Building Science for SPF Contractors

Allison A. Bailes III, PhD

THE INTERNATIONAL Women's LEADERSHIP ASSOCIATION

April 14, 2015

Dear Allison,

On behalf of The International Women's Leadership Association, it is my distinct pleasure to notify you that, in consideration of your contribution to family career, and community, you have been selected as a woman of outstanding leadership.

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The Energy Vanguard Blog

Do You Really Need to Run the Bath Fan in Winter?

Posted by Allison Bailes on January 22, 2018

You may have heard or read somewhere that you should run your bathroom exhaust fan whenever you take a shower and then let it run for a while after you're done with the shower. Showers increase the humidity in the bathroom. Sometimes it gets high enough to cause condensation to appear on the mirror...

Read more

20 Comments | Read/write comments

Tags:

Two Rules for Preventing Humidity Damage

Posted by Allison Bailes on January 17, 2018

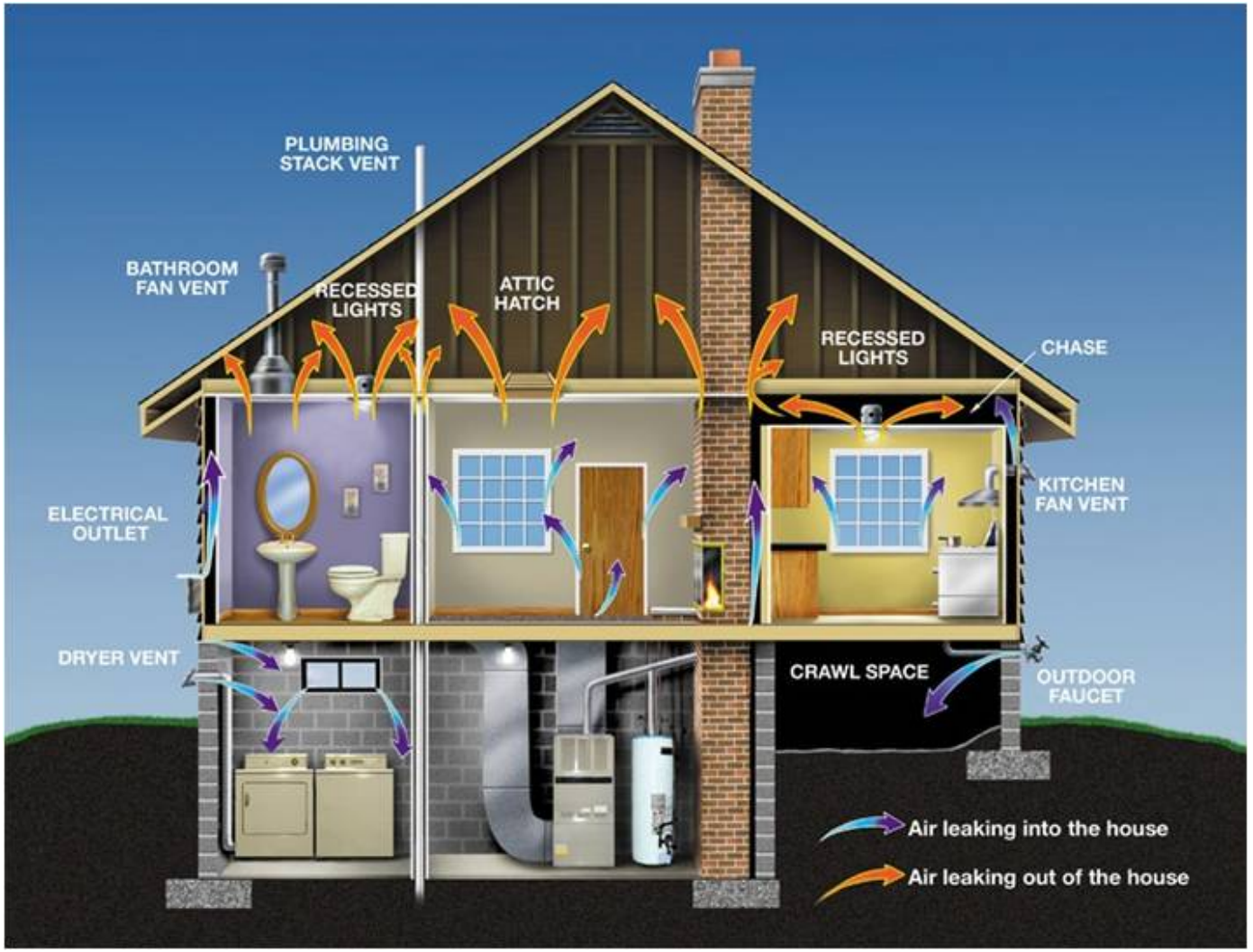
Because I've written so much about moisture in buildings, I get a lot of questions on the topic. Some are about walls. Some are about the attic. Some are about windows. Some are

Building Science 101

The 3 keys to good buildings:

1. A building is a system.
2. The design must fit the climate.
3. Uncontrolled flows of heat, air, & moisture cause problems.

