

Comparing spray foam, AeroBarrier, & other air sealing options in new & existing homes



In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

“This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code /1 hour energy** continuing education requirements.”

For additional continuing education approvals, please see your credit tracking card.

Overview

- How tight is tight?
- How do we measure tight?
- Tight where? Exterior, interior, interstitial?
- Sticky stuff
- Sticky stuff versus gaskets...
- New vs. existing
- Tools of the trade: blower doors, duct blasters, theatrical fogging, and IR cameras
- Tightness and ventilation...
contradiction in terms?

ASTM E 2178 & 2357

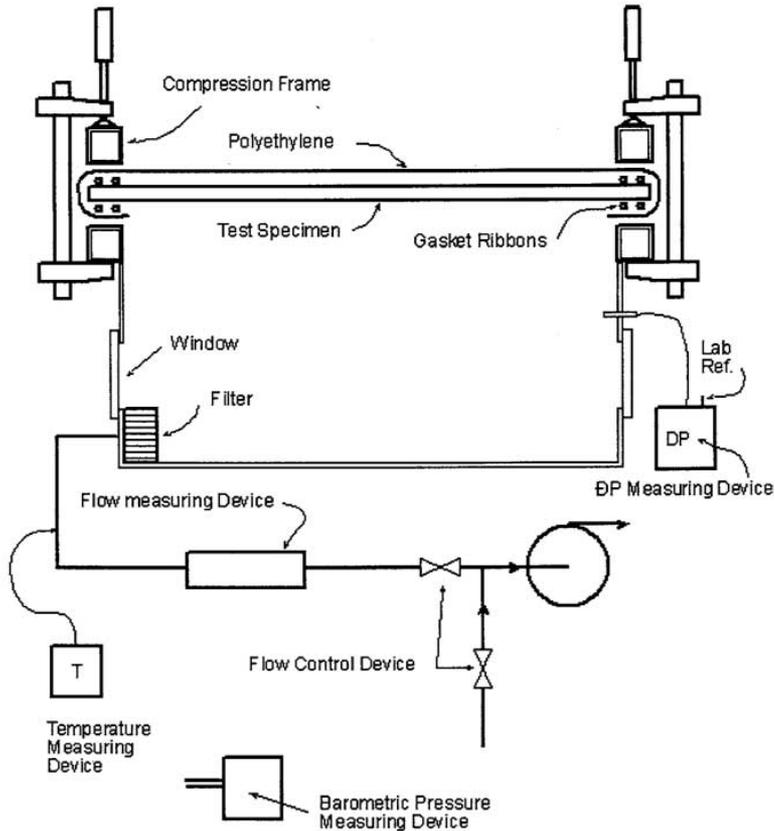
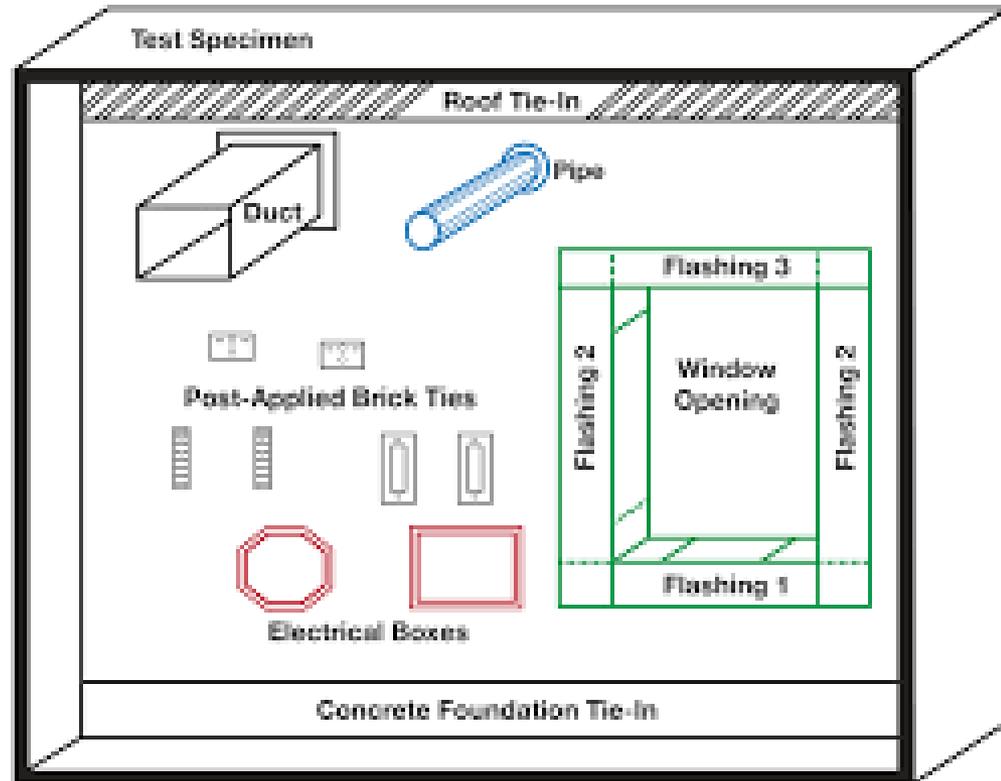


FIG. 1 General Configuration of Test Apparatus



0.004 cfm/ft.² @ ΔP 0.3 in. w.g.(1.57 psf) (75 Pa)

0.04 cfm/ft.² @ ΔP 0.3 in. w.g.(1.57 psf) (75 Pa)

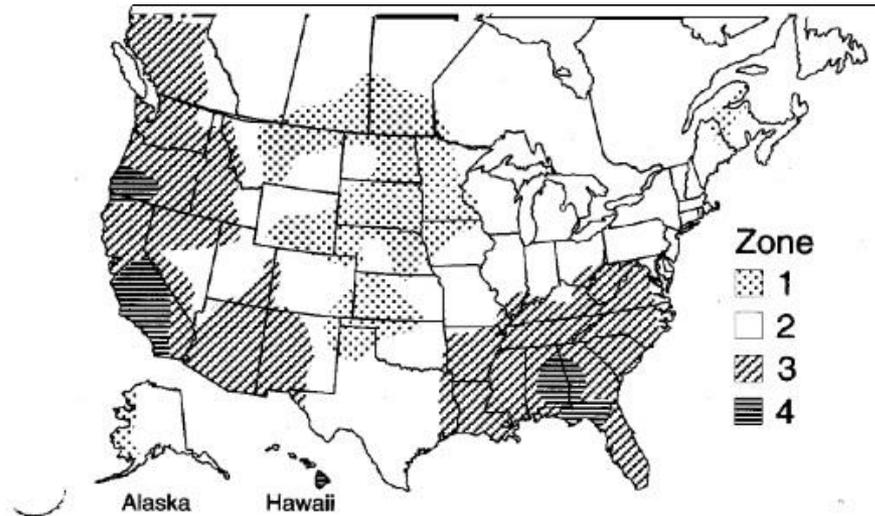
“What does the blower door number mean?”

- cfm50 – ACH50
- 2k sf about 2k cfm50 is 'decent'
- Old house: 2 – 3X leakier
- 10 cfm50 \approx 1 sq in



Converting/extrapolating: “nACH”

The LBL Factor



Zone	# of stories →	1	1.5	2	3
1	Well-shielded	18.6	16.7	14.9	13.0
	Normal	15.5	14.0	12.4	10.9
	Exposed	14.0	12.6	11.2	9.8
2	Well-shielded	22.2	20.0	17.8	15.5
	Normal	18.5	16.7	14.8	13.0
	Exposed	16.7	15.0	13.3	11.7
3	Well-shielded	25.8	23.2	20.6	18.1
	Normal	21.5	19.4	17.2	15.1
	Exposed	19.4	17.4	15.5	13.5
4	Well-shielded	29.4	26.5	23.5	20.6
	Normal	24.5	22.1	19.6	17.2
	Exposed	22.1	19.8	17.6	15.4

Converting/extrapolating: other metrics

Inputs	
<input type="radio"/>	Enter envelope area directly (assumes square footprint for volume calculations)
<input type="radio"/>	Enter volume directly (assumes square footprint for envelope area calculations)
<input checked="" type="radio"/>	Enter length, width and height
<input type="checkbox"/>	Use metric building dimensions
length	L 600 ft
width	W 50 ft
total height	H 50 ft (if blank - assumes 9 ft per floor)
number of floors	N 4 floors (if blank - assumes single story building)
exponent	n 0.6 (if blank - assumes 0.65)
Air leakage test result:	0.40 cfm at 75Pa per ft ² of envelope area

Assumptions: None

Air leakage test result - converted to other units	
39,203	cfm at 50Pa
50,000	cfm at 75Pa
25,864	cfm at 25Pa
4,392	EqLA (in ² at 10Pa)
2,444	EfLA (in ² at 4Pa)
2.037	EfLA (in ² at 4Pa) per 100ft ² of floor area
1.57	ACH50
0.3136	cfm at 50Pa per ft ² of envelope area
0.4000	cfm at 75Pa per ft ² of envelope area (USACE and code units)
0.3267	cfm at 50Pa per ft ² of floor area
66,606	m ³ /h at 50Pa
18,502	L/s at 50Pa
23,597	L/s at 75Pa
5.7355	m ³ /h at 50Pa per m ² of envelope area
7.3152	L/s at 50Pa per m ² of envelope area
2.0320	L/s at 75Pa per m ² of envelope area (code units)
7.3152	m ³ /h at 75Pa per m ² of envelope area

NOTE: air leakage of 0.40 cfm @ 75 Pa translates to 1.57 ACH50 (for this bldg.)

