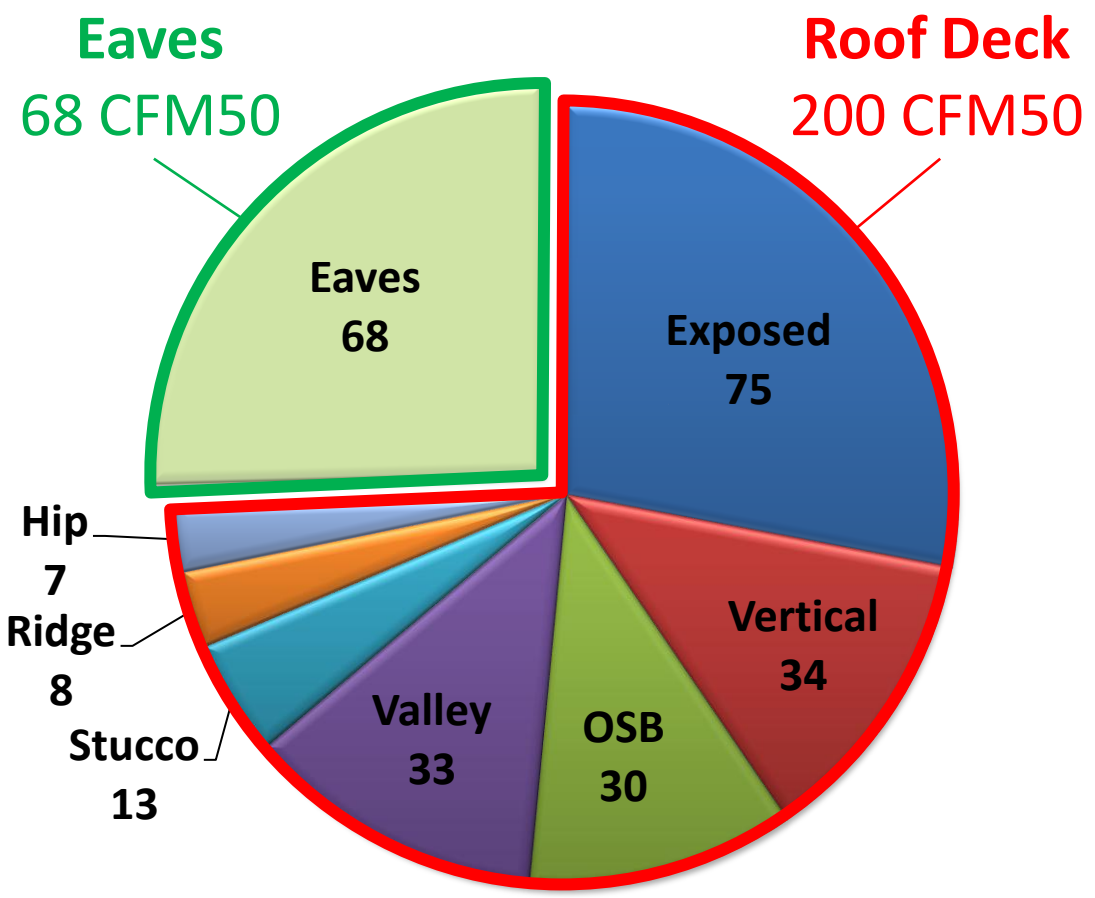
Complex Geometry ← → *Simple Geometry*

Leakage Reduction for an “Average” House



Total Joint Length	1,027 ft
Exposed	469 ft
Vertical	240 ft
Stucco	192 ft
Eaves	108 ft
Ridge	61 ft
Valley	43 ft
Hip	24 ft

Leakage Reduction in “Average” House (CFM50)



Reduction ≈ 0.4 ACH50

Insights on How Joints Leak

- Roof deck joints leak more at positive pressures because the felt billows away from joint.