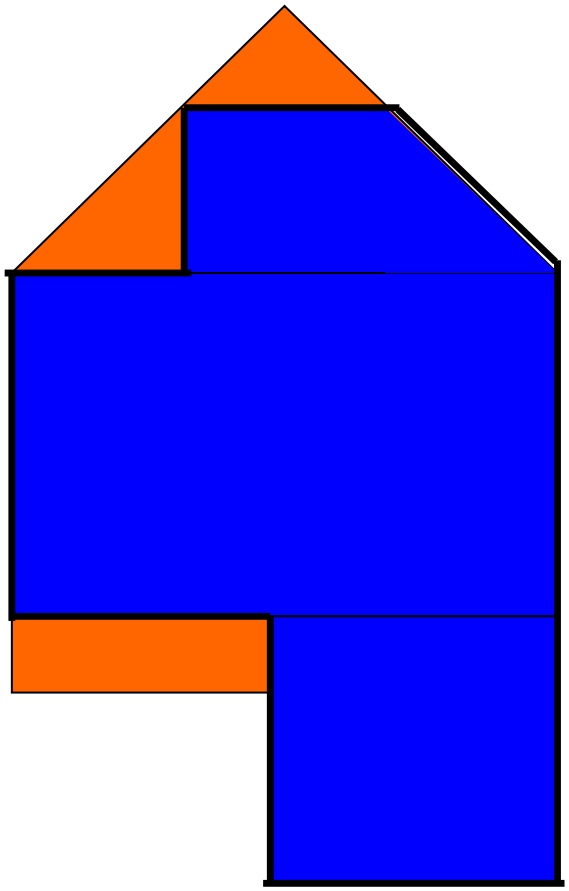
1. A Building Is a System



Building Enclosure

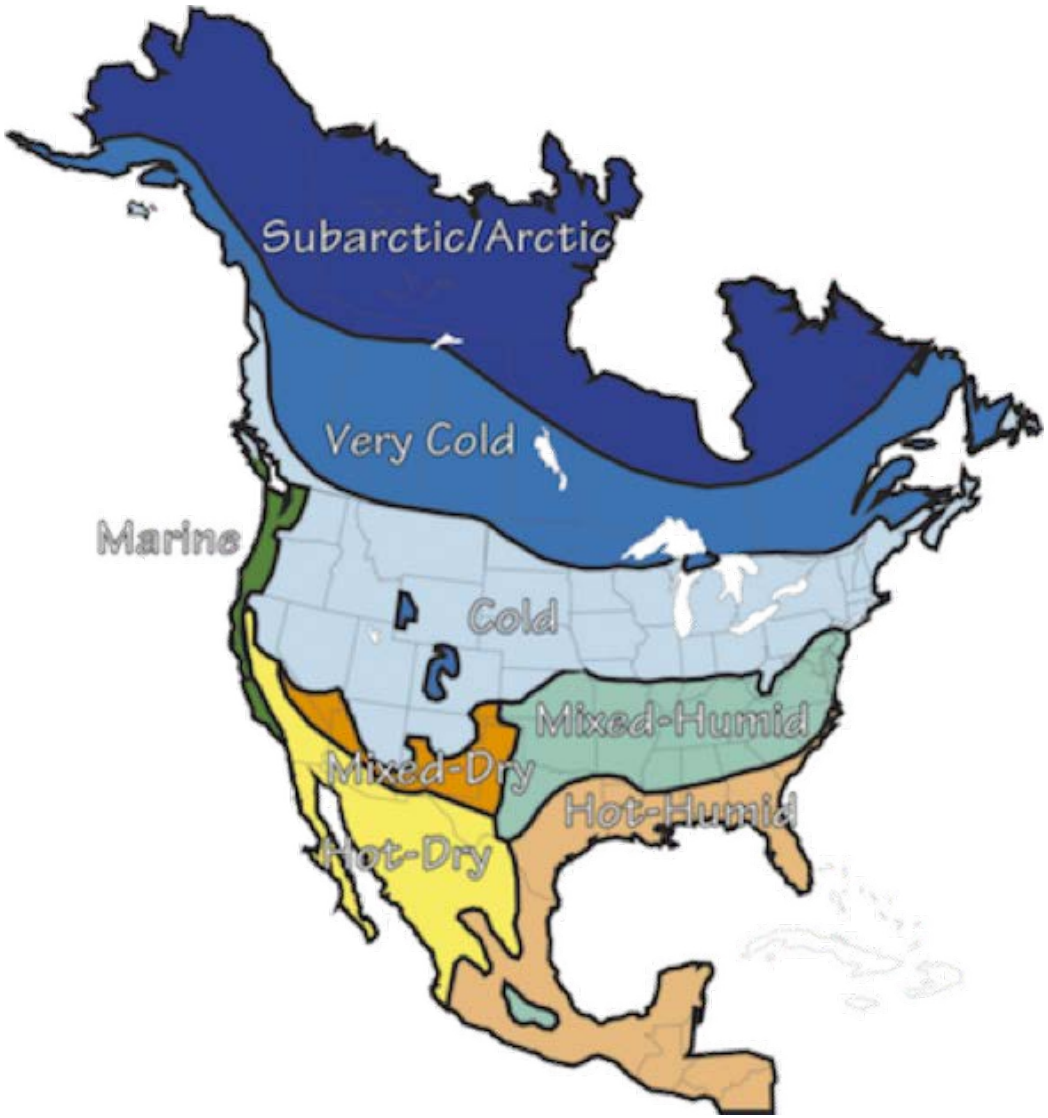
Boundary between conditioned & unconditioned spaces with two key components:

- Air Barrier
- Insulation



Air barrier should be touching insulation (in most cases) and continuous.

2. Design for Your Climate



3. Going with the Flow

Heat, Air, & Moisture take the path of least resistance:

- Hot → Cold
- High → Low Pressure
- Wet → Dry

→ **2nd Law of Thermodynamics**

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“In this house, we obey the laws of thermodynamics!”