GBA blog on blower door testing

Deep Dive into Blower Door Testing

Peter Yost interviews Collin Olson from The Energy Conservatory and learns about the blower door equation exponent, depressurization vs. pressurization, using sound to assess air leakage, and more



By Peter Yost | November 25, 2019



GBA blog on blower door metrics

Is it Time to Move Away From ACH @50 Pascals?

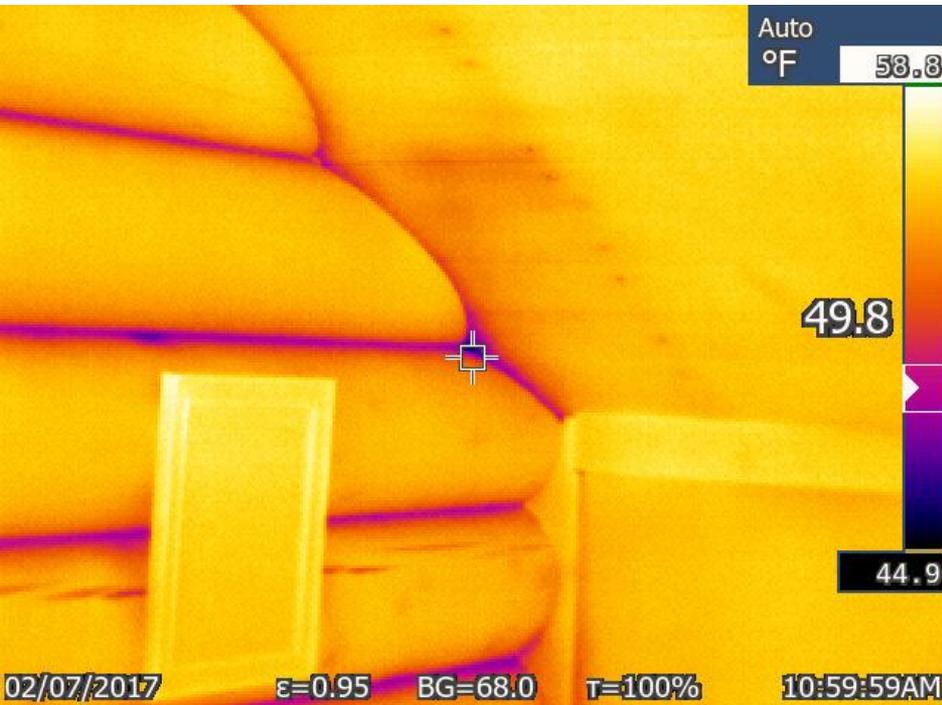
Momentum is building to abandon ach50 in favor of cfm50 per square foot of shell area



By Martin Holladay | September 14, 2018

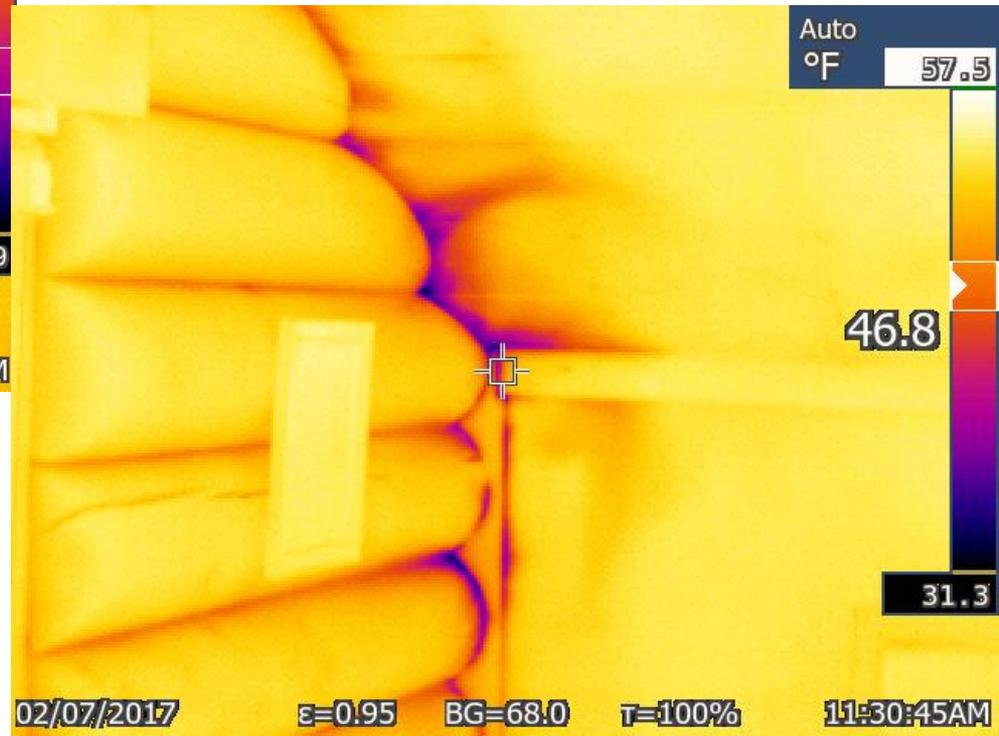


Combining IR & Blower Door



Blower door off

Blower door on (-50 Pa)



11:30:45AM

Theatrical fogging



Air control layer: exterior Huber ZIP sheathing

Steve Baczek, Architect



Air control layer: exterior Henry Blueskin

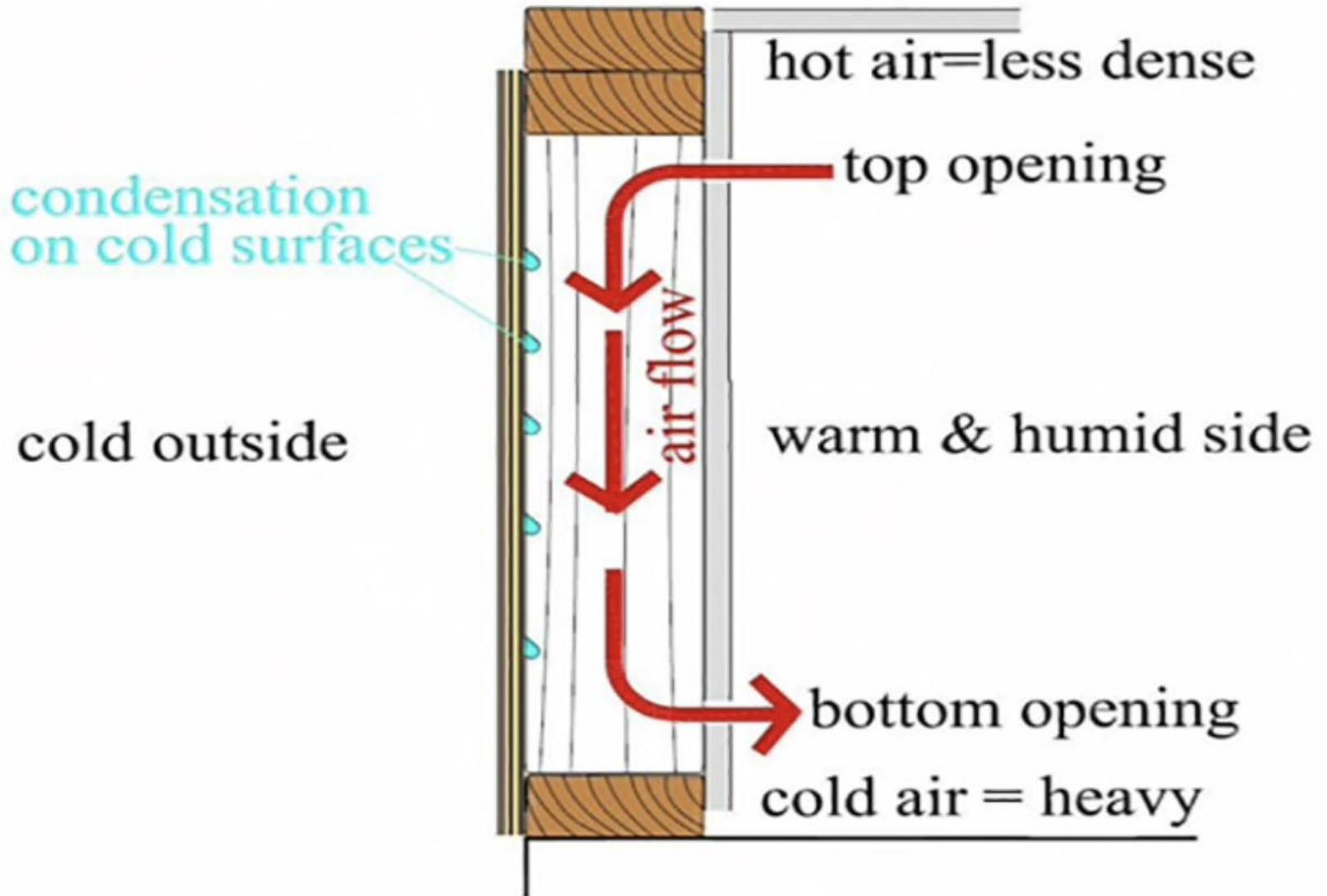


Air control layer: interior

475 Pro Clima Intello Plus



Air control layer: interior



Credit: Building Science Corporation

Air control layer: interior Airtight Drywall Approach (ADA)



Air control layer: interstitial (cavity)



Open cavity spray foam

Closed cavity injection foam



Henri Fennell

Sticky Business...