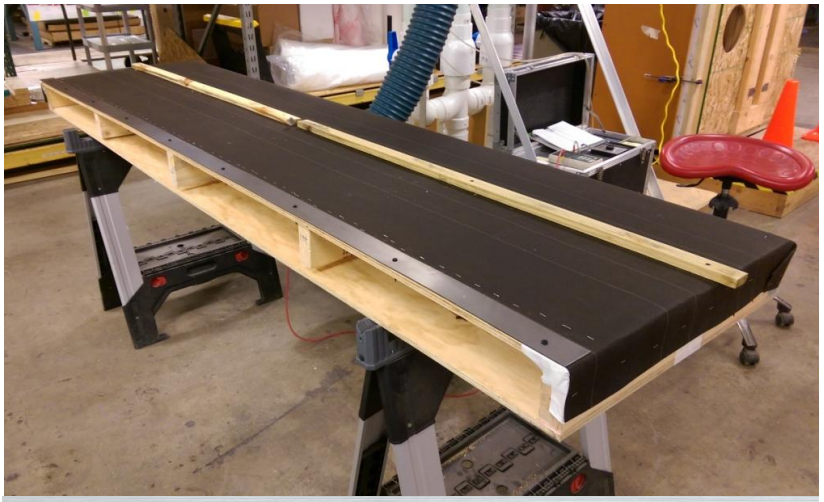
- Air between the felt and roof deck does not always take the shortest route in or out.
  - Battens direct air laterally toward rakes & valleys, away from nearby seams
  - Valleys, ridges, & hips direct air along the crease of a joint