~ Homer Simpson

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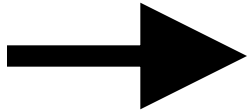
Going with the Flow

Controlling

Heat
Air
Moisture



Results in

Health
Comfort
Durability
Efficiency
And more

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БУЕСЛОВІЕ
СРАМОСЛОВІЕ

Everyone wears blinders.

Insulation

Flat…

Or Lumpy?

The Lumpy Problem

- 50% at R-50
- 50% at R-10
- Averages to R-30?

$$U_{avg} = \frac{U_1 \times A_1 + U_2 \times A_2}{A_{total}}$$

50% at R-10

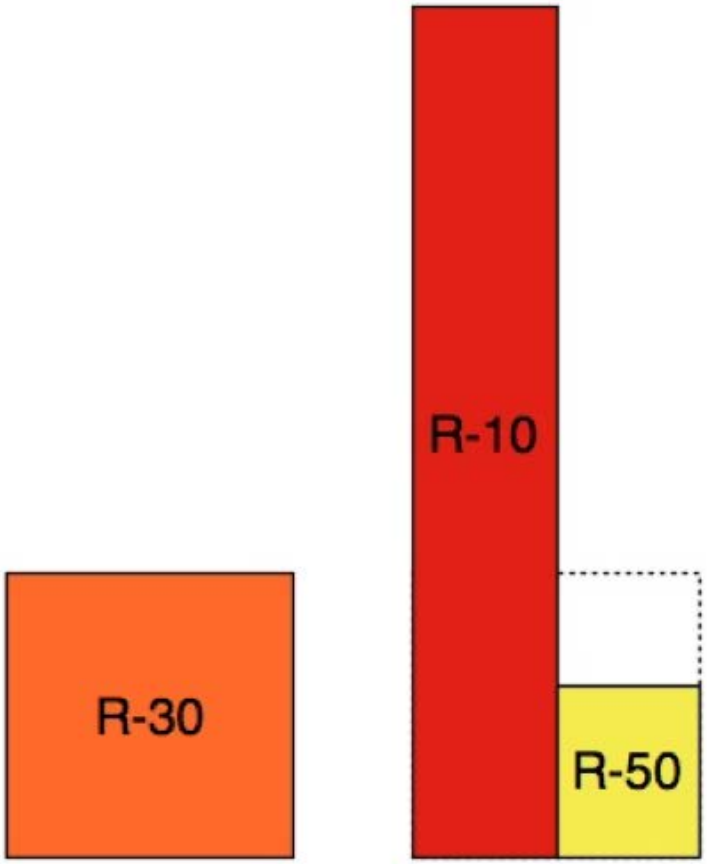
+ 50% at R-50 averages to…

R-17

$$Q = U \times A \times \Delta T$$

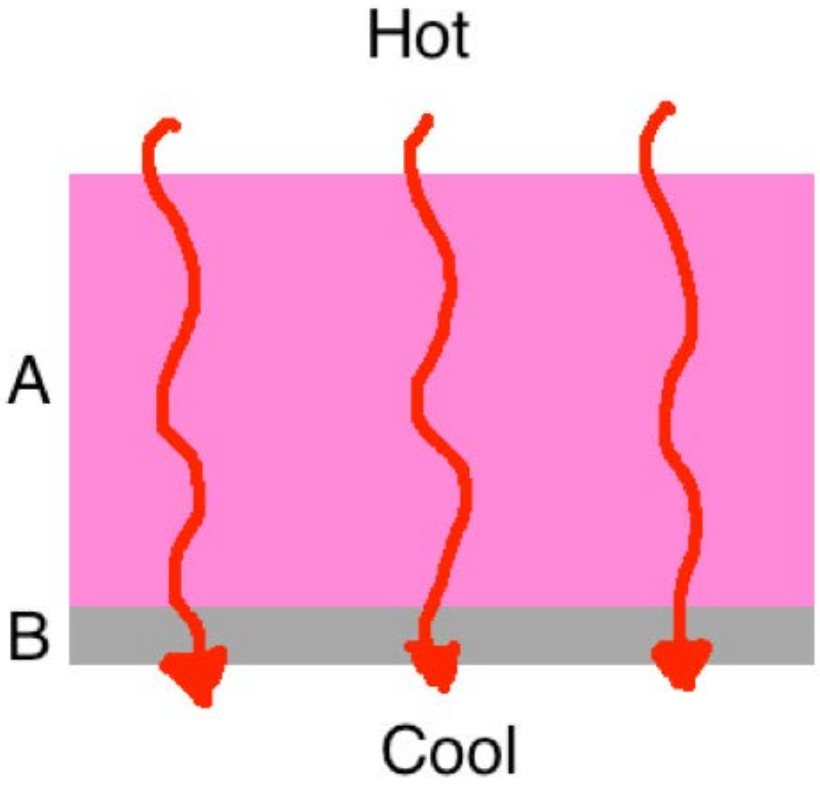
All 3 Modes in Play

- Conduction
- Convection
- Radiation

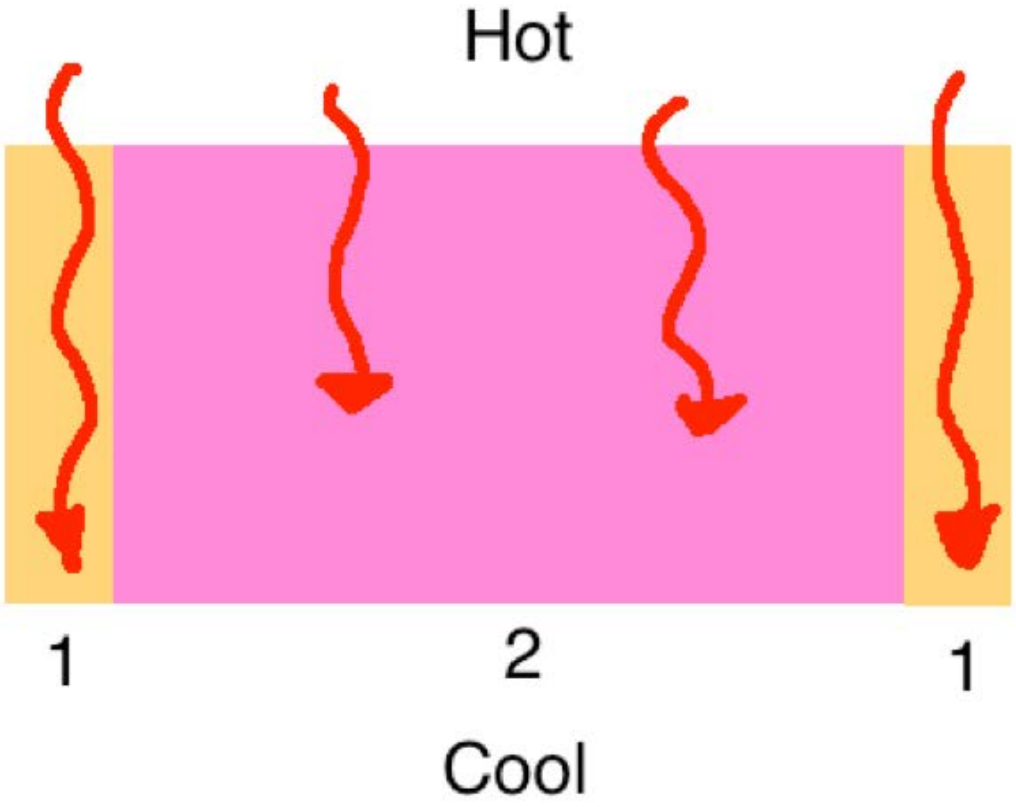


Total heat flow through flatly insulated attic (left) and lumpily insulated attic (right).

