PHRC Webinar Series | Tuesday, October 13, 2015 @ 1pm

Where to Draw the Line with Thermal Boundaries

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Description

- A Thermal Boundary is a term used to describe when flow of heat is restricted or slowed which is accomplished through insulation and a continuous air barrier. This one hour webinar will start off by discussing the definition of a thermal boundary in regards to residential construction. Next, a brief plan review will be completed showing key elements and requirements of the thermal boundary along with applying the "pen test" on a house cross section. The webinar will finish up by reviewing code and above code check lists to ensure the thermal boundary is compliant at both the plan review stage and during construction. At the end of this webinar, one will know how to identify, inspect and properly construct a durable and effective thermal boundary.

2

Learning Objectives

- Understand how to locate the thermal boundary and ensure that it is continuous by reviewing the construction documents, in particular, the cross section.
- Understand why proper construction of a thermal boundary is important to the health of not just the building assembly, but also the occupants.
- Understand the economic impact of a properly constructed thermal boundary through the reduction of heating and cooling costs.
- Recognize the code compliance paths. This will be delivered through reviewing construction documents along with pictures taken throughout the construction process.

3

Outline

- **What is a Thermal Boundary?**
- **What components make up a Thermal Boundary?**
- **Pen Test**
- **Summary**

4

What is a Thermal Boundary?

- A thermal boundary is not one specific stand-alone component in the building system. The thermal boundary is a system that composes the separation assembly from a conditioned area to an unconditioned area. To be effective, a thermal boundary must include two key components:
  - Water Barrier
  - Air Barrier
  - Thermal Barrier

5

The successful Thermal Boundary

- A thermal boundary can not work with one independent building material. It is an assembly and can only perform to its greatest potential if it is constructed as such.

6

Air Barrier and Thermal Barrier

7

Air Barrier

- An air barrier is any material that restricts the flow of air through a construction assembly. In wall assemblies, the exterior air barrier is typically a combination of **sheathing** and either housewrap, rigid insulation, drywall or spray foam.

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12

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14

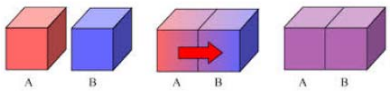
Air Barrier

- An air barrier is any material that restricts the flow of air through a construction assembly. In wall assemblies, the exterior air barrier is typically a combination of sheathing and either housewrap, rigid insulation, drywall or **spray foam.** Closed cell spray foam is typically used in a flash and batt situation where both spray foam and fiberglass batt insulation are both used to fill the stud cavity. Open cell can also be used as an air barrier, provided the correct thickness is used per the manufacturers installation instructions.

16

Thermal Barrier

- A thermal barrier slows the flow of heat. This is usually accomplished with insulation. Insulation comes in several different materials such as fiberglass, mineral wool and cellulose and is applied in ways such as batts, blown-in, spray foam and rigid foam.



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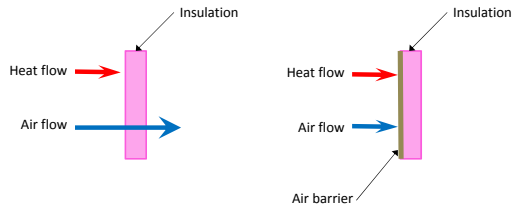
Air Barrier vs. Thermal Barrier

- The difference between and air barrier and thermal barrier and why both are needed for an adequate thermal boundary.



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Thermal Alignment

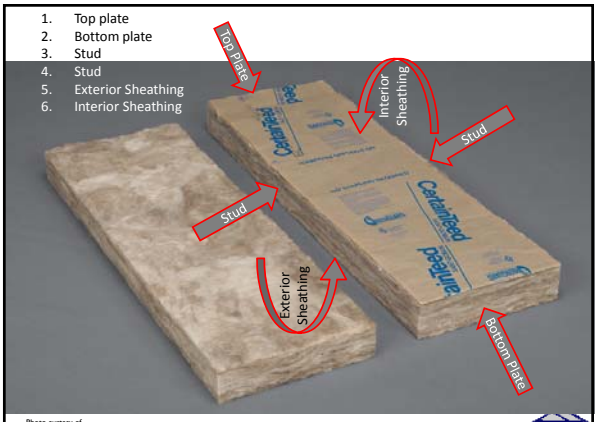
21

Key to a successful Thermal Boundary

- **Thermal Alignment**
  - Regardless of which material and application is used, insulation is not fully effective unless it is installed properly. This means it must be fully aligned with a continuous air barrier.
  - This means that it should be encapsulated on all 6 sides to be most effective.
    - Exception:
      - Attic insulation
      - Band joist insulation

