

Sustainable Energy Outreach Network



How (Older) Houses Work

May 23 & May 30

5:30 - 8:00 pm

Rockingham Free Public Library

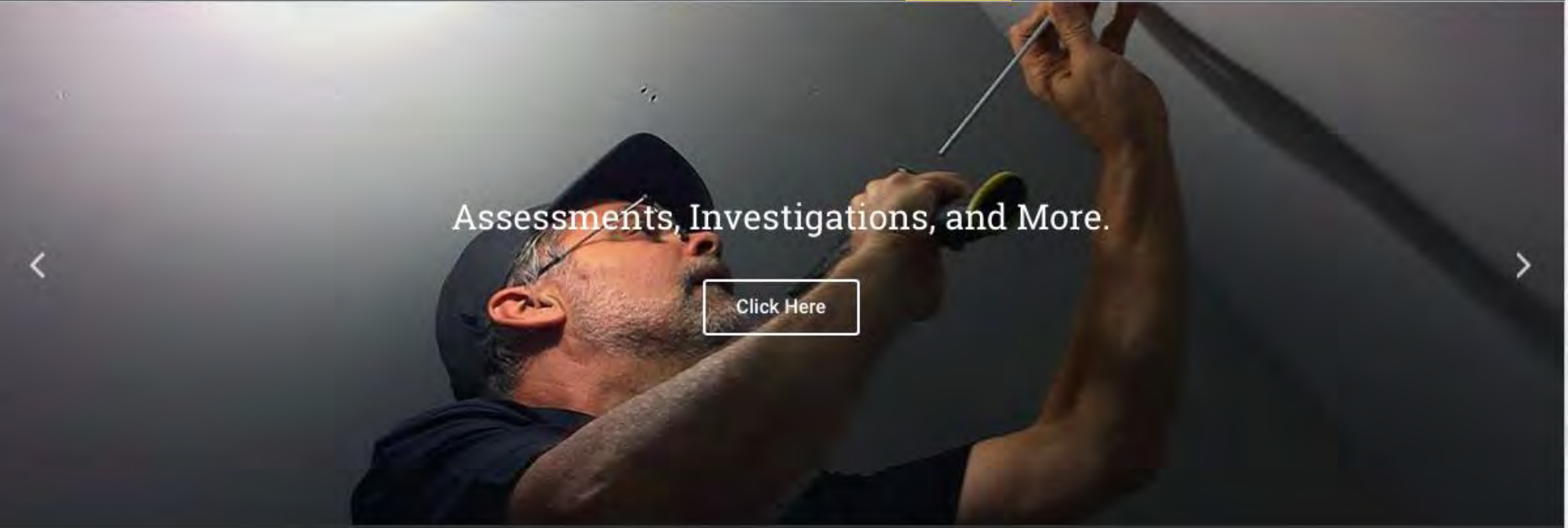
65 Westminster St.

Bellows Falls, VT

Attend One session: \$20

Attend Both: \$30





Assessments, Investigations, and More.

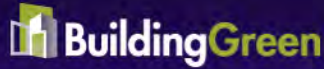
[Click Here](#)

What is a “building-wright?”

It's me; I made it up. But it captures pretty much everything that I do: analyze, review, research, investigate, and teach about buildings and how they work...or sometimes don't work.

https://www.buildinggreen.com/peter-yost

About us Consulting Earn CEUs Download Issues



PRODUCT GUIDANCE

SUSTAINABLE MATERIALS -

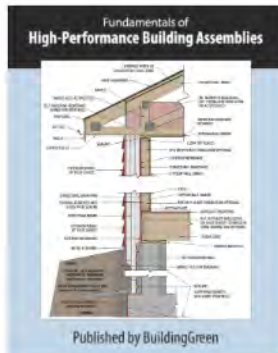
DESIGN STRATEGIES -

BUILDING SCIENCE -

BUILDINGS & PROJECT TYPES -

DESIGN PROCESS -

CODES & CERTIFICATIONS -



Published by BuildingGreen

Buy it now for \$199.95

Did you already purchase this product? If so, please [log in now](#) to access it.

Continuing education credits:

- 4 AIA (HSW)
- 4 GBCI
- 4 ILFI



IN-DEPTH COURSE

Fundamentals of High Performance Building Assemblies

Design assemblies that live up to their potential

High-performance buildings integrate site-responsive orientation, climate-responsive form, hefty R-values, efficient mechanical systems, healthy indoor air, and glazing that effectively balances daylight and heat gain.

BuildingGreen's four-part course, designed for architects and builders, provides methodologies for how best to design and manage these details and achieve superior performance—while avoiding expensive pitfalls.

What you'll learn:

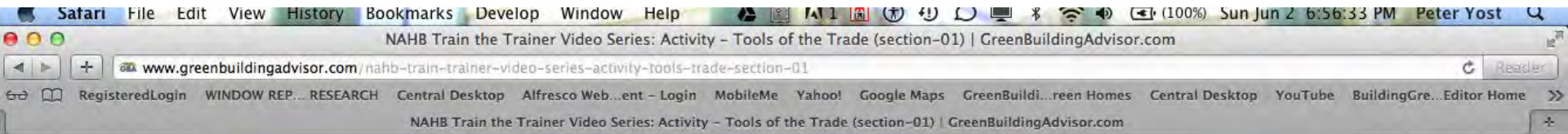
After completing the course, you will be able to:

- Recall how the acronym ENDURE speaks to the unifying aspect of high-performance buildings.
- Describe how to apply the principles of high-performance assemblies in everyday work.
- Employ integrated project delivery to co-design an installation sequence.
- Describe how to manage moisture flow with continuous control layers
- Describe how to achieve continuity in air barrier assemblies
- Determine the best places to locate thermal barriers
- Understand how to deal with vapor diffusion using advanced tools, methods and materials
- Discuss the difference between vented and ventilated assemblies



Course developer Peter Yost explains how high-performance assemblies are fundamentally different from traditional building assemblies.

www.greenbuildingadvisor.com



NAHB Train the Trainer Video Series: Activity - Tools of the Trade (section-01)

Three useful tools for measuring heat and moisture in buildings: infrared thermometer, digital hygrometer, and pin-type moisture meter



Building Science:
Principles



Tools of the Trade



Building Science:
Applied



Welcome to

Green Building Advisor

Not a member yet?

Register for a **FREE Account** to post questions (and answers) in our Q&A forum and comment on blogs.

Or get complete access to Green Building Advisor with our **FREE 10-day Trial**

Join the best green building conversation on the web

Videos in this Series:

How (Older) Houses Work

Wednesday, Feb. 27th: Session I

Wednesday, Mar. 6th: Session II



5:30 - 7:30 pm

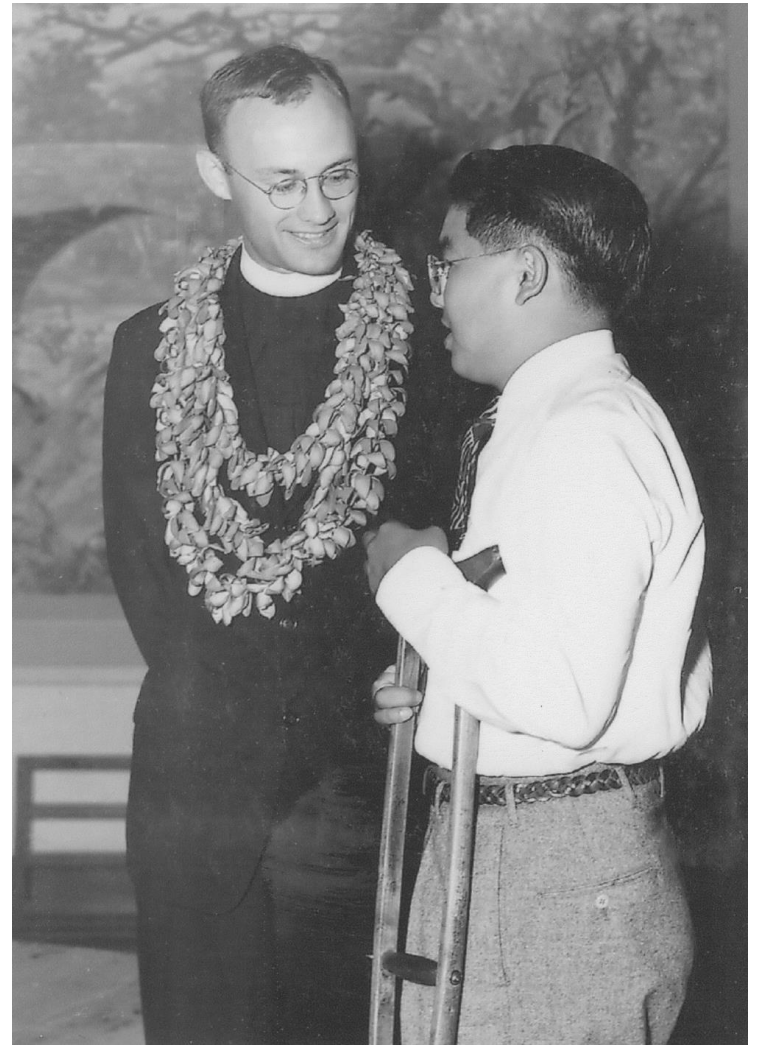
WWII Club
50 Conz Street
Northampton, MA