Understanding Air-Leakage in Unvented Attics

Air-Sealing

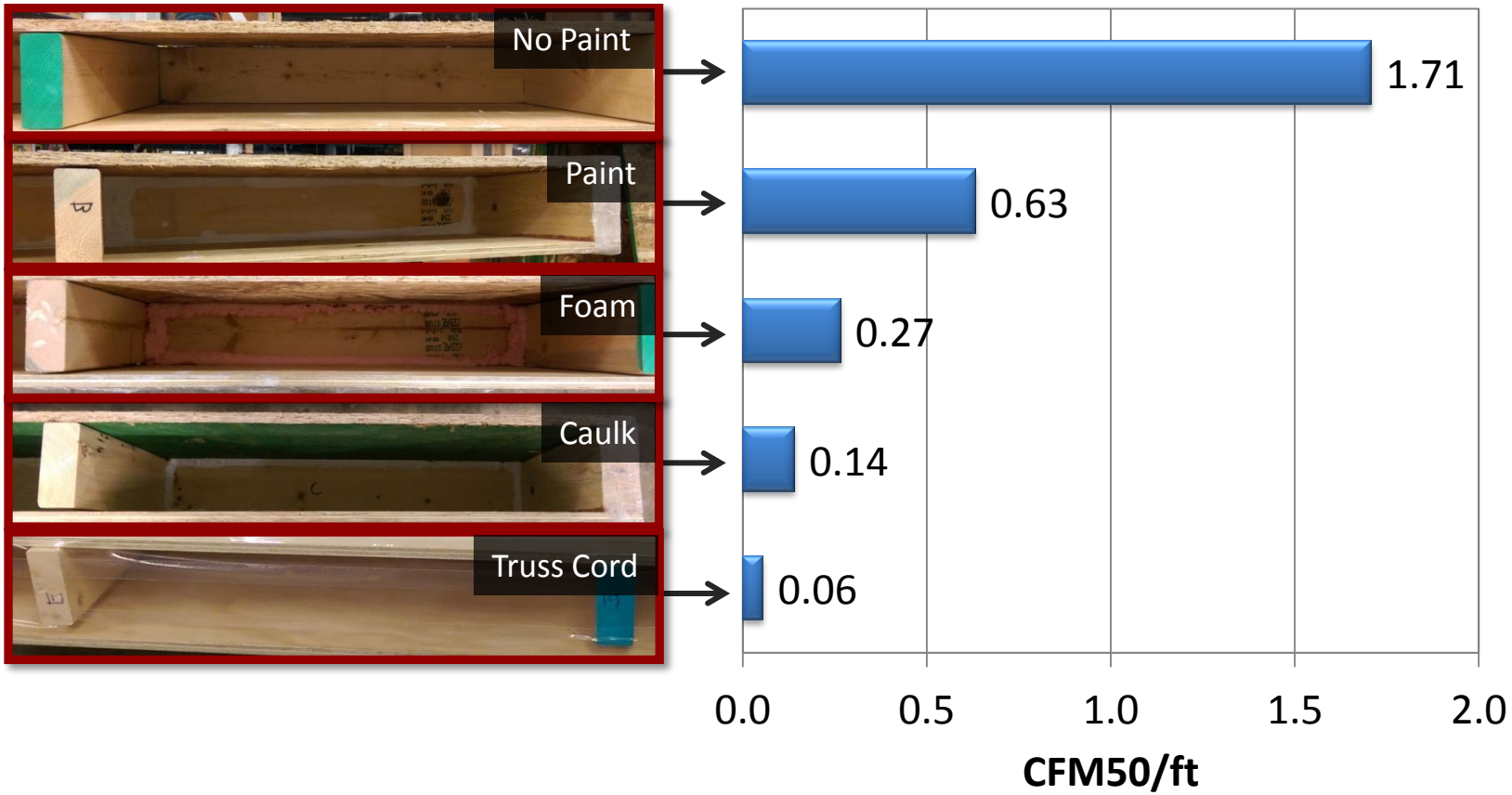
Prototyping Venues

Mock Attic



Joint Mimic

Sealing Eaves – *"What sealant should I use?"*

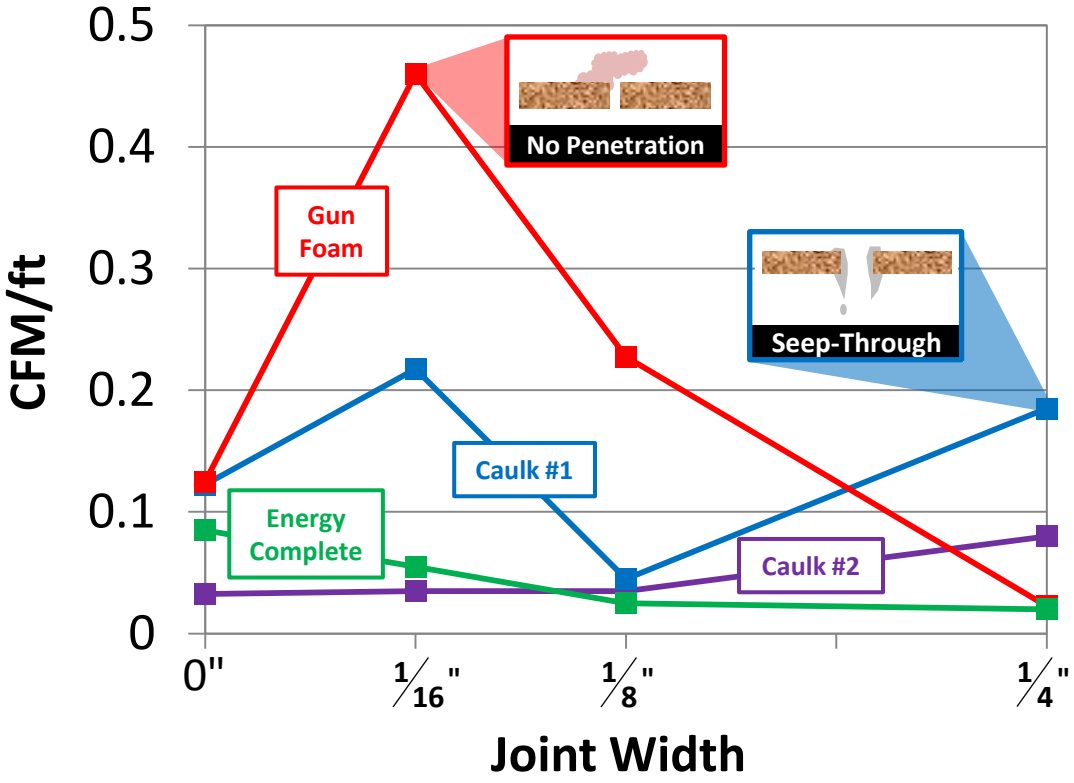


Findings

- Paint reduces eave leakage by ≈ 60% (compared to bare wood).
- Eaves with caulk have ½ the leakage of eaves with foam.
- Precise application is difficult with can foam, easy with caulk.
- Leakage over truss chord is negligible.