Liquid sealants



PSA tapes



Mastics – liquid flashing



Fluid-applied membranes

It all started innocently enough...

Bird's-Eye View

Key Materials

Builder Tips

ADHESIVE/SEALANT

Low-VOC construction adhesive [+ more](#)

BRICK VENEER

Brick is like a big hard sponge — let it dry, and everything is OK [+ more](#)

RIGID INSULATION FOR WALLS

Types of rigid insulation [+ more](#)

SHEATHING DRAINAGE MAT

Alternatives to sheathing drainage mat [+ more](#)

SILL SEALERS

Thicker sill sealers are better [+ more](#)

SILL SEALER

Sill sealer keeps sills or bottom plates away from concrete [+ more](#)

CONTINUOUS BEAD OF SEALANT

Which caulks and sealants works best, and where? [+ more](#)

CAVITY INSULATION

Which insulation is greenest? [+ more](#)

1/2" GYPSUM BOARD

Greener choices exist [+ more](#)

INTERIOR FINISH

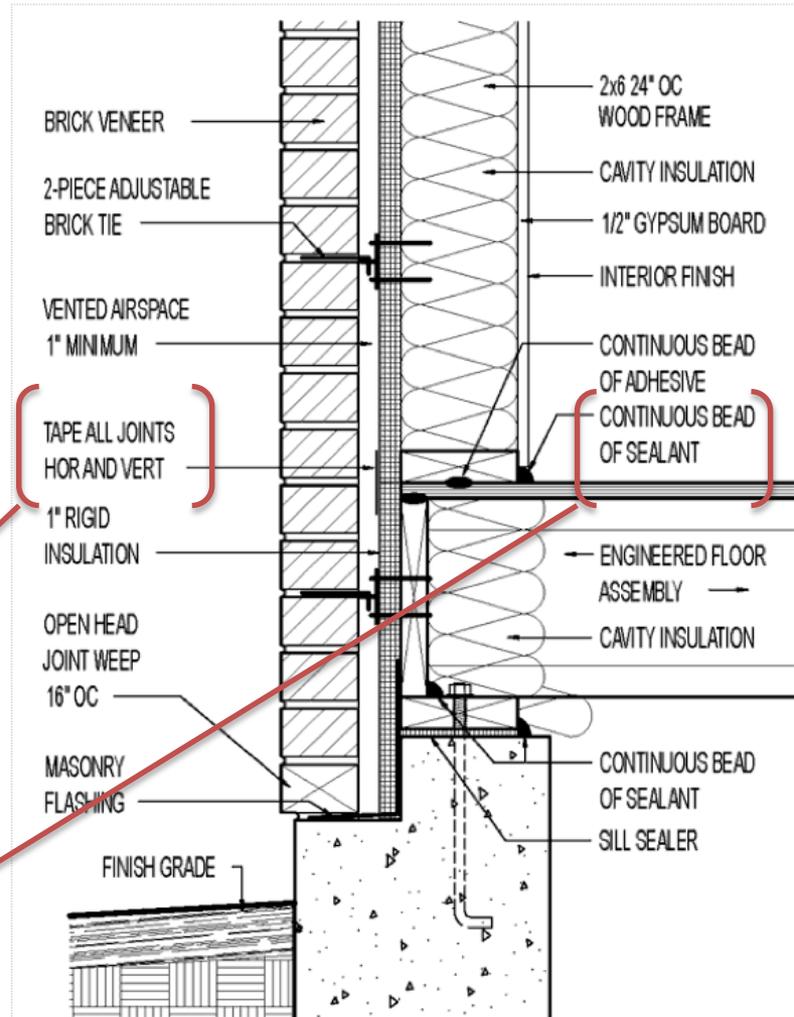
Let interior finishes let the walls dry [+ more](#)

2-PIECE ADJUSTABLE MASONRY TIE

Two-piece ties hold better; stainless steel lasts longer [+ more](#)

DRAWING DETAIL

Download: PDF | DWG



“TAPE ALL JOINTS
HOR AND VERT”

“CONTINUOUS BEAD
OF SEALANT”

Click to Enlarge

Sticky Business...



NEWS KNOWLEDGE BASE - CONSULTING PRODUCT GUIDANCE CONTINUING EDUCATION PEER NETWORKS

Enter terms

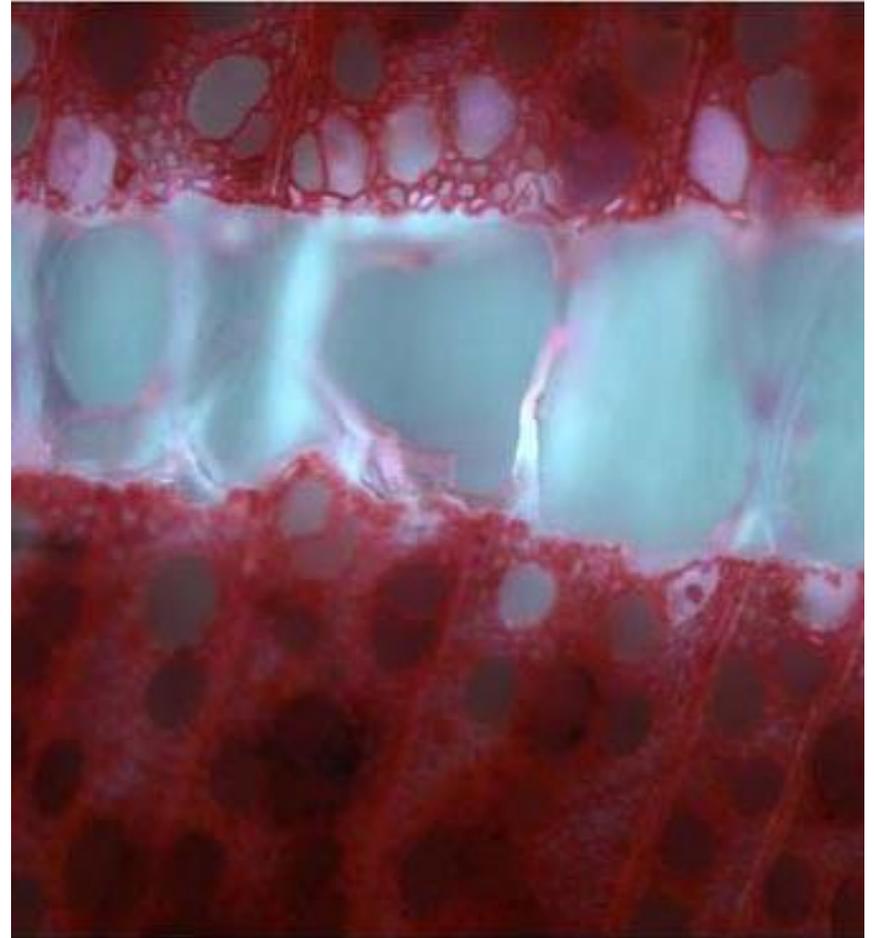
Did you mean

[stick business](#)