Attend One session: \$20

Attend Both: \$30

Feb. 27 & Mar 6: How Older Houses Work

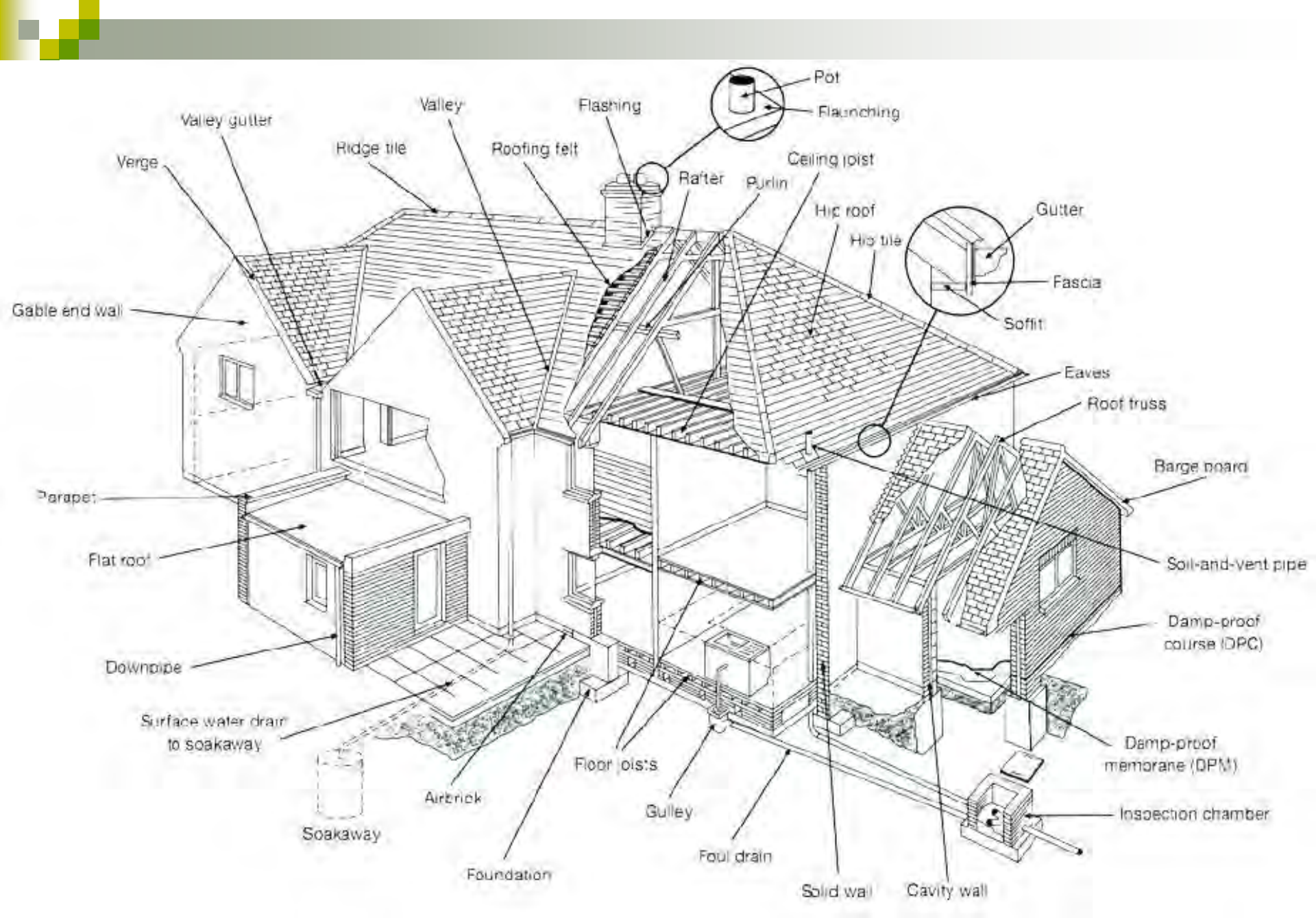
Chaplain Israel Yost 100th infantry (AJA – HI “one puka puka”)





Getting Started - Resources

- www.greenbuildingadvisor.com
 - Green Basics
 - Embedded glossary
 - Search
- “How Your House Works” - Charlie Wing
- “How Buildings Work” – Edward Allen
- “Residential Energy” – John Krigger & Chris Dorsi



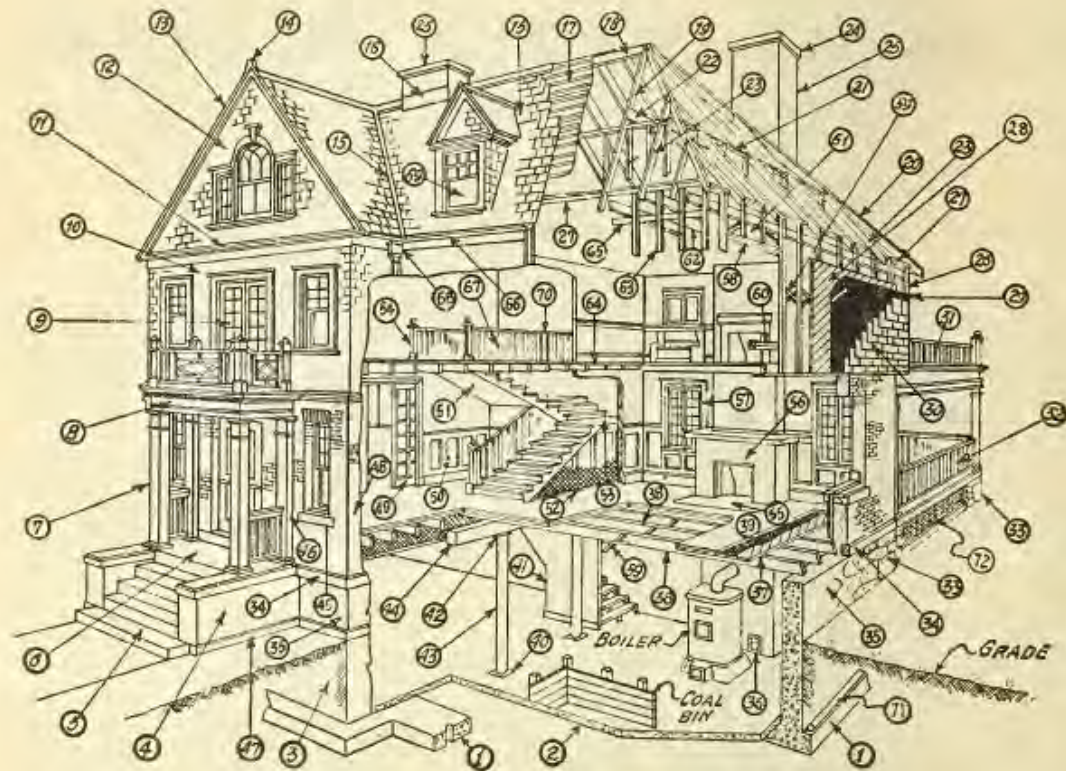


FIGURE 1.—Essential parts of a house

- | | | |
|-----------------------|-------------------------|--------------------------|
| 1. Footings. | 25. Chimney. | 49. Sliding door. |
| 2. Basement floor. | 26. Corner post. | 50. Wainscoting. |
| 3. Foundation wall. | 27. Plate. | 51. Stair soffit. |
| 4. Buttress. | 28. Diagonal sheathing. | 52. Metal lath. |
| 5. Steps. | 29. Sheathing paper. | 53. Platform. |
| 6. Platform. | 30. Shingle. | 54. Newel post. |
| 7. Porch column. | 31. Balcony. | 55. Hearth. |
| 8. Porch cornice. | 32. Veranda. | 56. Fireplace. |
| 9. French doors. | 33. Piers. | 57. Casement window. |
| 10. Frame wall. | 34. Water table. | 58. Rough head. |
| 11. Eaves cornice. | 35. Underpinning. | 59. Bridging. |
| 12. Gable end. | 36. Clean-out door. | 60. Rough sill. |
| 13. Rake cornice. | 37. Subfloor. | 61. Truss over opening. |
| 14. Finial. | 38. First-floor joists. | 62. Ceiling joists. |
| 15. Valley. | 39. Finish floor. | 63. Studding. |
| 16. Chimney flashing. | 40. Column base. | 64. Second-floor joists. |
| 17. Shingle battens. | 41. Plaster partition. | 65. Ribbon board. |
| 18. Ridge board. | 42. Column cap. | 66. Gutter. |
| 19. Common rafter. | 43. Iron column. | 67. Balustrade. |
| 20. Hip rafter. | 44. Girder. | 68. Leader head. |
| 21. Purlin. | 45. Window sill. | 69. Dormer window. |
| 22. Collar beam. | 46. Pilaster. | 70. Handrail. |
| 23. Jack rafter. | 47. Ground course. | 71. Drain. |
| 24. Chimney cap. | 48. Brick wall. | 72. Lattice. |

Your house is a lot like your car...
...except for how it is built.