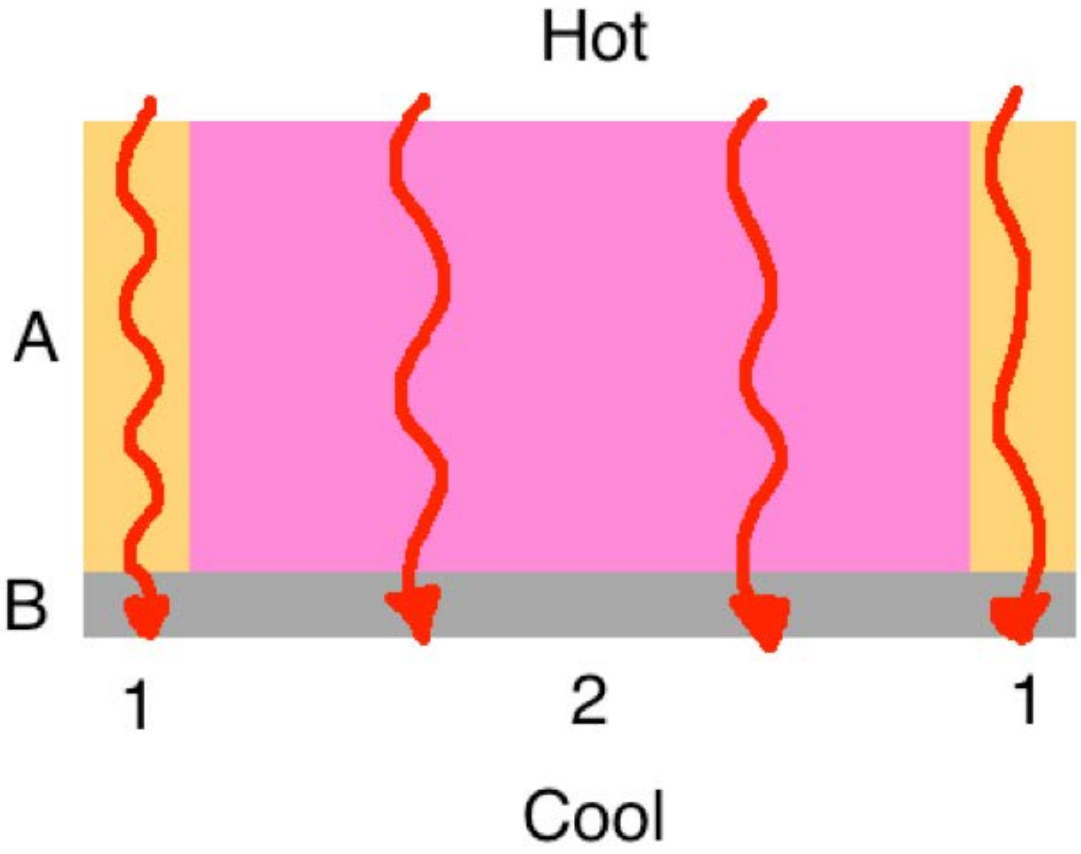
Series Heat Flow



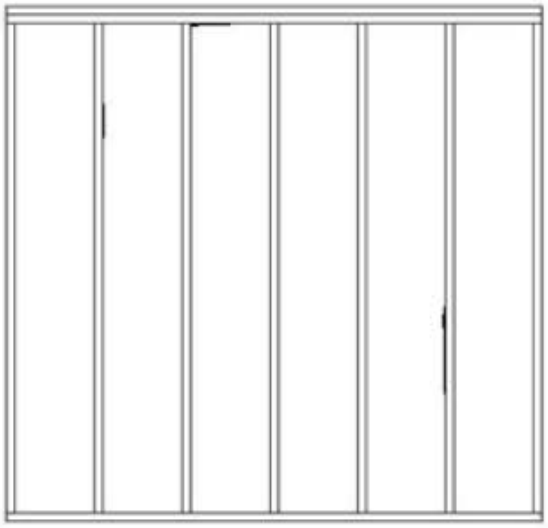
Parallel Heat Flow



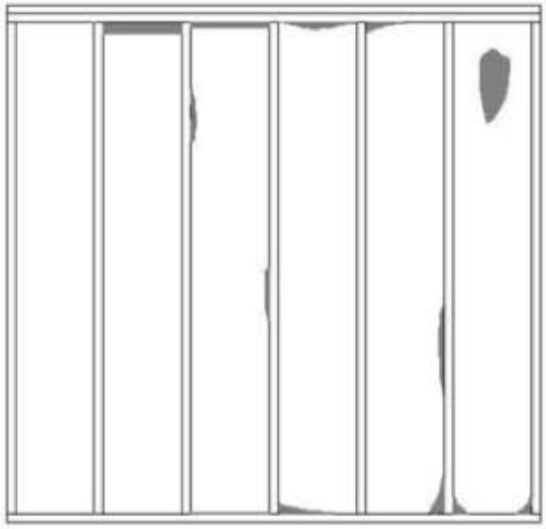
Series & Parallel Heat Flow



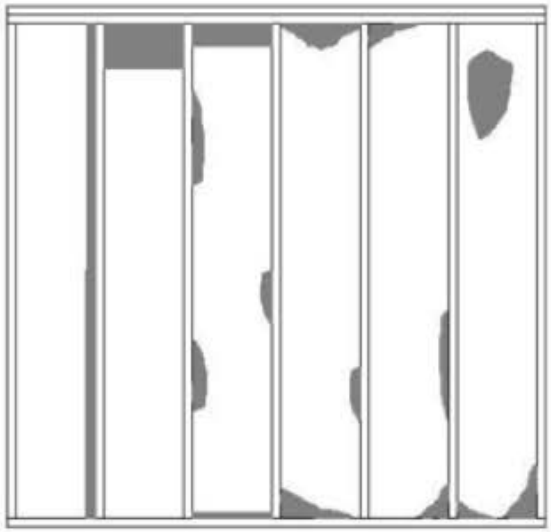
RESNET Insulation Installation Grading



Grade I: Almost no gaps



Grade II: Up to 2%



Grade III: 2% - 5%

RESNET protocol for the effect of missing insulation on installation grade

Diagrams from the HERS Standards