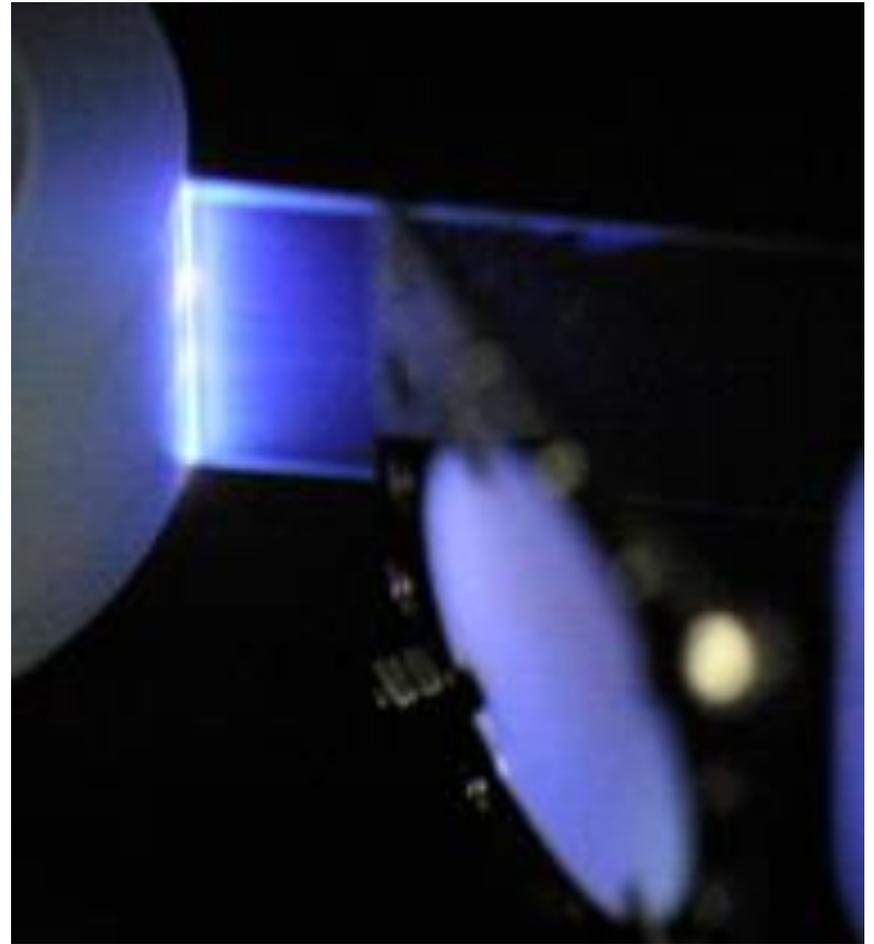
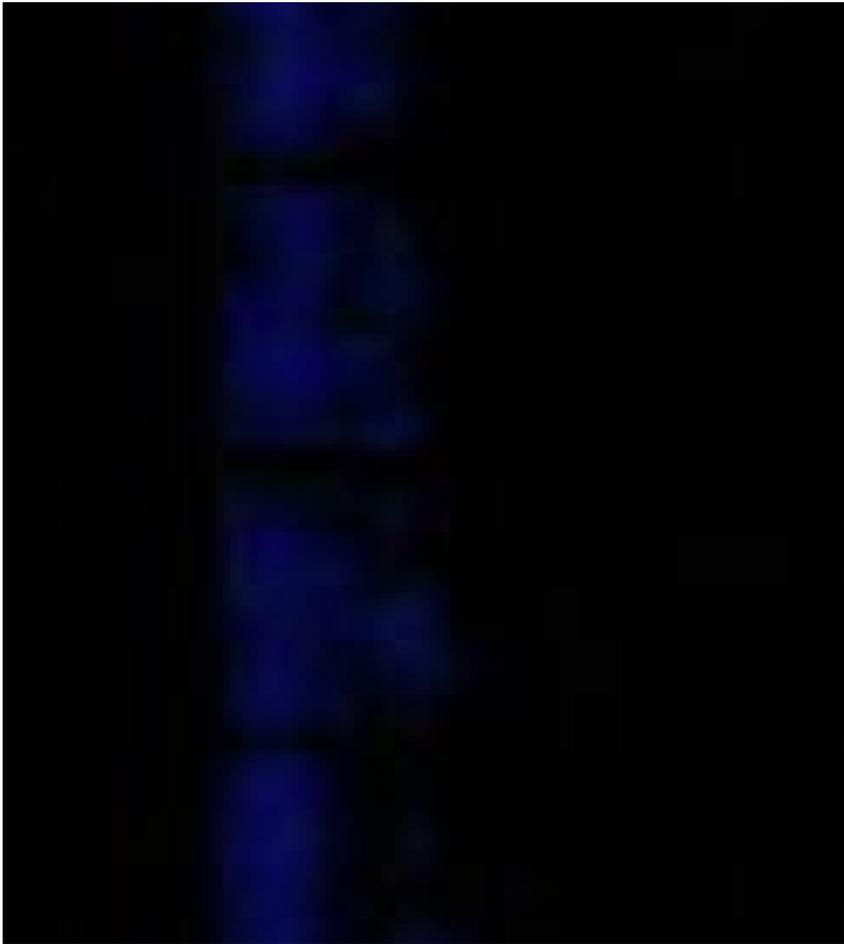
- [Stickiness Explained! Making Building Tapes and Membranes Stay Put](#)
BLOG POST
When you use tape to seal a seam or flash a sill, you need peel-and-stick performance—not “stick-and-peel.”
- [Our Real-World Flashing Tape Tests Find a Clear Winner](#)
BLOG POST
We took the best PSA tapes from our last round of testing and worked them over on rough OSB and window flanges. One tape worked no matter what.
- [Testing Pressure-Sensitive Tapes: Rounds Two and Three](#)
BLOG POST
Tension and pressure, tears and creeps. The Wingnut Test Facility (WTF) gets dope-slapped in our latest round of experiments.
- [4 Insider Tips for Choosing Flashing Tapes, from a Real-Life Engineer](#)
BLOG POST
A research engineer at Pella Windows finally offers some adult supervision for our benchtop tape tests.
- [Shocking Truth About Tapes Emerges from Wingnut Test Facility!](#)
BLOG POST
Think you understand pressure-sensitive adhesives? Think. Again. (EDITOR'S NOTE: Do not try this at home.)
- [Sustainable Sealants: The Challenges of Predicting Service Life](#)
BLOG POST
Caulk joint sealants can be a major deciding factor in how long your building envelope lasts. Is there a better way to predict how long the sealants last?
- [3 New Ways to Learn Building Enclosure Commissioning](#)
BLOG POST
With the need for BECx rising, the industry is working to train designers and other specialists to do the job.
- [Adhesives and Sealants: Performance First, but Materials Matter](#)
BLOG POST
Exterior adhesives and sealants are formulated for performance, but some contain chemicals that pose risks to unprotected workers or the environment.
- [Sealing Without Stickum: Gaskets Make a Place for Themselves](#)
BLOG POST

Why are some things “sticky?”

- Physical bonding (both substances stay the same)
 - Polymers (big chains of repeated content) that can “wet”
 - “Favorable thermodynamic surface energies”
 - Molecular mobility



Why are some things “sticky?”



We're not completely sure...but cool stuff like triboluminescence!

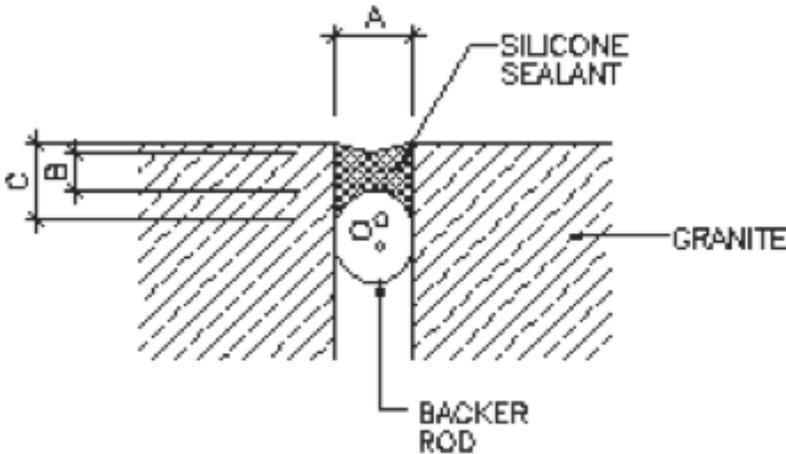
Liquid Sealants

- Sticky
- Flexible
- Non-compressible
- Adhered to two surfaces only
- Bond break with support

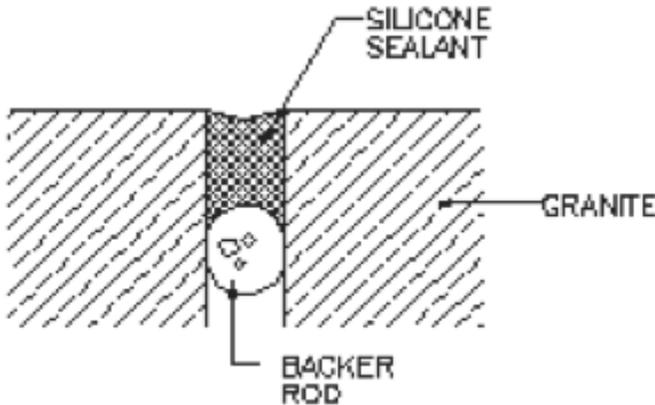
Liquid Sealants

CONVENTIONAL MOVING WEATHERSEAL

GOOD JOINT DESIGN



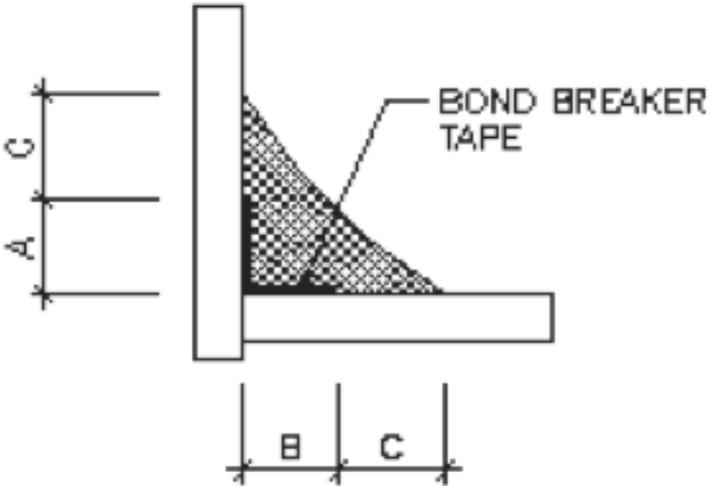
POOR JOINT DESIGN



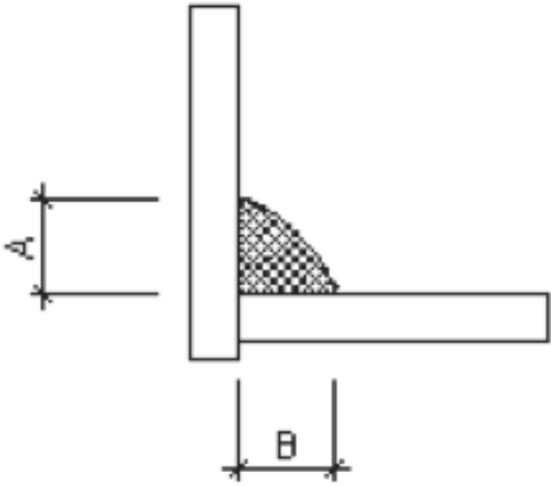
Liquid Sealants

MOVING CORNER JOINT

GOOD JOINT DESIGN



POOR JOINT DESIGN



Backer rod



Liquid Sealants

Table 1: Comparison of Properties for Polyurethane and Silicone Construction Sealants