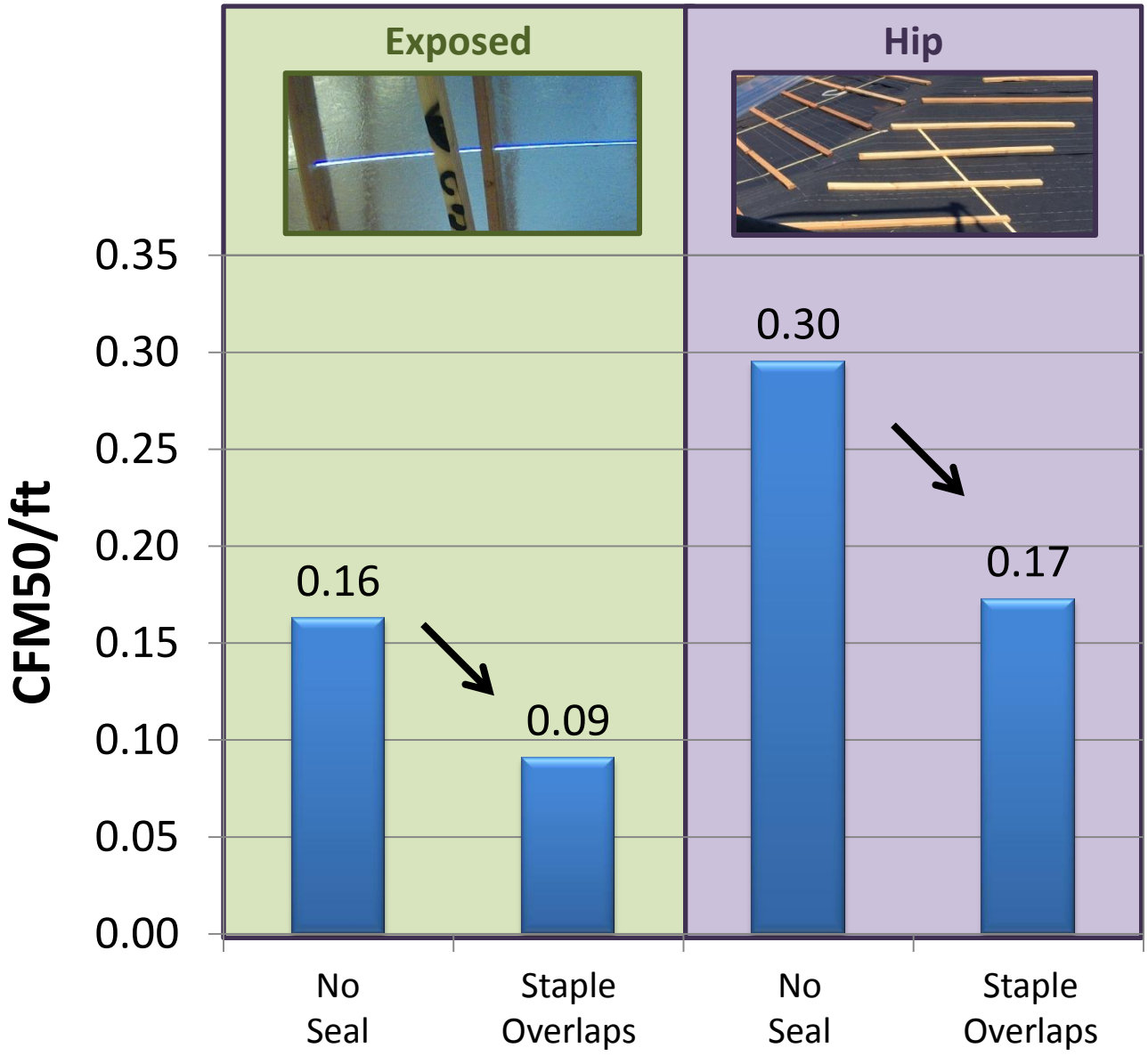
(≈ 0.06 CFM/ft of eave)