2015 IECC
R-Value Table

TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5[h]	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

2015 IECC
U-Factor Table

TABLE R402.1.4
EQUIVALENT *U*-FACTORS[a]

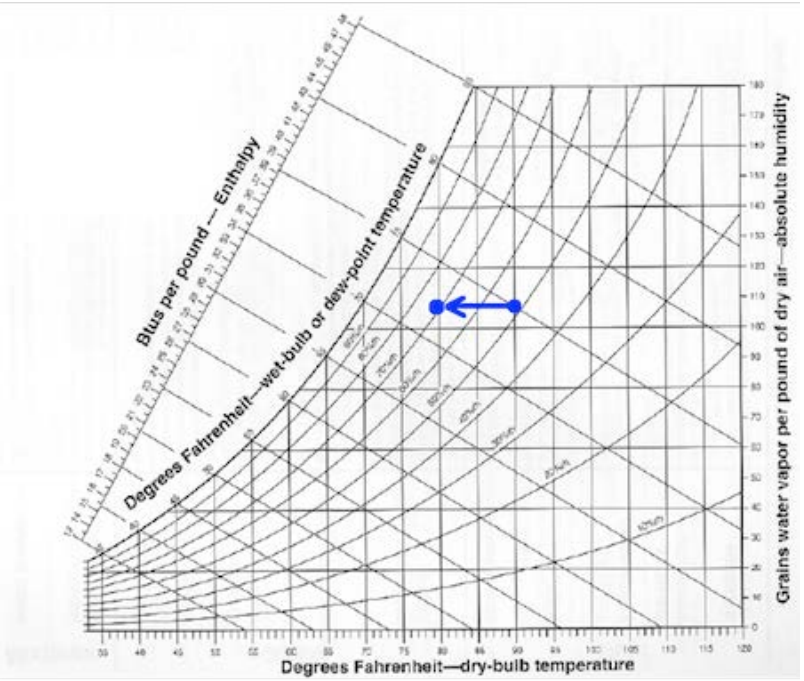
CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.084	0.165	0.064	0.360	0.477
3	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	0.55	0.026	0.045	0.057	0.028	0.050	0.055