<i>Property</i>	<i>Silicone</i>	<i>Polyurethane</i>
Recovery from stress	++	++
UV resistance	++	+
Cure rate (one component sealant)	++	- to ++
Low temperature gunnability	++	-
Tear resistance	-	++
Cost	-	++
Paintability	--	++
Available in colors	-	++
Unprimed adhesion to concrete	-	++
Resistance to hydrolysis	++	-
Non-bubbling	++	-
Self-leveling formulations	-	++

Scale: -- very poor, - poor, + moderate, ++ good

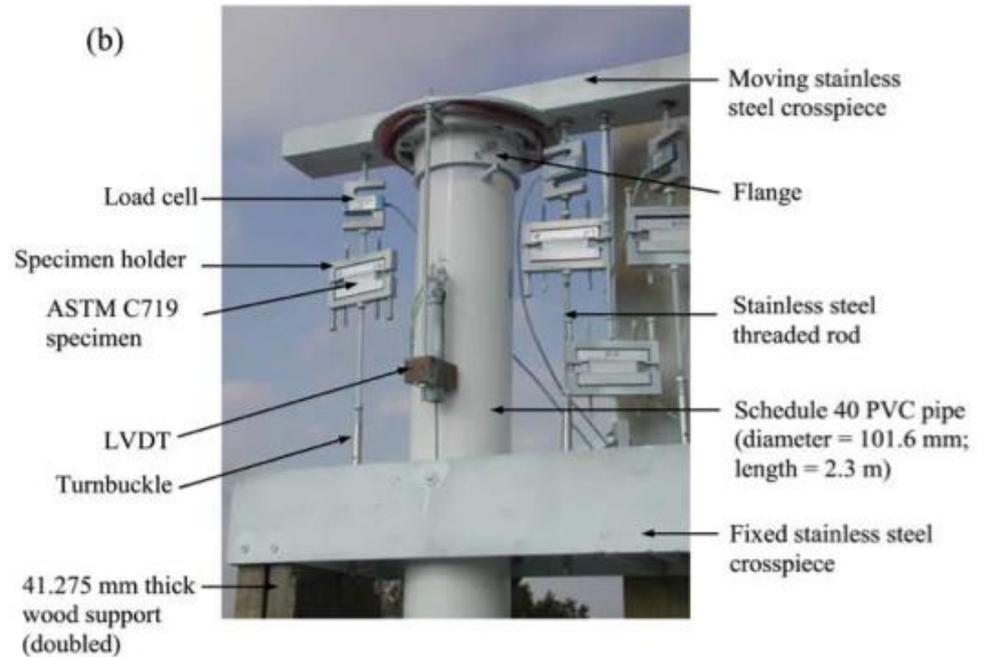
Durability – service life prediction

- NIST – National Institute of Standards & Tech
- Started service life prediction research in about 2001
- ASTM standards 2011
- Field test for service life prediction of sealants: ASTM C1589

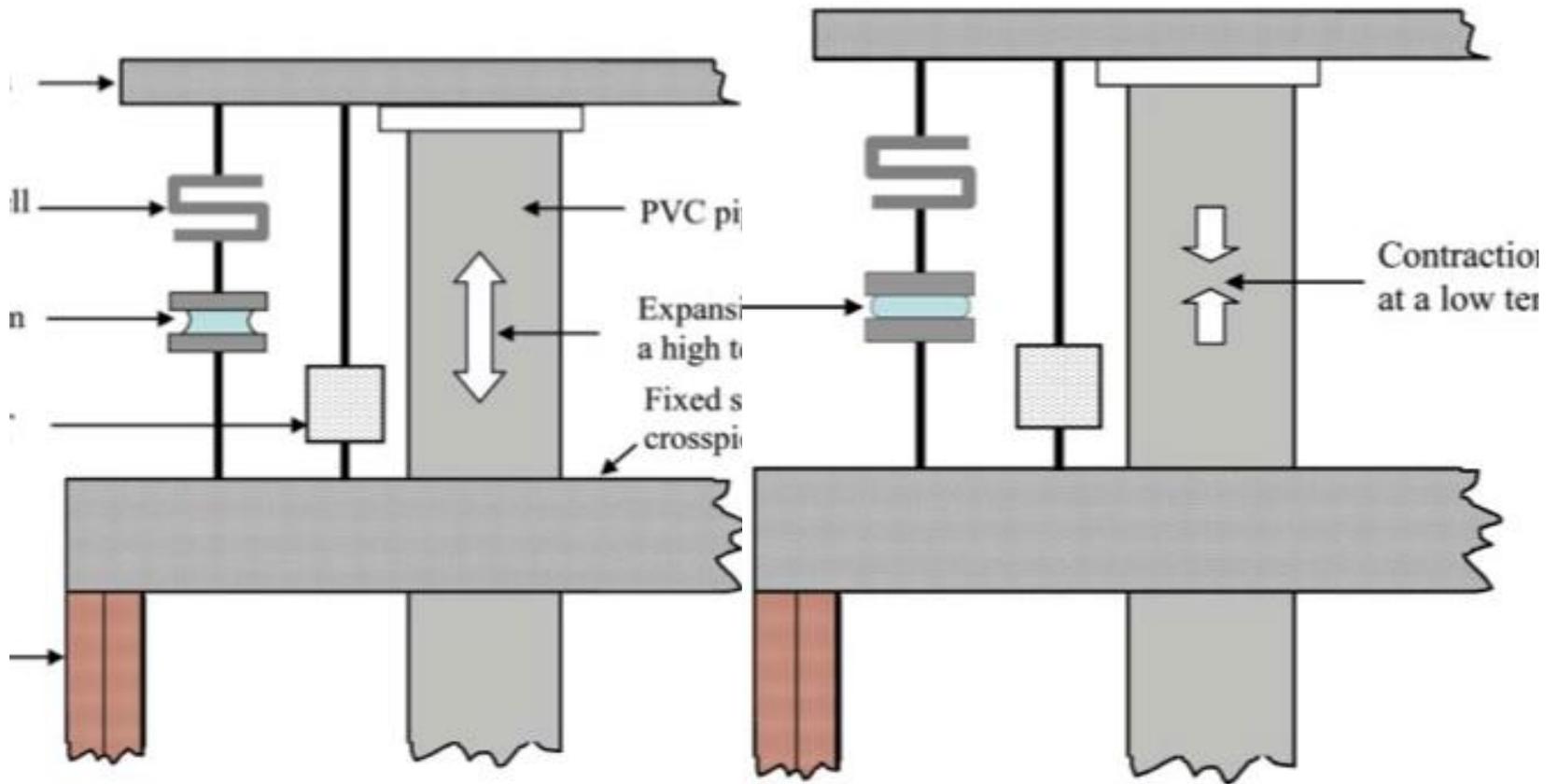


Christopher White - NIST

Field Test Rig



Field Test Rig



ASTM C1735 - 11 Standard Test Method for Measuring the Time Dependent Modulus of Sealants Using Stress Relaxation

Pressure Sensitive Adhesive (PSA) Tapes

- Rubber - modified bitumen (traditional “peel-n-stick”)
- Rubber – butyl
- Acrylic
- Silicone

Tape 101

Rubber: Adhesives which are based on natural or synthetic rubbers and formulated with tackifying resins, oils and anti-oxidants. Rubber is the most cost effective PSA and offers quick stick capability. Rubber adhesive is not recommended for high heat applications.

Acrylic: Adhesives formulated with acrylic polymers and generally has a better long term aging and more resistance to solvents and environmental factors. Acrylic adhesives typically develop a stronger bond than the traditional Rubber adhesive and are able to take higher temperatures

Silicone: Formulated with Silicone polymers and the only adhesive that will bond well with silicone substrates. Silicone adhesives are relatively expensive and have a very low initial tack, but can withstand higher temperatures than both Rubber and Acrylic adhesive.

Characteristic	Rubber	Acrylic	Silicone
Cost	Lowest	Med/High	Very High
Tack	Med/High	Med/Low	Low
Temp. Resistance	Low	High	Very High
Adhesion	Med/High	Moderate/High	Med/Low
Shear	Med/High	Moderate/High	Excellent
Solvent Resistance	Poor	Good	Excellent
UV Resistance	Poor	Excellent	Excellent
Plasticizer Resistance	Poor	Moderate/Good	Excellent
Low-surface energy materials	Excellent	Poor/Moderate	Poor
High-surface energy materials	Excellent	Excellent	Moderate

GBA Energy Nerd (Martin Holladay) – “Best” tapes

- 3M 8067 (acrylic tape)
- Venture 1520 – 1521 (acrylic tape)
- Nashua 330X (acrylic tape)
- Barricade 732 (OptiFlash? – butyl membrane)
- Grace Vycor (modified bitumen membrane)

NOTE: PRIMERS!