Practicing this stuff at home....



Changing the way your home works





What *should* your home do for you?

- Shelter
- Comfort/health
- Safety
- Value
- Thrifty
- Beauty



What do buildings do for us?



Keep stuff out...

- Weather
- Pests
- Bad people



Keep stuff in...

- Heat or “coolth”
- Pets
- Good people



Let stuff in...

- Sunlight
- Fresh air
- Clean water
- Power (electricity)



Let stuff out...

- Stale air
- Excess moisture
- Combustion by-products
- Waste water



What ***doesn't*** your home do for you?

Why not just a home inspection?

[Home](#) [Homebuyers / Sellers](#) [Join ASHI](#) [Resources](#) [Members Only](#) [Education](#) [InspectionWorld](#)

Search



Palm-Tech
HOME INSPECTION SOFTWARE

Email Reports from
Your Mobile Device

[Contact Us](#) | [Member Login](#)

[Home](#) > [Resources](#) > [Standard of Practice](#)

Insulation and ventilation

TABLE OF CONTENTS

- [Introduction](#)
- [Purpose & Scope](#)
- [Structural System](#)
- [Exterior](#)
- [Roof System](#)
- [Plumbing System](#)
- [Electrical System](#)
- [Heating System](#)
- [Air Conditioning Systems](#)
- [Interior](#)
- [Insulation and Ventilation](#)
- [Fireplaces and Solid Fuel Burning Appliances](#)
- [General Limitations and Exclusions](#)
- [Glossary of Italicized Terms](#)

11. INSULATION AND VENTILATION

POSTCARDS FROM THE FIELD



[More Postcards](#)

FROM THE ASHI REPORTER



[Read This Month's Issue](#)

Why not just a home inspection?

11. INSULATION AND VENTILATION

11.1 The *inspector* shall:

A. *inspect*:

1. insulation and vapor retarders in unfinished spaces.
2. ventilation of attics and foundation areas.
3. kitchen, bathroom, laundry, and similar exhaust *systems*.
4. clothes dryer exhaust *systems*.

B. *describe*:

1. insulation and vapor retarders in unfinished spaces.
2. absence of insulation in unfinished spaces at conditioned surfaces.

11.2 The *inspector* is NOT required to disturb insulation.

LATEST TWEETS

Learn how conducting a thorough pre-flight procedure can prevent drone-related claims.
<https://t.co/bQNPY4RkE1>

"I eyeballed it..."
#PostcardsFromTheField
<https://t.co/0YVTN1EINM>

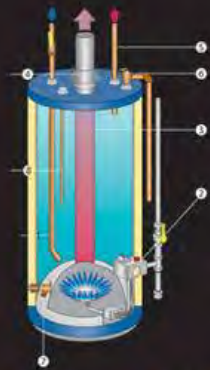


[Follow ASHI on Twitter](#)

FOR INSPECTORS

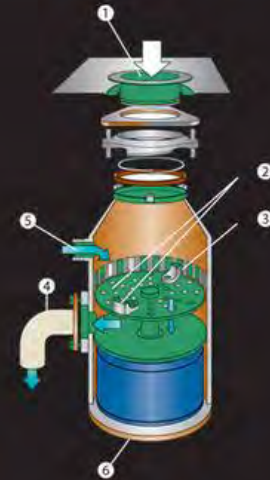
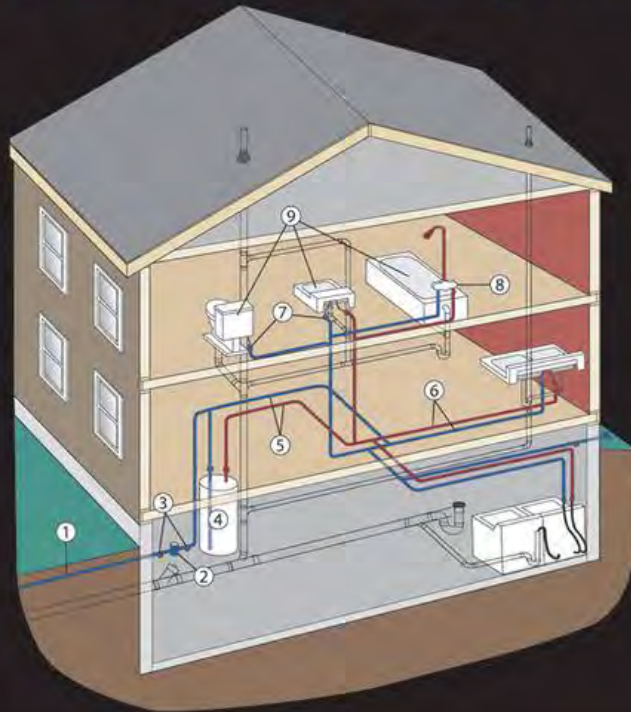
[ASHI Member Perks](#)
[Home Inspector Training](#)
[ASHI Online Learning Center](#)
[ASHI Discussion Forum](#)
[ASHI Print on Demand](#)
[ASHI Reporter](#)
[ASHI Standards of Practice](#)
[ASHI Code of Ethics](#)
[InspectionWorld](#)

UPDATED & EXPANDED



HOW YOUR HOUSE WORKS

A Visual Guide to Understanding and Maintaining Your Home



CHARLIE WING

RSMeans

Building Performance Institute



Building Performance Institute, Inc.