U-0.035 = R-28.6

U-0.030 = R-33.3

U-0.026 = R-38.5

Moisture



The Physics of Water

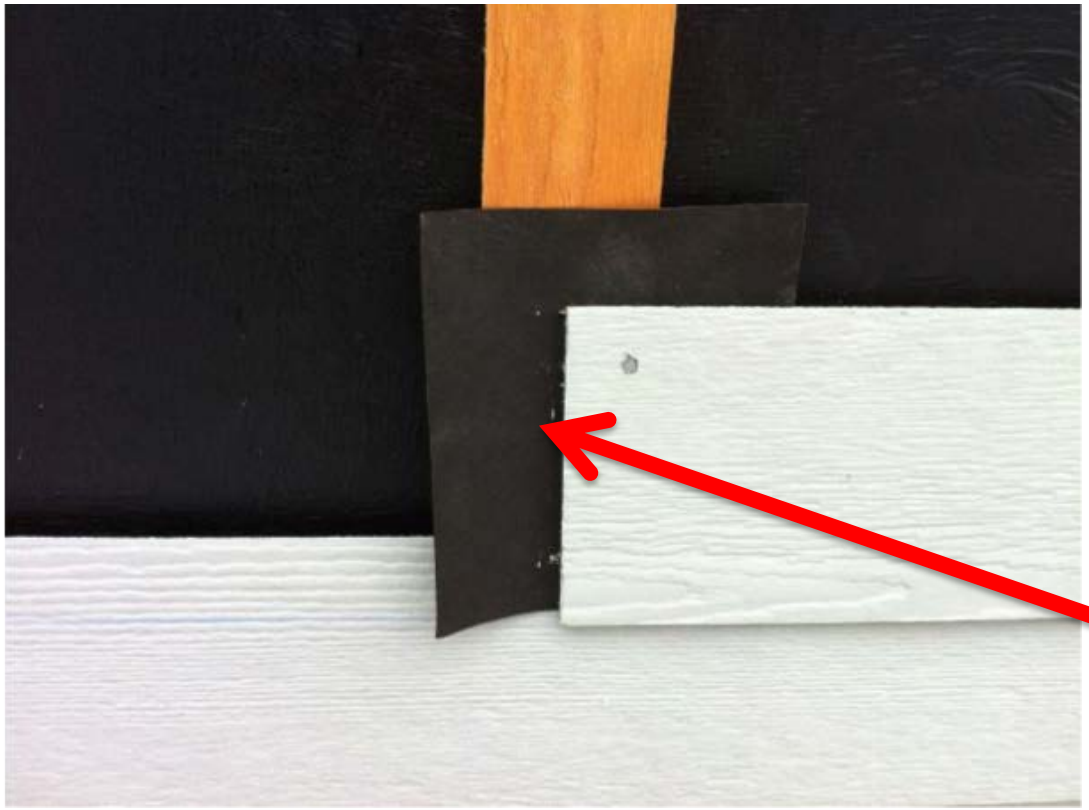
2nd Law of Thermodynamics for Moisture

Water moves from wet to dry areas.

Law of Gravity for Moisture

Water moves downward.

Wind-Driven Rain



Water will get behind the cladding.

Felt at siding joints

The Drainage Plane

Housewrap

The Drainage Plane

Foamboard

Seams must be taped

The Drainage Plane

Taped Sheathing

The Drainage Plane

Liquid-applied

The Drainage Plane

Peel-and-Stick

The Drainage Plane

Felt

“The three biggest problems in buildings are water, water, and water.”