PSA Standards

- ASTM (big list...)
- PSTC (Pressure Sensitive Tapes Council)
- AAMA - Voluntary Specification for Self Adhering Flashing Used for Installation of Exterior Wall Fenestration Products

Test methods adhesives

Adhesives ASTM Standard test methods

Method

Resistance of Adhesive Bonds to Chemical Reagents	D896-97
Tensile Properties of Adhesive Bonds	D897-95a
Applied Weight Per Unit Area of Dried Adhesive Solids	D898-96
Peel or Stripping Strength of Adhesive Bonds	D903-98
Exposure of Adhesive Specimens to Artificial Light	D904-99
Strength Properties of Adhesive Bonds in Shear by Compression Loading	D905-98
Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading	D906-98
Standard Terminology of Adhesives	D907-99
Impact Strength of Adhesive Bonds	D950-98
Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)	D1002-99
Cleavage Strength of Metal-to-Metal Adhesive Bonds	D1062-96e1
Standard Test Methods for Viscosity of Adhesives	D1084-97
Determining Strength Development of Adhesive Bonds	D1144-99
Effect of Moisture and Temperature on Adhesive Bonds	D1151-90
Resistance of Adhesives to Cyclic Laboratory Aging Conditions	D1183-96e1
Flexural Strength of Adhesive Bonded Laminated Assemblies	D1184-98
Storage Life of Adhesives by Consistency and Bond Strength	D1337-96
Working Life of Liquid or Paste Adhesives by Consistency and Bond Strength	D1338-99
Standard Specification for Adhesive for Acoustical Materials	D1779-98
Conducting Creep Tests of Metal-to-Metal Adhesives	D1780-99
Climbing Drum Peel for Adhesives	D1781-98
Atmospheric Exposure of Adhesive-Bonded Joints and Structures	D1828-96
Peel Resistance of Adhesives (T-Peel Test)	D1876-95
Preparation of Surfaces of Plastics Prior to Adhesive Bonding	D2093-97
Preparation of Bar and Rod Specimens for Adhesion Tests	D2094-91
Tensile Strength of Adhesives by Means of Bar and Rod Specimens	D2095-96e1
Creep Properties of Adhesives in Shear by Compression Loading (Metal-to-Metal)	D2293-96
Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)	D2294-96
Strength Properties of Adhesives in Shear by Tension Loading at Elevated Temperatures (Metal-to-Metal)	D2295-96
Standard Guide for Preparation of Metal Surfaces for Adhesive Bonding	D2651-90
Durability Assessment of Adhesive Joints Stressed in Peel	D2918-99
Determining Durability of Adhesive Joints Stressed in Shear by Tension Loading	D2919-95

3M™ All Weather Flashing Tape 8067

Test Description	Tape Thickness (Backing & Adhesive)	Adhesion to Housewrap* oz./in. (N/100 mm)	Adhesion to Polyethylene oz./in. (N/100 mm)	Adhesion to OSB oz./in. (N/100 mm)	Nail Sealability before and after Thermal Cycling	Adhesion to Anodized Aluminum after 7 days at 176°F (80°C)	Adhesion to Anodized Aluminum after 7 days in water	Adhesion to Anodized Aluminum after Thermal Cycling	Adhesion to Anodized Aluminum after UV Exposure	Application Temperature Range °F (°C)	Service Temperature Range °F (°C)
Test Method	ASTM 3652	ASTM D-3330 per AAMA 711-05	ASTM D-3330 per AAMA 711-05	ASTM D-3330 per AAMA 711-05	ASTM E331 as modified per AAMA 711-05 Annex 1	ASTM D3330 after conditioning per AAMA 711-05	ASTM D3330 after conditioning per AAMA 711-05	ASTM D3330 after conditioning per AAMA 711-05	ASTM D3330 after conditioning per AAMA 711-05	ASTM D3330	Tested per AAMA 711-05
Results	9.9 mils (0.25 mm)	50 oz./in. (55 N/100 mm)	60 oz./in. (66 N/100 mm)	60 oz./in. (66 N/100 mm)	Pass	70 oz./in. (77 N/100 mm)	65 oz./in. (71 N/100 mm)	75 oz./in. (82 N/100 mm)	60 oz./in. (66 N/100 mm)	0 to 120°F (-18 to 49°C)	-40 to 176°F (-40 to 80°C)

Note: This technical information and data should be considered representative or typical only and should not be used for specification purposes.

* Spun bonded polyethylene

“Head of Water Test” specified in ASTM D1970

Service Life Prediction for Tapes?

[THIS PAGE INTENTIONALLY LEFT BLANK...]

Gaskets



BG34
for gaps to 3/8"



BG36
for gaps to 5/8"



BG38
for gaps to 7/8"



BG44
for gaps 1/4" to 1/2"



BG46
for gaps 3/8" to 3/4"



BG48
for gaps 1/2" to 1"



BG61 for rim joists



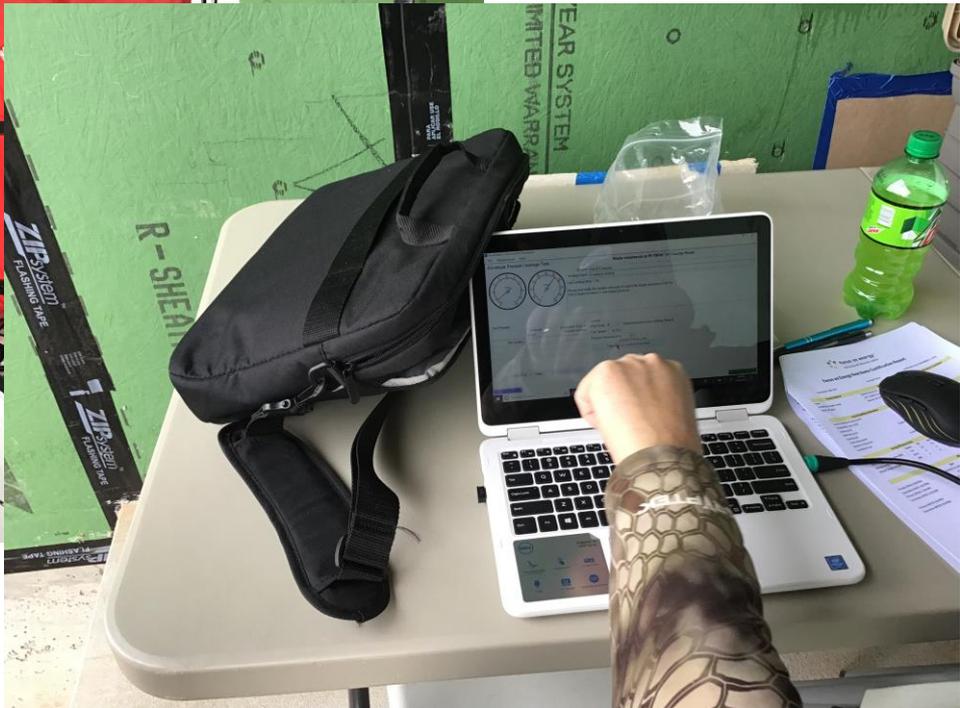
BG63 for 2x4 plates



BG65 for 2x6 plates

The allure of “quality-free” installation







AeroBarrier – Interior or Exterior



AeroBarrier – Interior or Exterior



AeroBarrier –



New construction continuous air barrier



STEVEN BACZEK
architect

Retrofit continuous air control layer



Air control layer priorities

- Bulk water first...
- Lid (attic)
- Bottom (basement, especially rim joist)
- Shafts/chases
- Walls

NOTE: IAQ along the way (including radon...)