Helping you become healthy, comfortable, and efficient at home



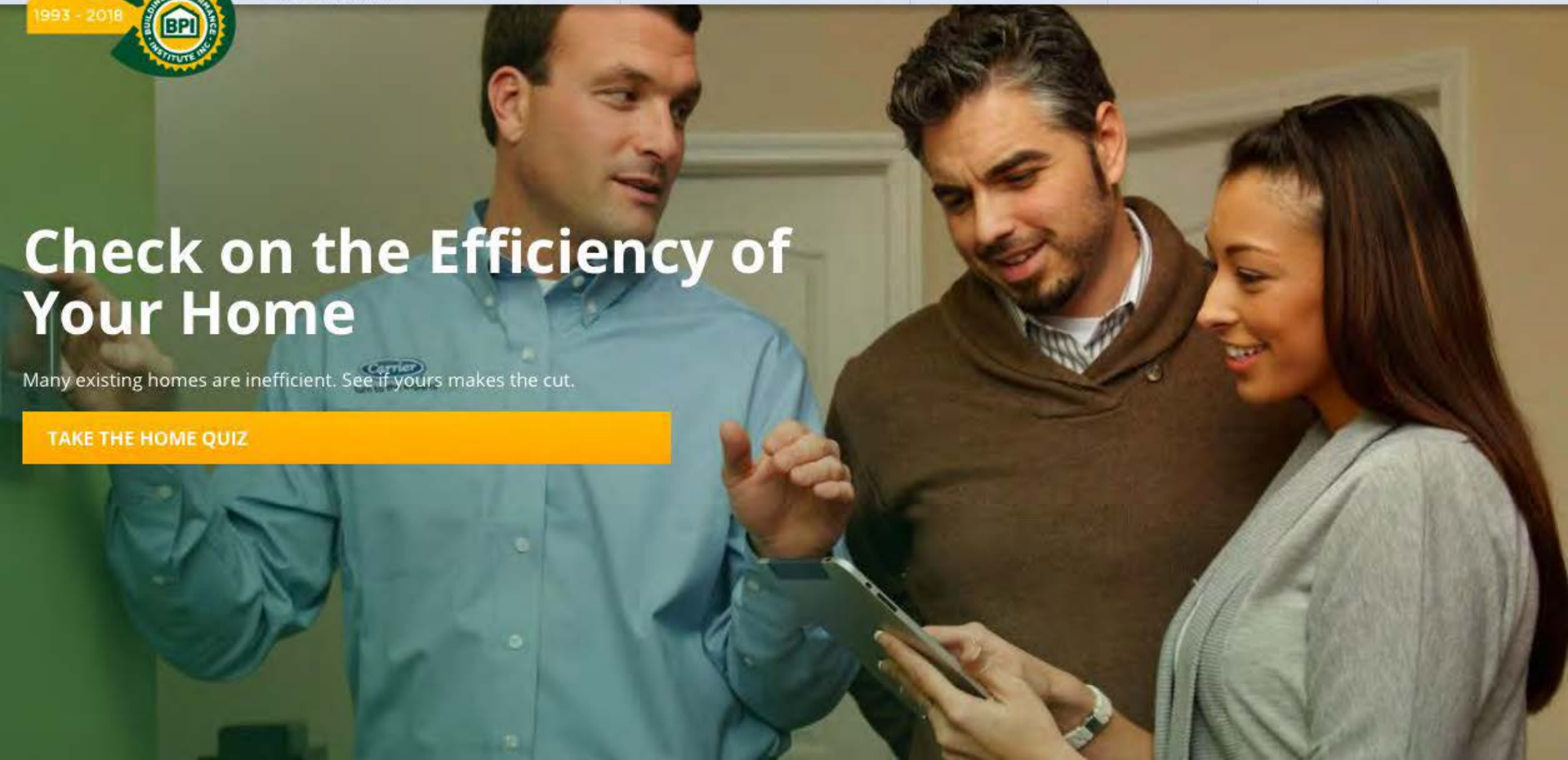
Follow us

[WHAT IS HOME PERFORMANCE](#) [FIND A CONTRACTOR](#) [CASE STUDIES](#) [ABOUT US](#) [BLOG](#)

Check on the Efficiency of Your Home

Many existing homes are inefficient. See if yours makes the cut.

[TAKE THE HOME QUIZ](#)





Definition: Building Science

- “Building science” refers to the discipline of developing effective design and construction solutions for the management of the physical forces that affect a building’s performance (and its occupants), including the movement of air, water, and heat within and through the building enclosure.

Basic Building Science: “Hygrothermics”

```
graph TD; A["Basic Building Science: 'Hygrothermics'"] --> B["WATER"]; A --> C["HEAT"]
```

WATER

HEAT




Hygrothermic principles

- Most building materials don't perform as well when they are wet
- Colder building materials don't dry out as much/as well
- Insulation can make building materials colder and wetter, longer
- If you manage energy better, you must manage water better

Building-Wright building assessment form

| BUILDING ASSESSMENT | |
|--|---|
| <p>The goal of every building is to have comprehensive and continuous management of:</p> <ul style="list-style-type: none">• Bulk water• Air leakage• Heat flow• Vapor (and soil gases)• Pests (insects, rodents, etc.)• Wildfire (location-dependent)• Indoor Air Quality <p>When we improve the energy efficiency of a building, we need to evaluate moisture management with the same degree of care. This worksheet systematically lists the items you need to check to understand how and how well a building is performing in terms of energy, durability, and human health and safety.</p> <p>The final section—Explanations/Resources—can help you with each item below.</p> | |
| RENOVATOR: _____ | INTERIOR DESIGNER: _____ |
| OWNER: _____ | ARCHITECT: _____ |
| BUILDING ADDRESS: _____ | |
| TRADES: _____ | |
| DATE OF ASSESSMENT: _____ | |
| EXISTING BLDG | # Stories: _____ Foundation Type _____ |
| | Orientation: _____ Exterior Siding _____ |
| | <input type="checkbox"/> Garage (attached/detached) |
| Year built _____ | # Years in building _____ |
| History | |
| _____ | |
| _____ | |
| Complaints and Problems Noted | |
| _____ | |
| _____ | |
| Comfort Issues | |
| _____ | |
| _____ | |
| Summary of Scope of Work | |
| _____ | |
| _____ | |
| _____ | |



Water moves over/on/through buildings in 4 ways

- Bulk water (mostly down)



Assessment:

Site water management

- Soil(s)
- Slope(s)
- Drainage pathways
- Depth to groundwater table
 - Holes dug?
 - Neighbors: holes dug?
- Hardscapes (driveway, walkways)
- Puddles



Assessment:

Building(s) water management

- Roof loads
 - Gutters and downspouts
 - Variegated landing zone
 - Roof complexity(ies)
- Finished grade slope building perimeter
- Distance: finished grade to wood
- Foundation perimeter drains (sump or drain-to-daylight)

An Underground Roof?

A below-grade detail that handles water off of roofs when gutters can't



By Peter Yost | May 17, 2011





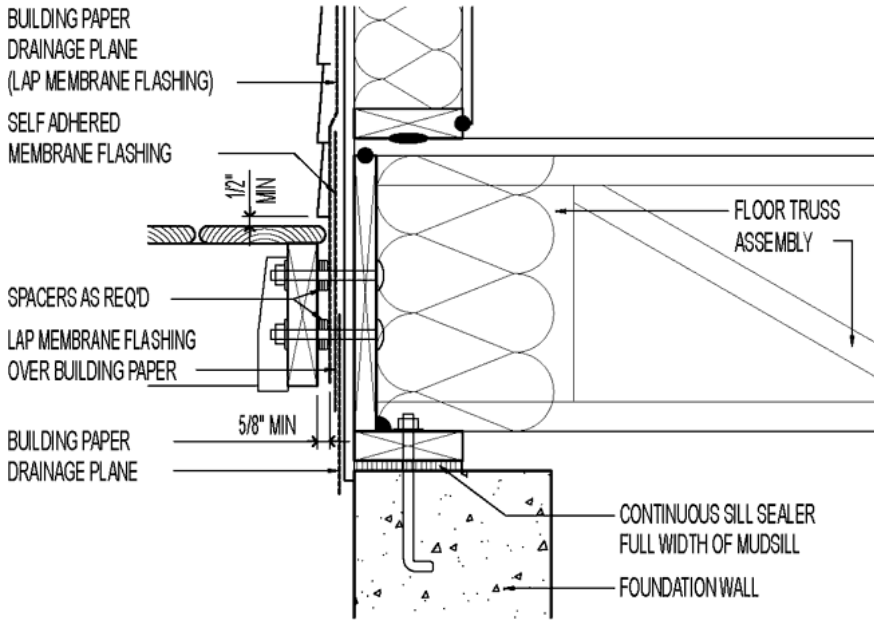
Assessment:

Building(s) water management

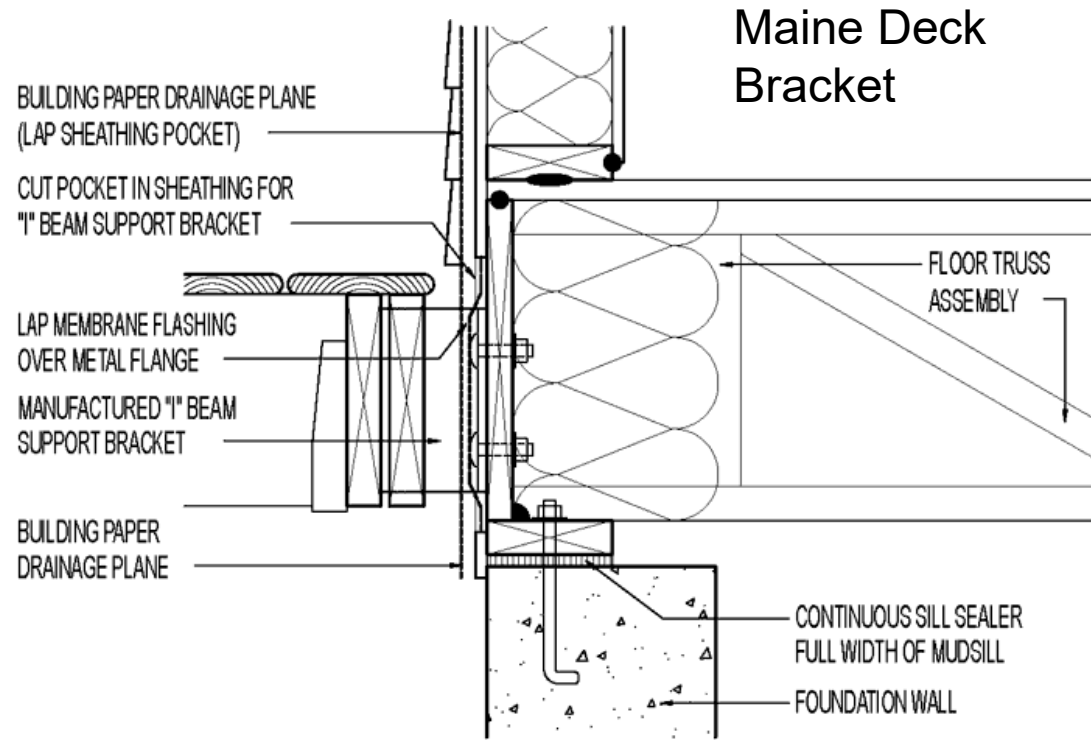
- Building perimeter vegetation (irrigation)
- Window/entryway sheltering
- Window plane of installation
- Sills
- Decks
- Miscellaneous penetrations
- Bay/bow windows
- Cantilevers