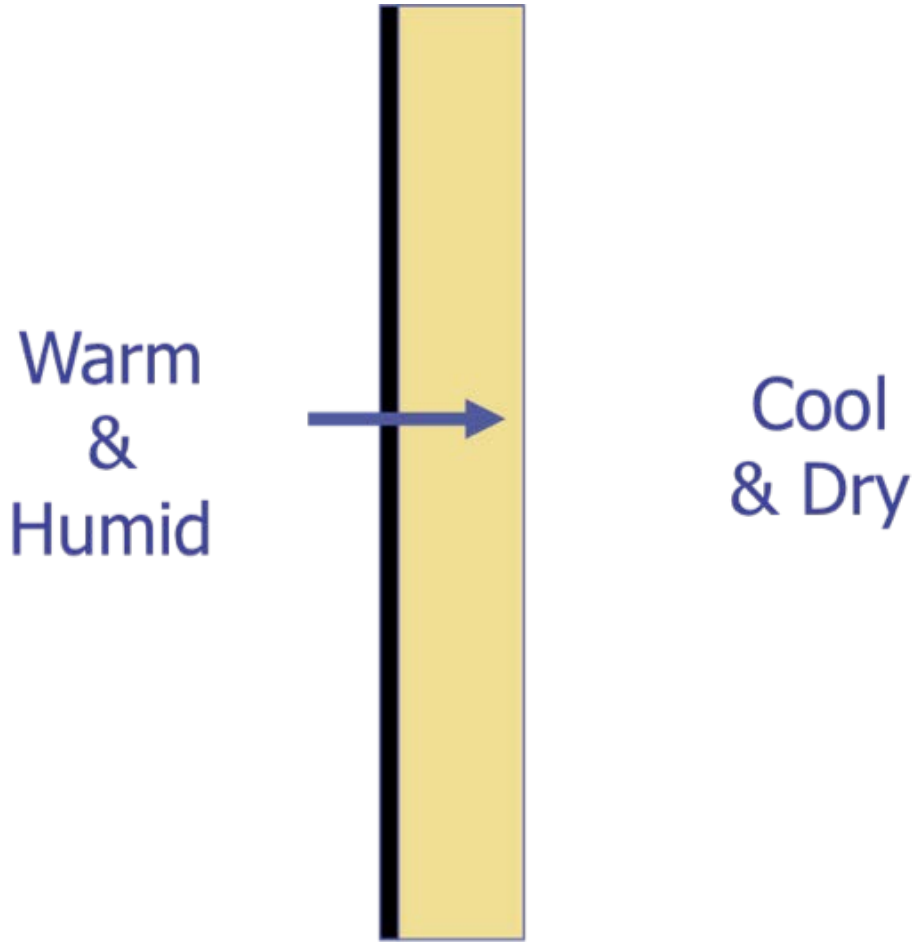
~ Gus Handegord

Fundamental Rule of Material Wetness

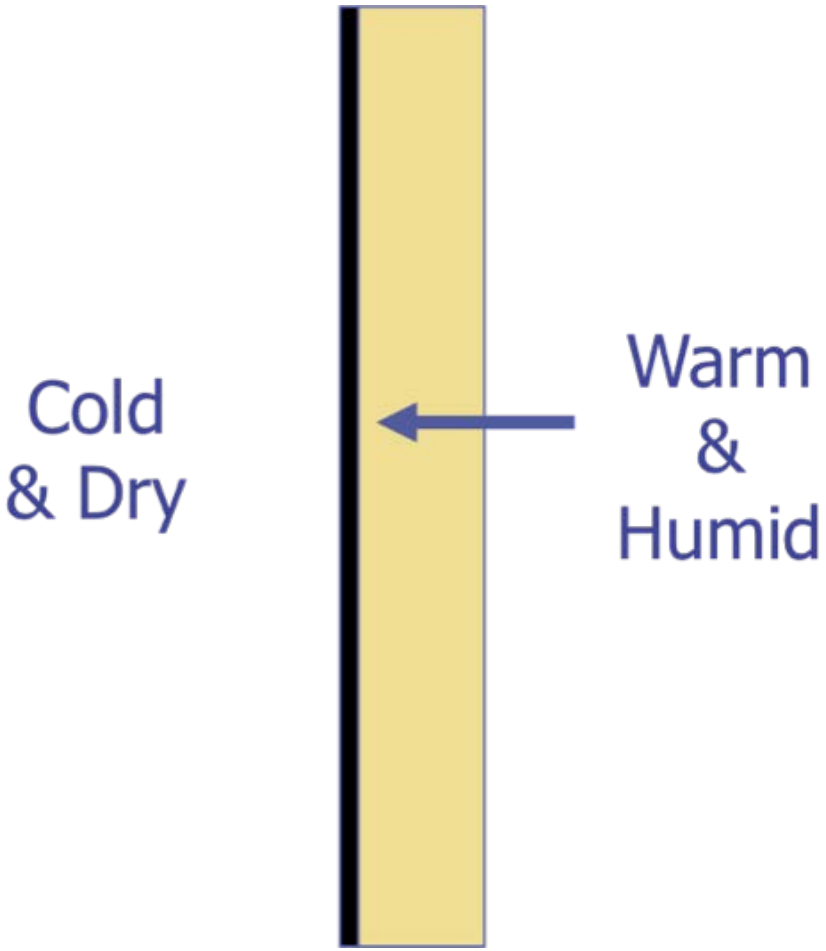
Cold materials tend to be wet and warm materials tend to be dry.