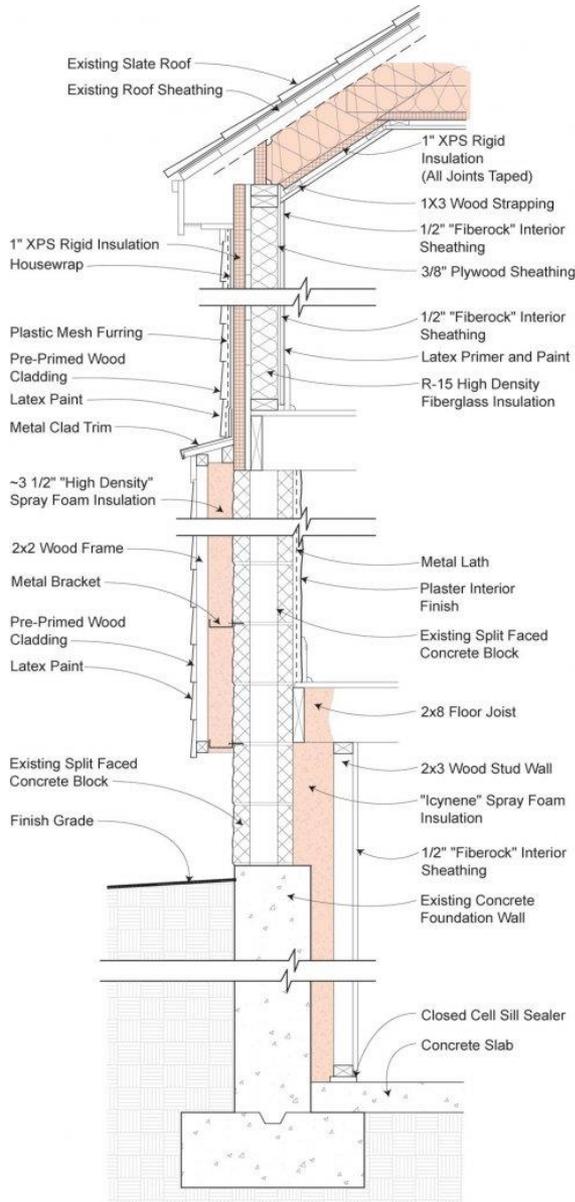
Retrofit continuous air control layer



Attic

Retrofit continuous air control layer

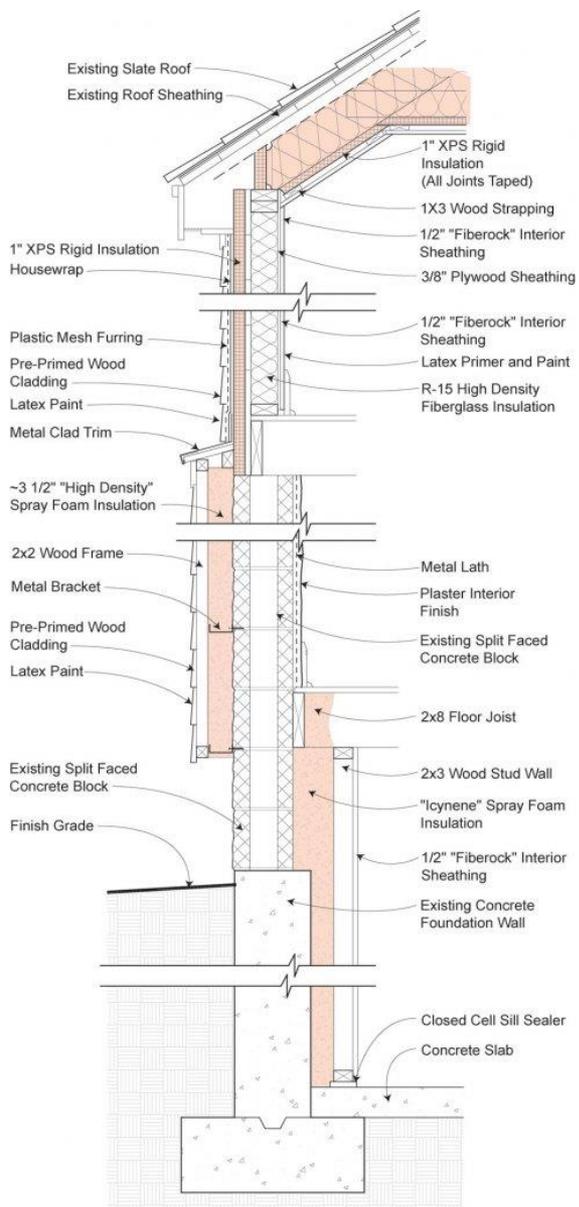
Basement



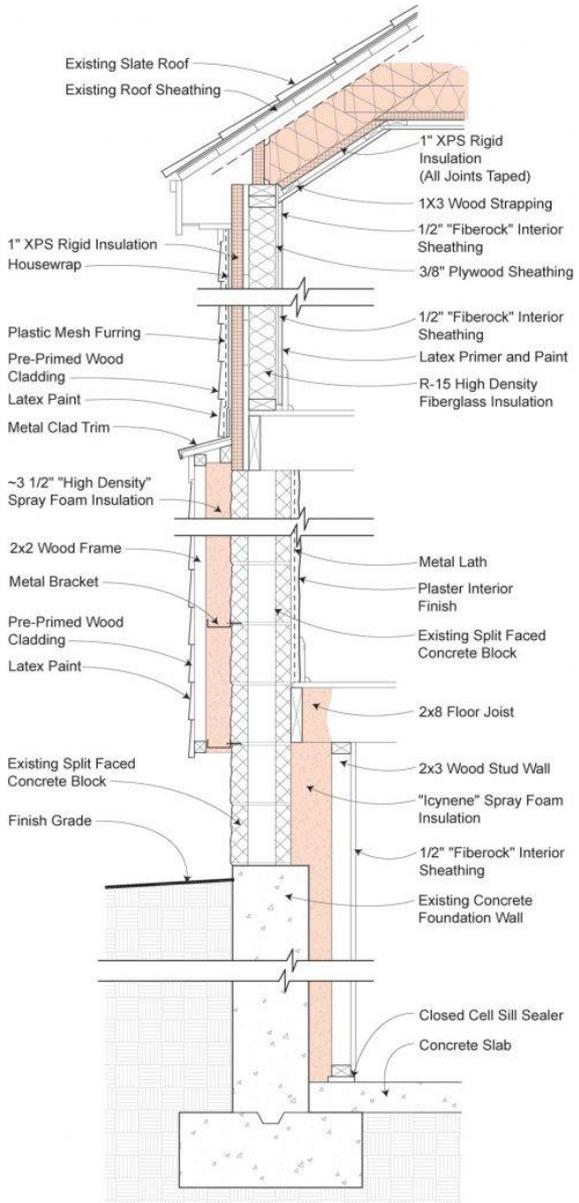
Retrofit continuous air control layer



Retrofit continuous air control layer



Retrofit continuous air control layer



The retrofit air sealing problem

- Gaskets are out...
- Sticky stuff: PSA tapes are out...
- Sticky stuff: liquid sealants are out...
- Piecemeal from the interior: no better than around 4 ACH50?
- Jacket on the exterior? 1 ACH50 achievable
- Spray foam: our only option?
- AeroBarrier: our new option?

The Promise of AeroBarrier for Air Sealing Homes

AeroBarrier West is using this air sealing system on existing and even occupied homes