Attached Decks



Deck Spacers



Maine Deck Bracket



Water moves over/on/through buildings in 4 ways

- Bulk water (mostly down)
- **Wicking (mostly up)**



Your foundation(s)

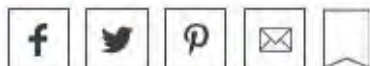
- Bulk water leaks into your home
- Wicking from soil (efflorescence and rising damp) - bare dirt and evaporation
- Wicking through porous building materials
 - Slabs and evaporation
 - Sill beams/mud sills/rim joists

Water Tables and Basements

How to use geologic, soil, and historical maps to keep your basement dry



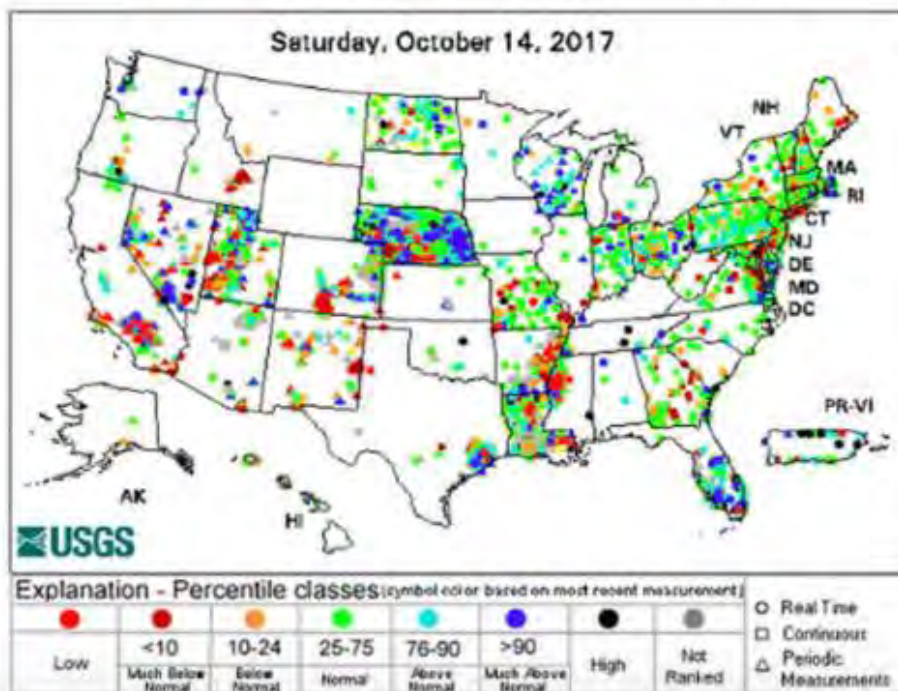
By Peter Yost | October 26, 2017




Long-Term Groundwater Data Network

Use the buttons above the map to select the data frequency and length of record.
NOTE: Javascript must be enabled for the map to work correctly.

| | | |
|---|--|--|
| <input checked="" type="radio"/> Annual Data | <input type="radio"/> Monthly Data | <input type="radio"/> Daily Data |
| <input checked="" type="radio"/> 20 Years or More | <input type="radio"/> 30 Years or More | <input type="radio"/> 50 Years or More |





Water moves over/on/through buildings in 4 ways

- Bulk water (mostly down)
- Wicking (mostly up)
- **Leaking air (all over the place by pathways – a “point” effect)**

When air moves, it is always carrying moisture with it...



What drives air leakage (a hole, another hole, driving force)?

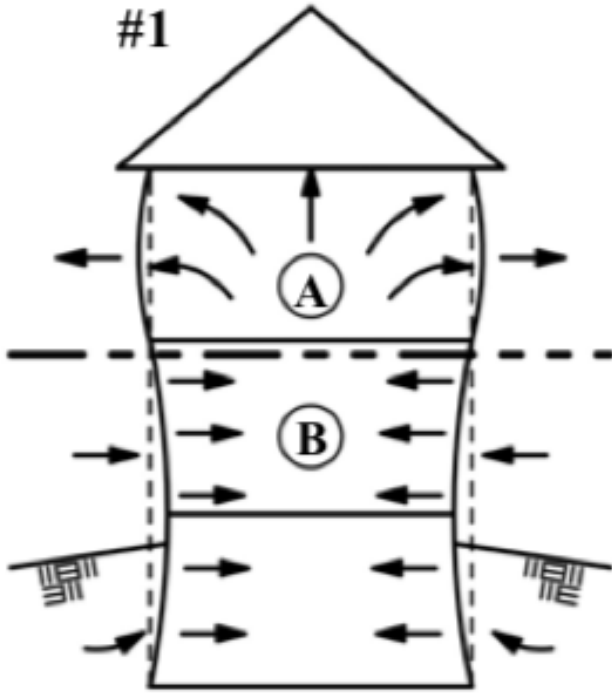
- Stack Effect

- Wind

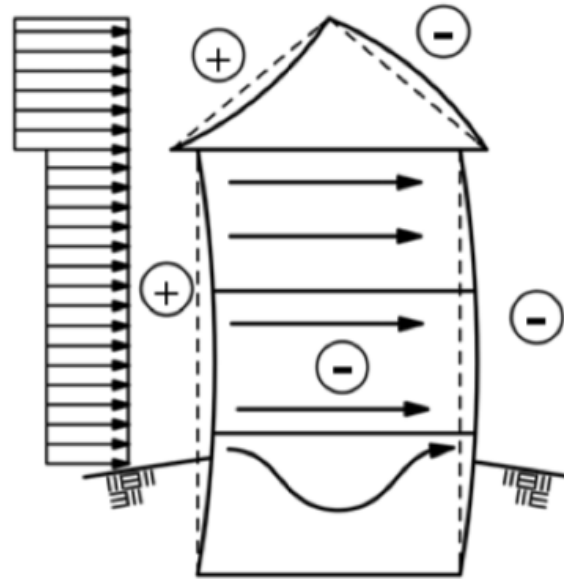
- Fans
 - Forced air space conditioning systems
 - Ventilation systems
 - Exhaust fans

Air leakage driving forces

#1

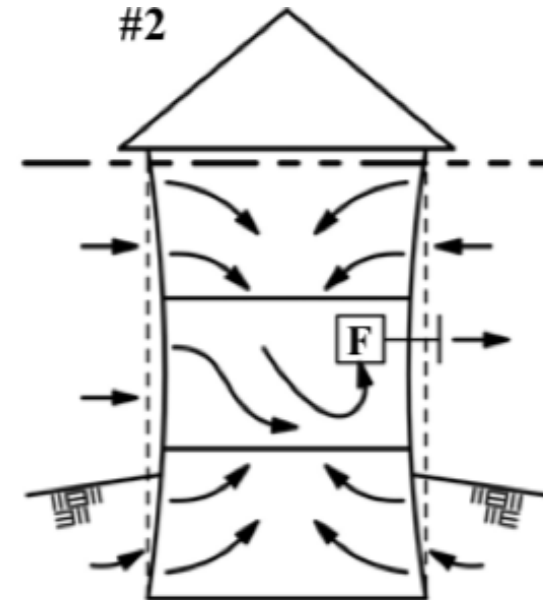


Stack effect




Wind

#2



Fans (exhaust)



Water moves over/on/through buildings in 4 ways

- Bulk water (mostly down)
- Wicking (mostly up)
- Leaking air (all over the place by pathways)
- **Vapor (space to space by pressure – a “field” effect)**