from *Water in Buildings* by Bill Rose

Condensing Surface



Condensing Surface

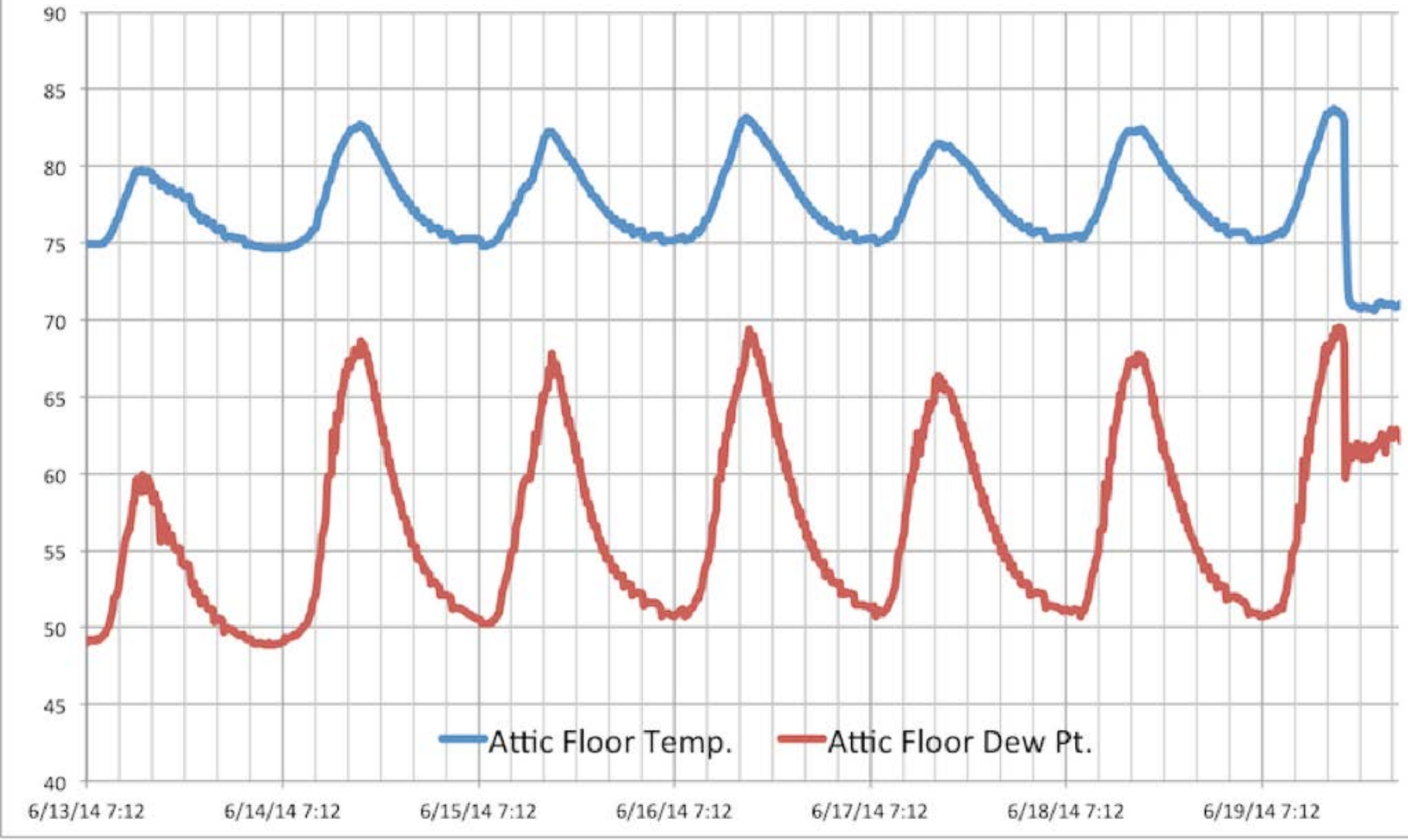


Fat Walls


N3
(5-½-in. ocSPF)
N2
(12-in. cellulose
N1
(12-in. ocSPF)

Open-Cell SPF in Attics

Attic Floor Temperature & Dew Point



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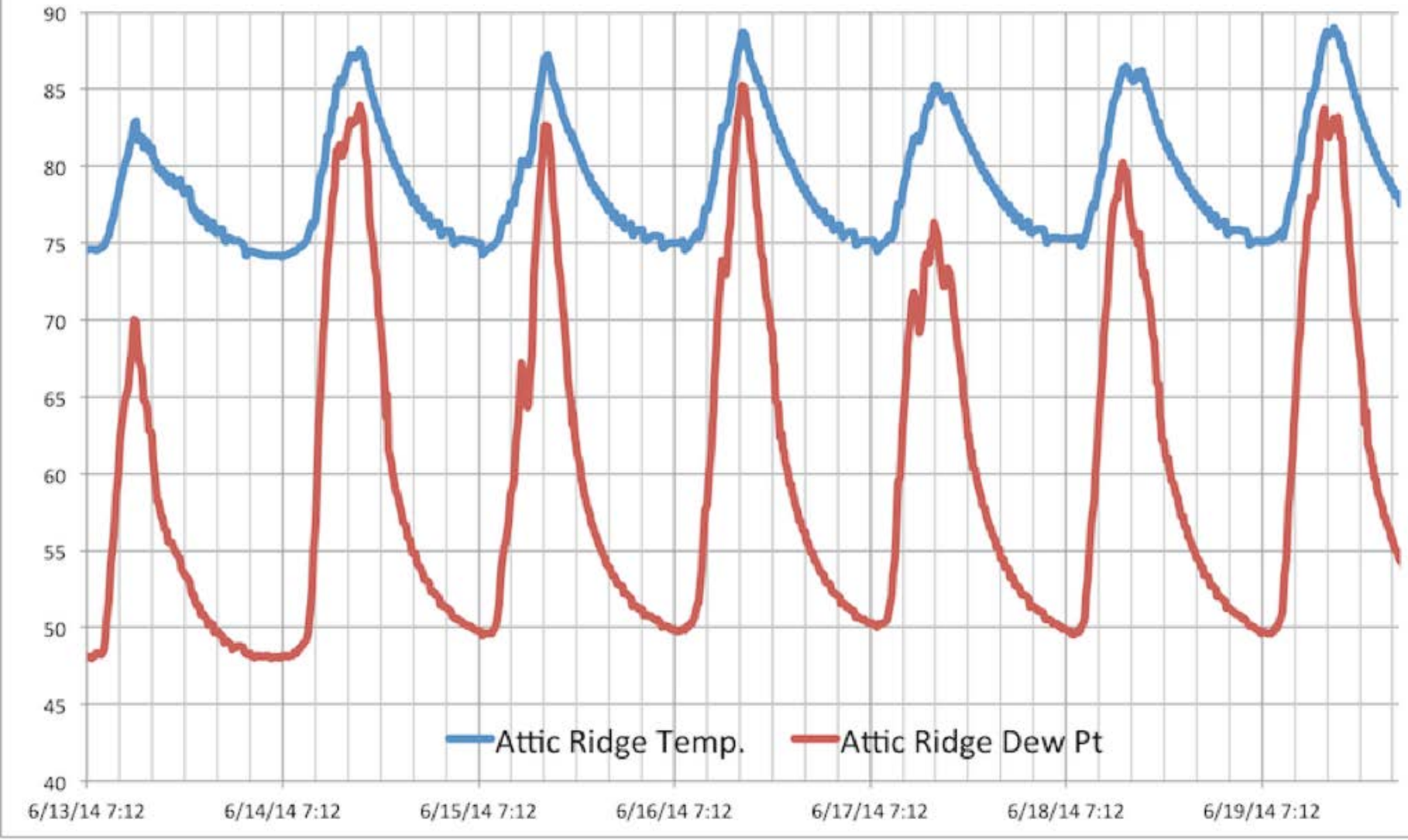
Attic Ridge Temperature & Dew Point



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Lessons

- Spray minimum thickness, not average
- Don’t miss ANY areas!
- Cover those rafters/top chords
- Keep water out
- Use vapor retarder in fat walls in cold climates
- Keep attic humidity low with OC-SPF

Contact Info

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