By Peter Yost | August 7, 2019

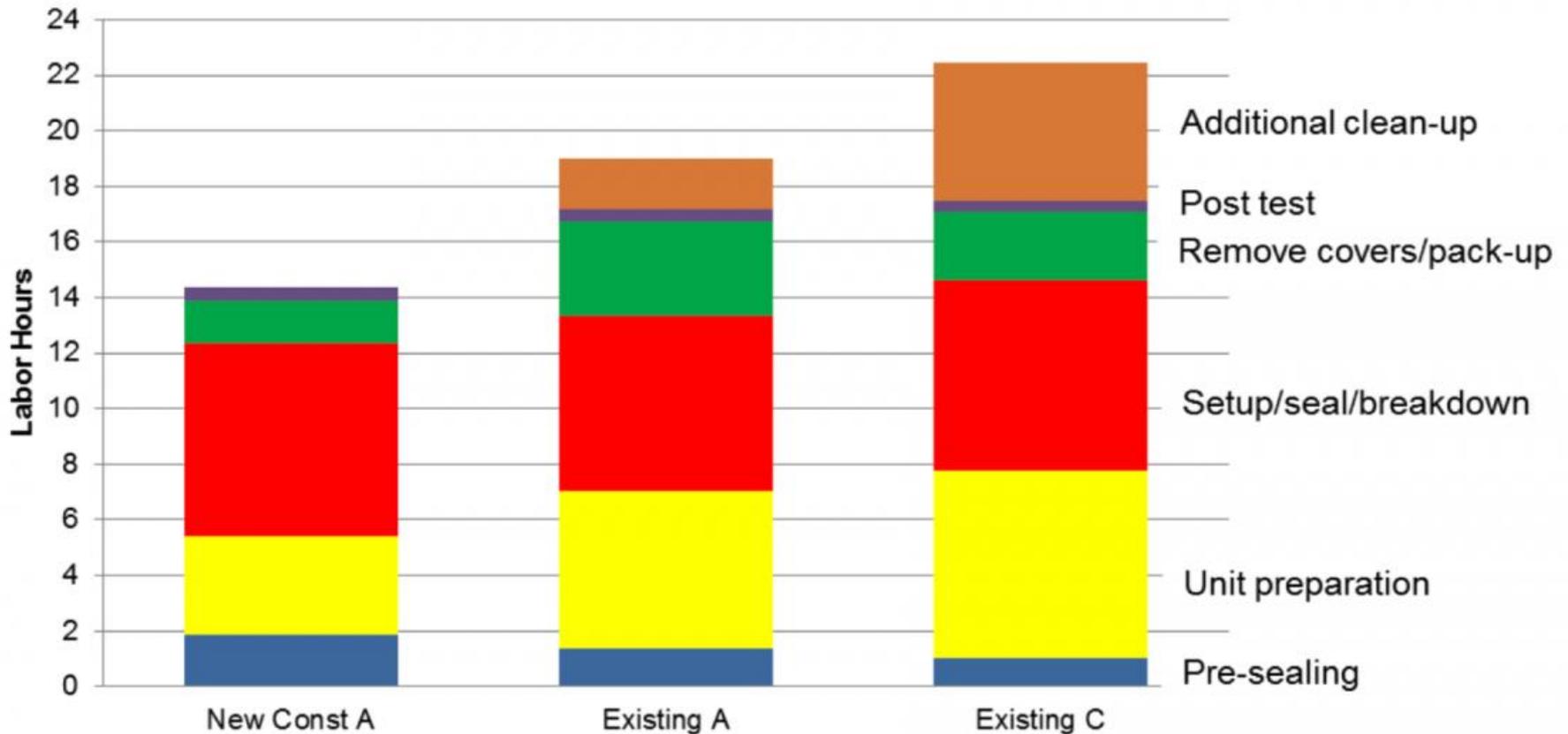




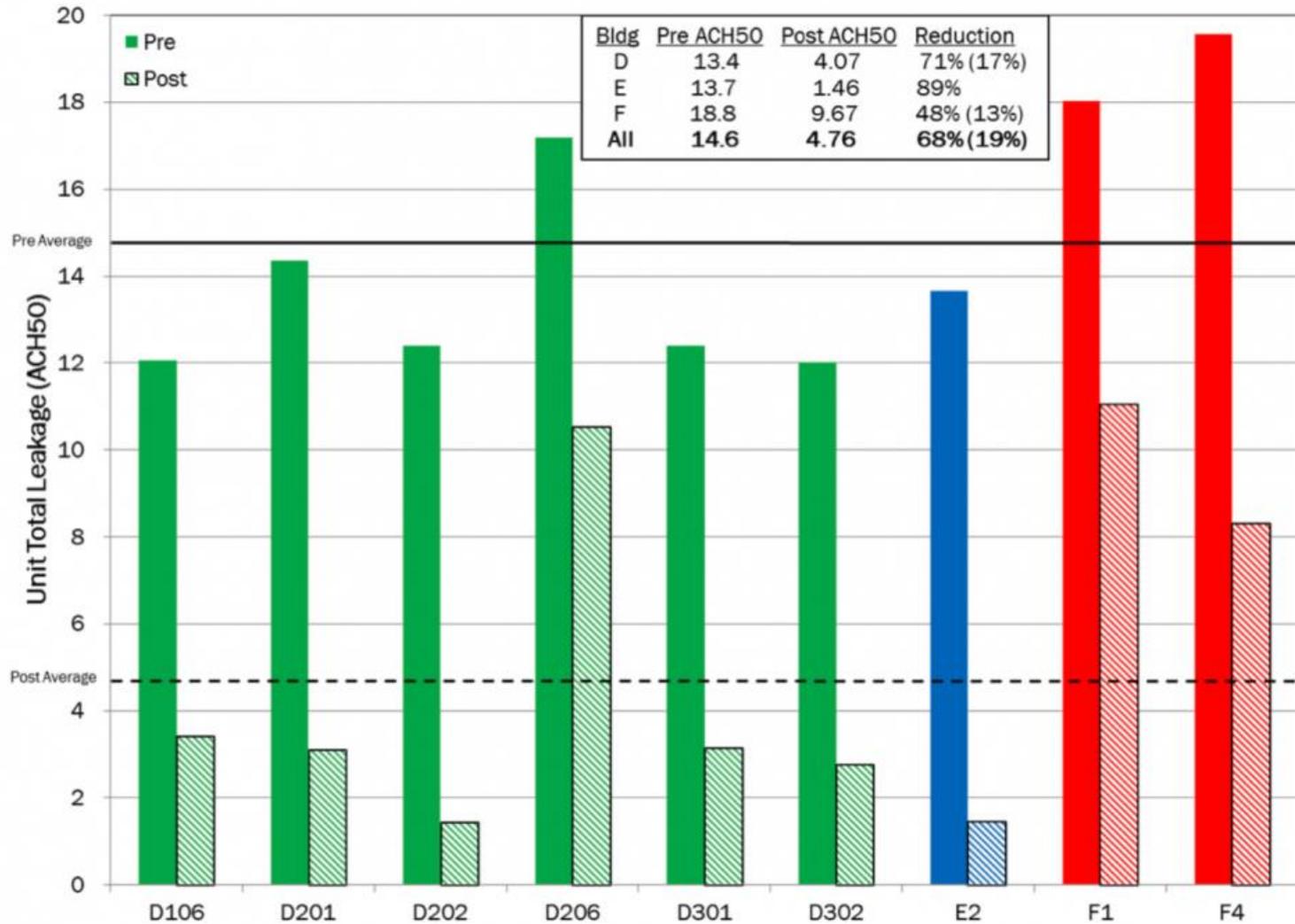




Site Work Prep: how long does it take?



Leakage Results: 9 Existing Units



Average leakage: pre= 14.6 ACH50, post= 4.8 ACH50
 6 of 9 within 15% of new construction code requirement

WTF and AeroBarrier...

- AB is doing long term field testing
 - Building America
 - Jake Bruton projects
- Durability testing
 - Flexing
 - Aging
 - Compatibility
- WTF is working with AB on testing...Keene State College

Keene State College: ARCH 490

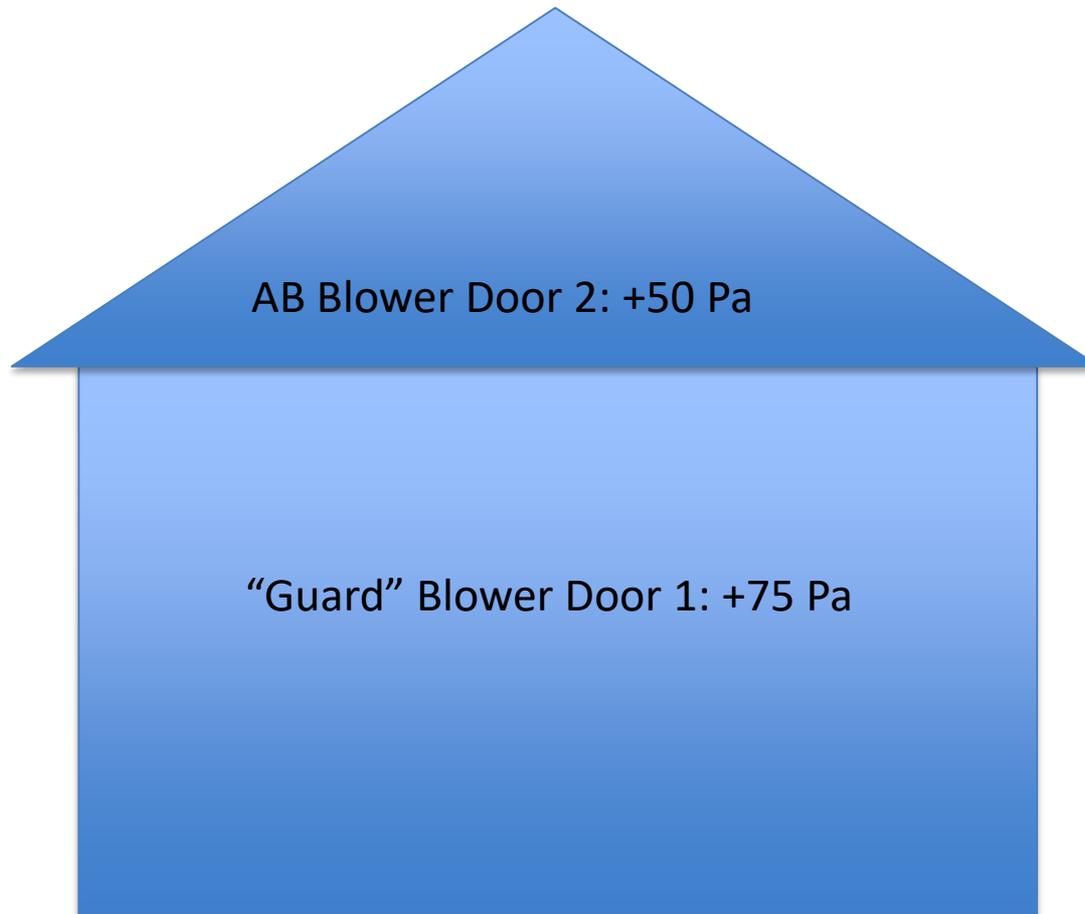
Building Performance Assessments

(The science, the tools, interpreting results and making recommendations)

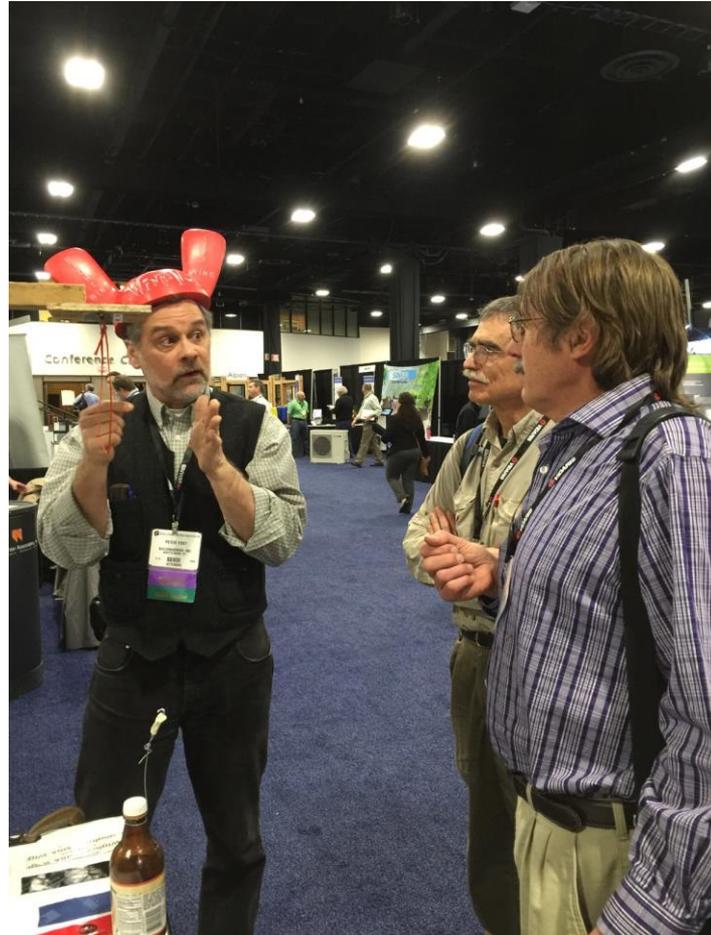


Breaking news?

“Guarded” existing space AB



Thanks...




PETER YOST
BUILDING - WRIGHT