Special vapor situations

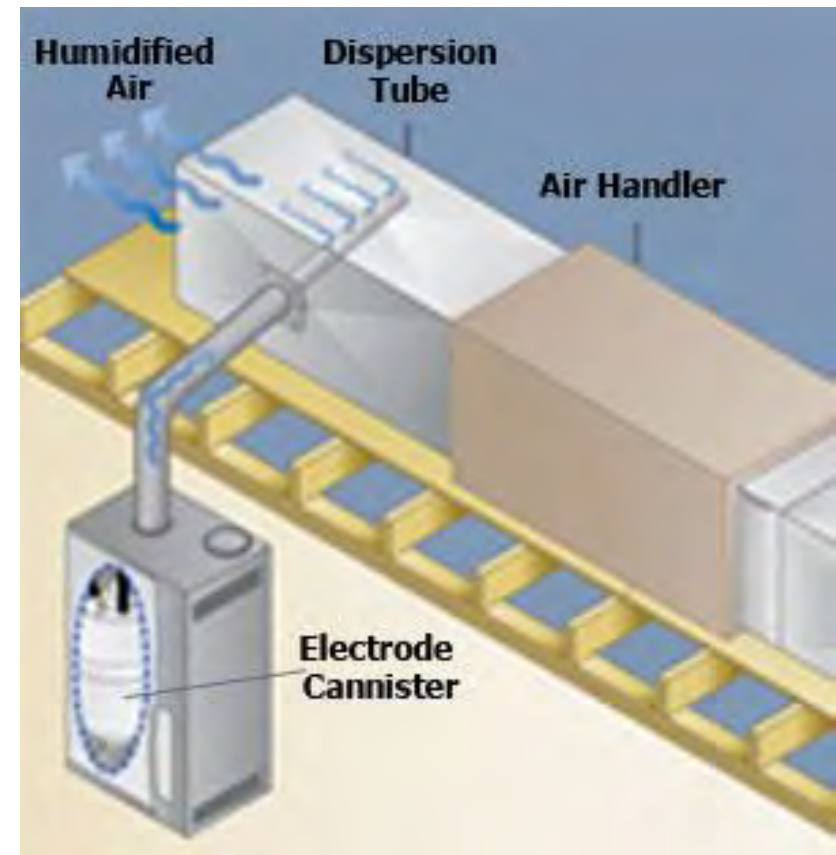


Special situations: humidifiers



Scroll wheel

Steam



Sources - Household Moisture

| Source | Quantity (pints) |
|---------------------|-------------------------|
| Showering | ??? |
| Clothes drying | 4 - 6/load |
| Cooking (dinner) | 1.2 (+1.5 gas) |
| 5 house plants | 1/day |
| 1 cord “green” wood | 600 - 800/season |
| 4 people | .5/hour |
| Building materials | ??? |
| Ground moisture | 0 - 100/day |

Source: Minnesota Extension Service (also, see GBA blog...)

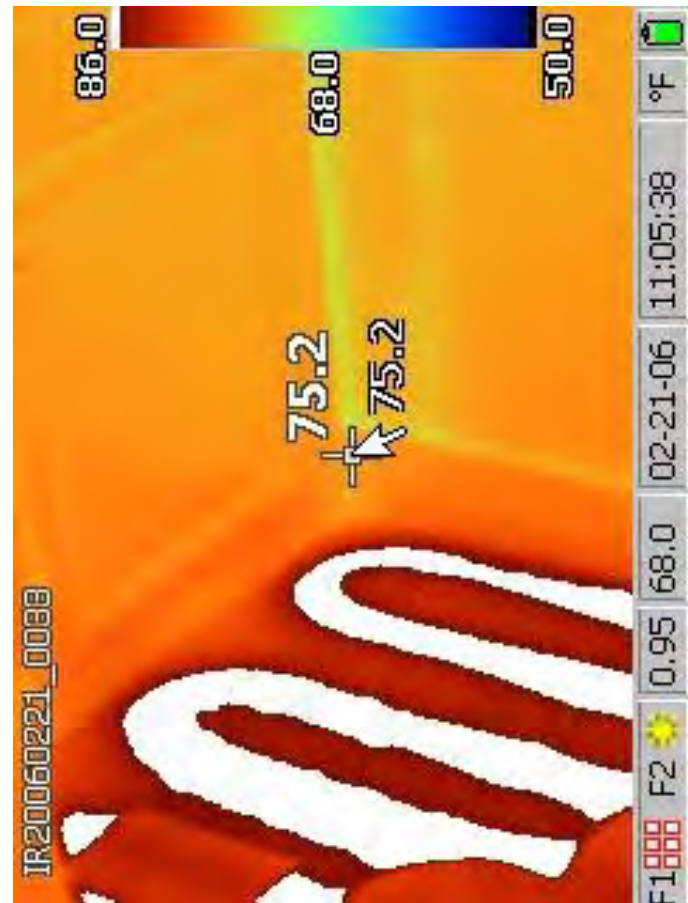
Sources - Household Moisture

| Source | Quantity (pints) |
|---------------------------|----------------------------|
| Showering | .5 (5 - min shower) |
| Clothes drying | 4 - 6/load |
| Cooking (dinner) | 1.2 (+1.5 gas) |
| 5 house plants | 1/day |
| 1 cord “green” wood | 600 - 800/season |
| 4 people | .5/hour |
| Building materials | 6 - 17/day |
| Ground moisture | 0 - 100/day |

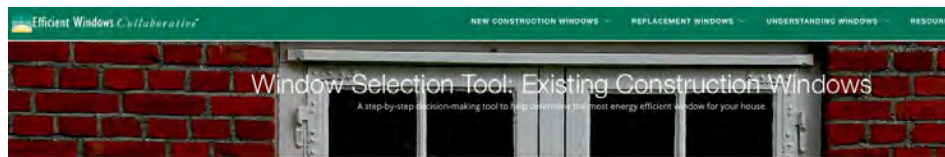
Source: Minnesota Extension Service (also, see GBA blog...)

How does heat get around?

- Radiation – speed of light; surface temperature & area
- Conduction – “fast” through solids
- Convection – “slow” through fluids



Windows: most complex heat transfer



A screenshot of the 'Window Selection Tool' interface. It features a navigation bar with 'SELECT LOCATION', 'SELECT HOUSE TYPE', 'SELECT WINDOW TYPE', and 'NEXT' buttons. Below the navigation is a map of the United States color-coded by Energy Star Zones: North (blue), South Central (yellow), South (orange), and South West (red). To the right of the map is a text box explaining the tool's purpose and use. The AERC logo is visible at the bottom of the interface.



[About AERC](#) [Membership](#) [Certification Program](#) [Resources](#) [News](#) [Contact](#) [Members Only](#)

[Home](#) > [Resources](#) > [Window Attachments](#)

Window Attachments

About AERC

- > [Leadership](#)
- > [Project Partners](#)
- > [AERC FAQs](#)
- > [Privacy Policy](#)

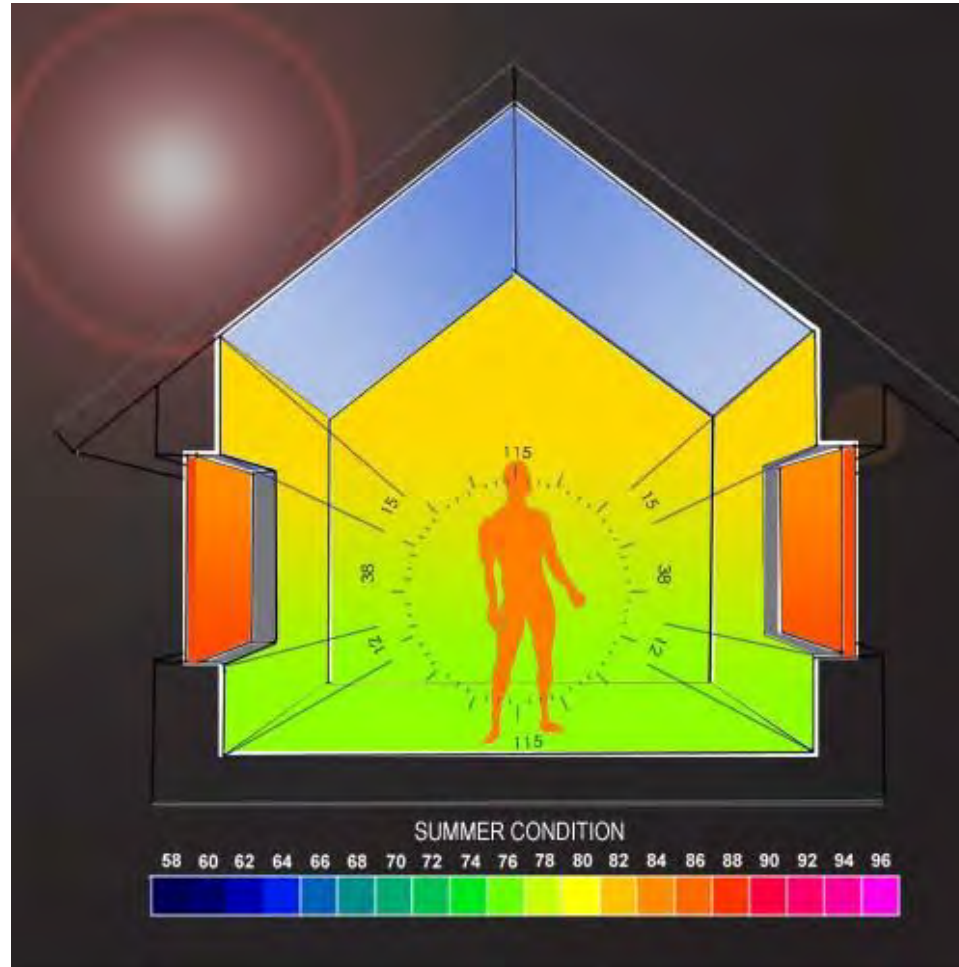
Membership

About Window Attachments

Window attachments are products installed either internally or externally on a window that can serve a variety of purposes including: adding to the room aesthetic, protection, enhanced view and natural light, reducing draftiness, lessen glare and heat from the sun, or privacy. These products include low-emissivity (low-e) storm windows and interior panels, cellular shades, interior and exterior shades and shutters, window films, solar screens, window quilts, window films, and awnings.