Impact of Joint Width on Sealant Effectiveness

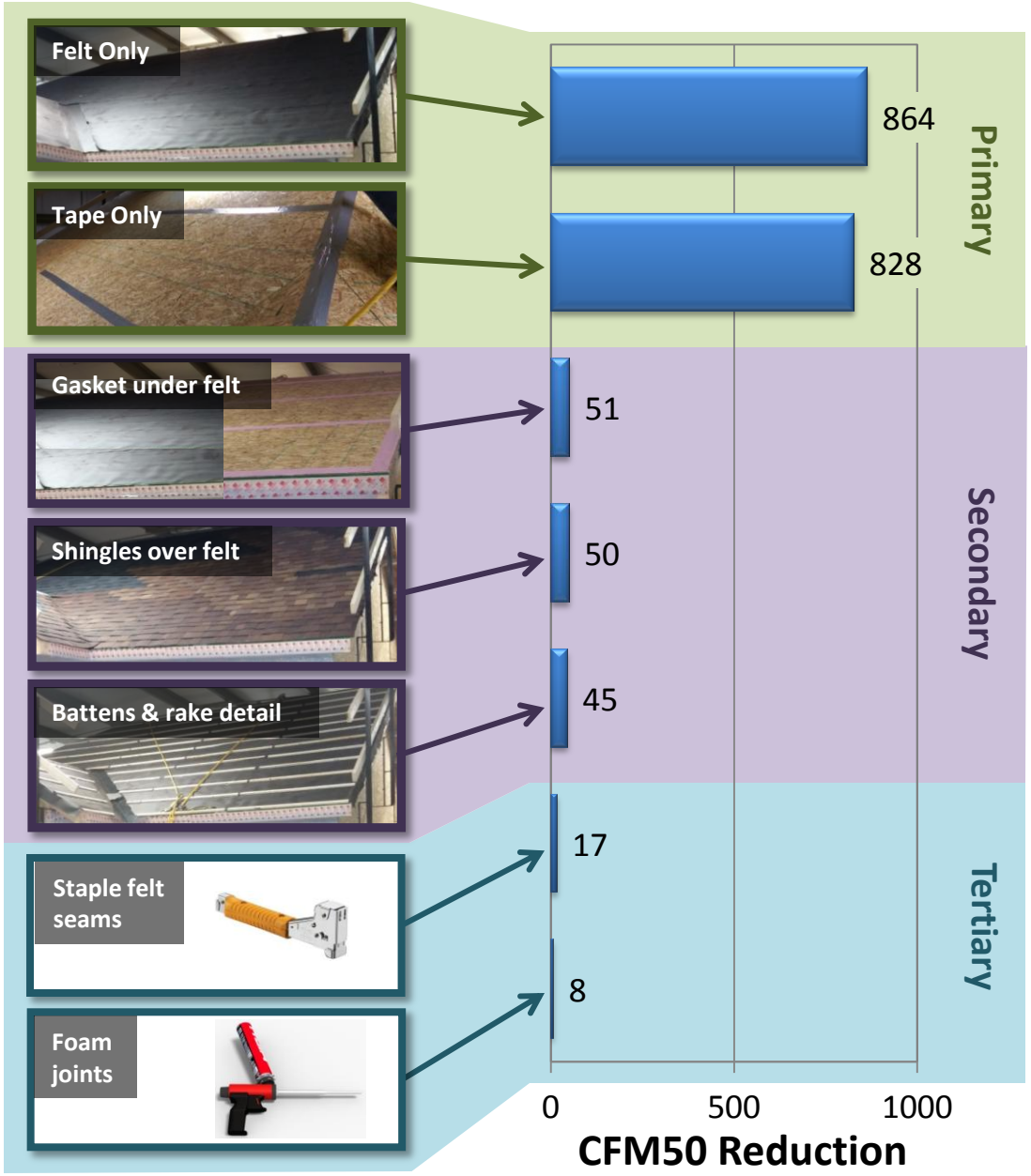


Sealant effectiveness varies by joint width.

Sealing Deck Joints – *Stapling Felt as an Alternative*



Sealing the Roof Deck



Findings

- Successive "layers" of roofing materials yield diminishing returns.
- Tertiary sealing measures had small/moderate impact (< 150 CFM50).
- Felt & battens provided a good baseline seal.
- No Silver Bullets.
- Final air-tightness was insensitive to increased leakage of bare roof.

Notes

- Mock roof deck = 800 sq ft
- Actual roof deck = 2400 sq ft
- Adjust results by 3x

Summary

- **Existing air-barrier** for air-permeable UVAs is typically air-tight relative to walls and code.
- **Roofing membrane** is an air-leakage “safety-net” for framing irregularities.
- Sealing **roof & eave joints** may not yield big gains.
- **Complex framing** correlates with increased air-leakage.

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Acknowledgements

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