Examples and descriptions of window attachment products provided courtesy of Efficientwindowcoverings.org.

Thermal Comfort – Operative Temperature



**Operative temperature \approx
50% air temperature + 50% mean radiant temperature**



Prioritizing moisture movement

- #1 – bulk water
- #2 – capillary water
- #3 – air-transported moisture
- #4 – diffusive moisture movement



Prioritizing heat transfer

- #1 – convection (air sealing)
- #2 – conduction (insulation)
- #3 – radiation (coatings in windows)



Prioritizing your actions

- #1 – Bulk water management
- #2 – Air sealing
- #3 – drying potential of building assemblies
- #4 - Insulation



Prioritizing air sealing

- #1 – Top (attic)
- #2 – Bottom (rim joist/sill beam)
- #3 – Shafts (basement to attic)
- #4 – Walls/windows



Mold/Rot Basics

- Temperature/Food/Water/Air
- Molds (spores) are everywhere, all the time...
- They like the same temperatures we do...
- They like many of the materials out of which we like to build...
- Mold generally shows up at 19% MC or higher
- Rot requires 25- 28% MC
- The easiest/most effective approach to control mold/rot is, generally, managing moisture.

Puzzle 1 (Zone 6) – Insurance co. mitigated kitchen mold keeps coming back...



View as you drive up...



Pieces – addition with full basement



Crawlspace inspection...



“Incorrectly-installed” floor insulation...





Key Takeaways/Lessons Learned

- Do the “edges” first...
- Existing info
- “Walk” the exterior (bulk water)
- Foundation (bulk & capillary)
- Follow the water...



Puzzle 1 - New Construction Takeaway

- “Confused” areas of buildings are a REAL problem
- Make sure that attics & crawlspaces are either completely in or completely outside your control layers: water, air, & thermal

Puzzle 2 (Zone 5b) – mold in attic



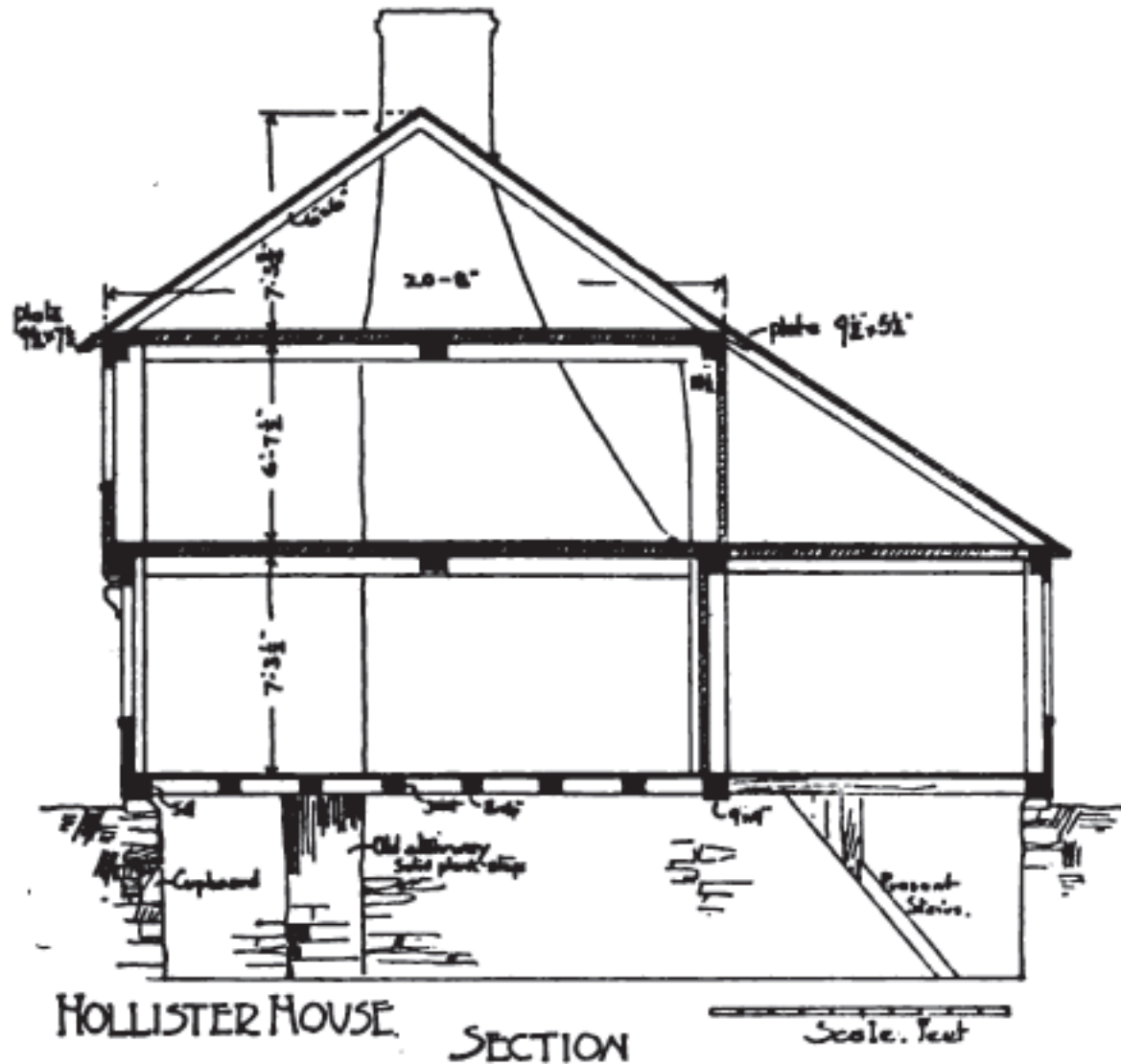
Mold in the Attic



North side



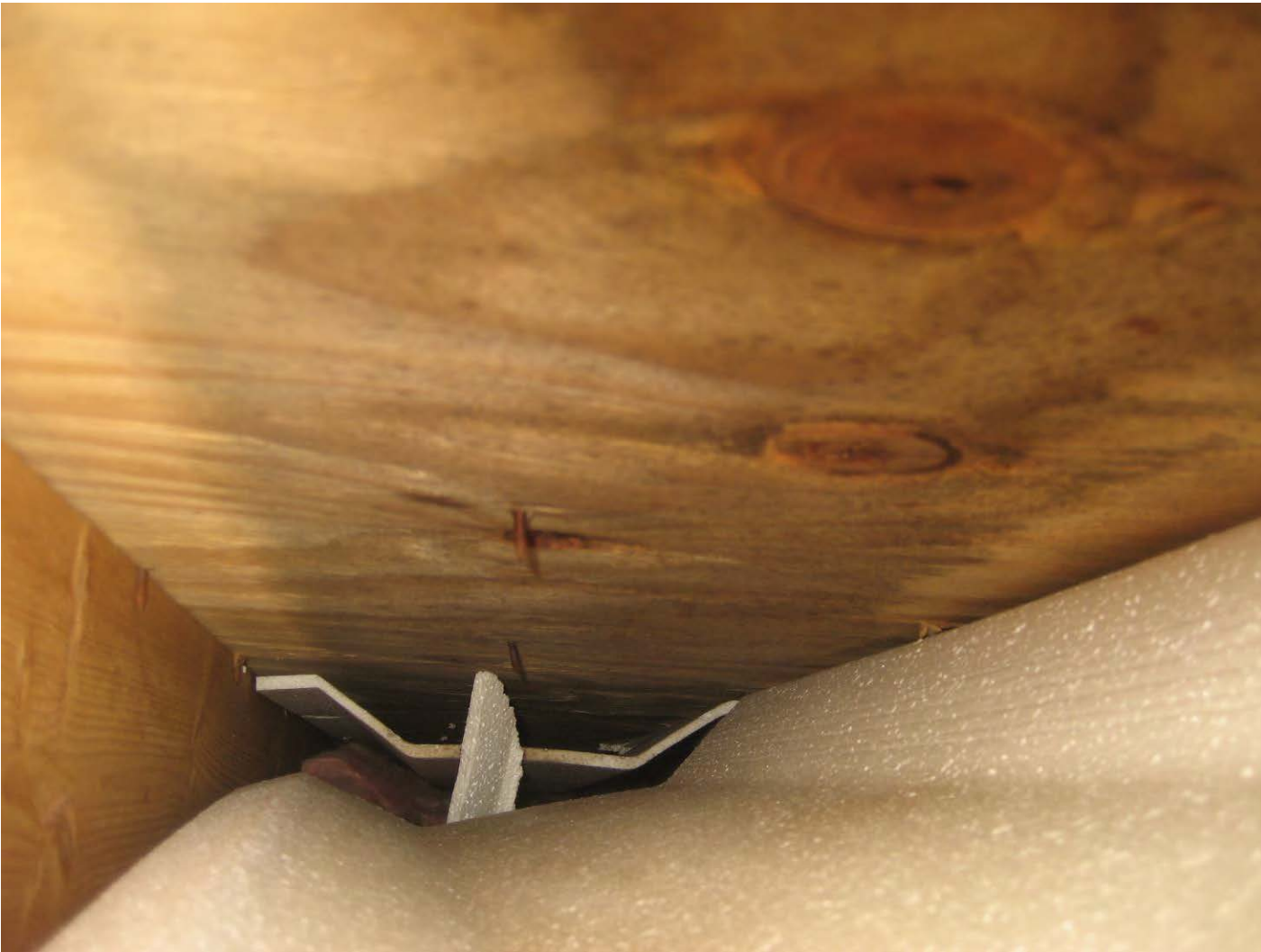
Classic "Saltbox"



Original diagnosis: inadequate attic ventilation



In the knee wall

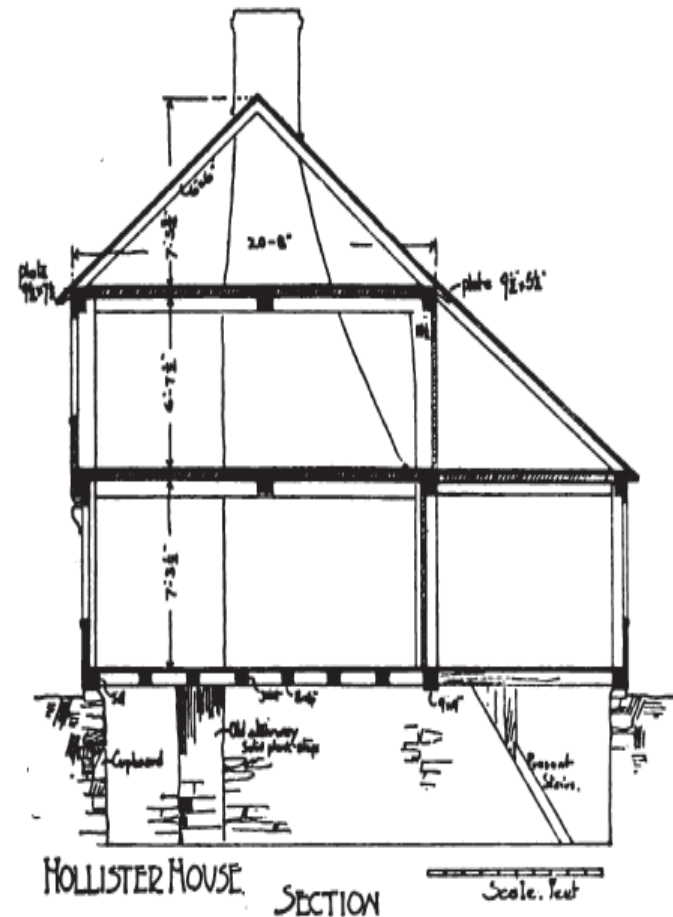


Patterns in the Attic Mold?



Pieces

- Mold in attic
- Home inspector: inadequate attic venting
- HI “solution:” add mechanical attic exhaust



North side



Knee wall attic doors



Key Takeaways/ Lessons Learned

- Patterns of moisture expression are key
- Back-up “arm-chair” building science with on-site full confirmation
- Follow the water...



Puzzle 3 (Zone 5b) – DER with damp basement



DER of 1st & 2nd floor office space
but concerns with damp basement





Pieces

- Interior gut of wood-frame building to significantly improve energy efficiency
- Engineer on project encouraged hygrothermal building assessment
- Significant moisture issue(s) in basement











Moisture data from basement

- Thermastor Santa Fe DEH set on 70%
- Hygrometer readings: 69F, 70% RH
- 1st floor framing in direct contact with brick foundation; MC readings, generally: 12 – 13%
- 2 spots with 19% MC

Equilibrium moisture content (EMC)

| EMC Calculator | |
|---------------------|---|
| Required Data Entry | |
| Temperature (F) | <input type="text" value="69"/> Degrees |
| Relative. Humidity | <input type="text" value="70"/> Percent |
| EMC | <input type="text" value="13.1"/> Percent |

Moisture Detection System

Moisture Content, RH, T, CO2
wireless, data-log, wired
systems

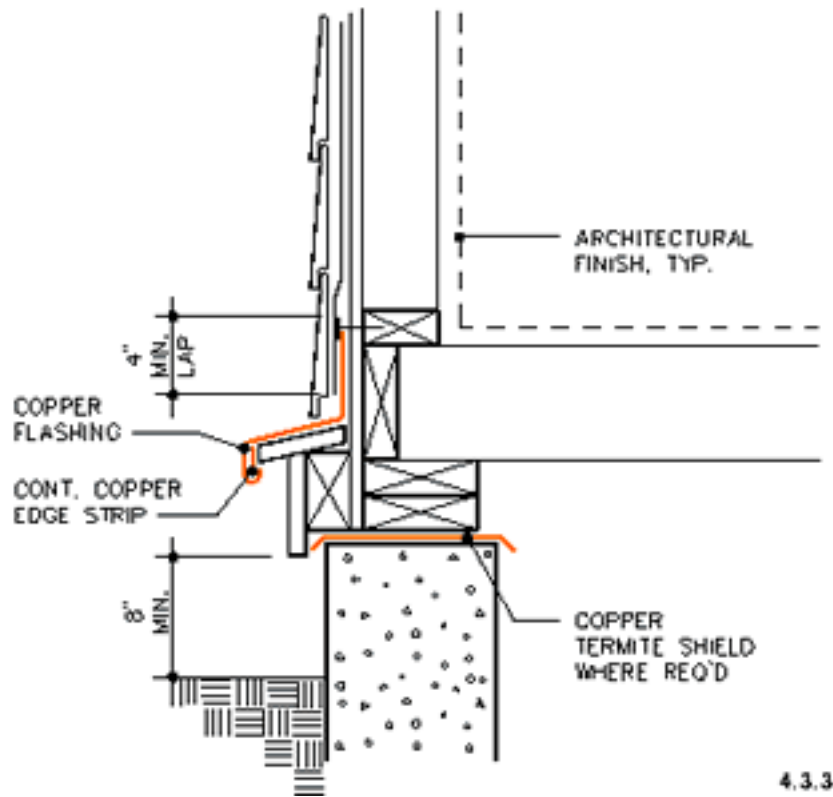
● ○

Bulk water manage 2 “spots”





Re-building the wood siding water table with rigid insulation



Detail from Copper Development Association Inc.



Key Takeaways/Lessons Learned

- Correlate wood moisture content with RH, if you can
- Maintain or improve moisture-energy balance
- Warm suspect elements when you can



Whew...

Puzzle fatigue...



Summary: Assessment b4 Action; manage E and M w/ = intensity

- Moisture first
 - Bulk water/capillary water
 - Air-transported moisture (double bennie here with managing heat as well)
 - Attic air sealing first; rim joist/sill next
 - Maintain/improve drying potential of assemblies
- IAQ next or along the way
 - Combustion safety
 - Radon
- Thermal last



Prep for Thursday May 30...

- Your burning questions...
- Your projects
- Using/addressing the Building Assessment form
- Using GBA
 - Building Science videos
 - Green Homes remodeling projects

http://seon.info/WMGC_HOHW_B-W1