22

1. Top plate
2. Bottom plate
3. Stud
4. Stud
5. Exterior Sheathing
6. Interior Sheathing



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Water Barrier

24

Water Barrier

- First line of defense for water intrusion is the exterior cladding.

25

Water Barrier

- Second line of defense for water intrusion can be the water-resistive barrier. This can be installed as a system using housewrap or rigid foam and flashing details.

26

27

28

The Pen Test

29

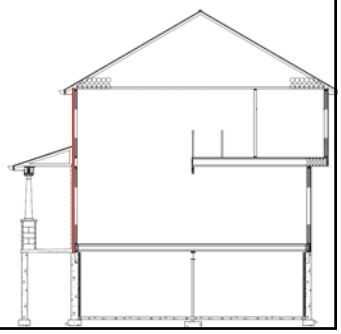
The Pen Test

- The Pen Test is an exercise that helps point out potential areas of concern within the thermal boundary. This is a simple test where you examine a building section and trace the control layers for Water Barrier, Thermal Barrier and Air Barrier. If at any point you have a disruption, you may have a flaw in your design. The pen test can also be a tool where you can translate critical areas of concern to contractors to ensure proper installation.

30

Exterior wall

- The thermal boundary in an exterior wall:
  - Bulk water
    - Cladding
    - Water-resistive barrier
    - Flashing
  - Heat
    - Insulation
    - Thermal Alignment
    - Mechanicals
  - Air infiltration
    - Air barrier
    - Penetrations
    - Flashing



31

Cladding

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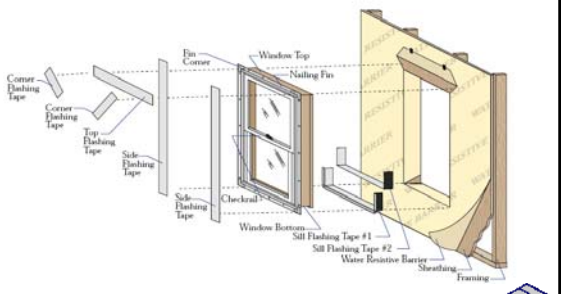
Water-resistive barrier and Penetrations

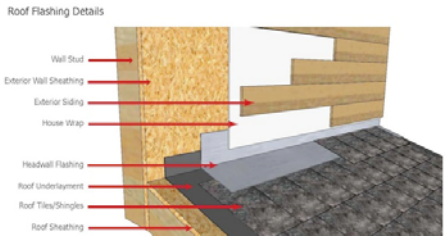
33

Penetrations: Windows



34

Flashing: Head Flashing at roof wall



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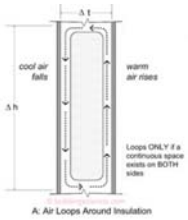
Insulation: Walls

Insulation: Full alignment

- **What happens if the insulation is not fully aligned?**

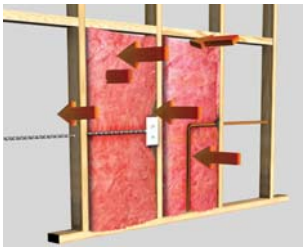


A: Air Loops Around Insulation

Warm air rises and cool air falls. This is called a convective loop. What happens to the efficiency of the insulation?

Insulation: Free of voids and gaps

- **Insulation should fill the entire cavity.**

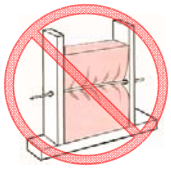
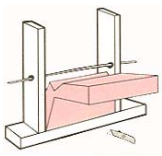
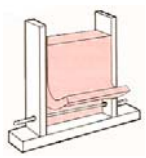


Insulation should be tight fitting around electrical boxes and cut to proper length to eliminate voids and gaps.

McGraw Hill Construction

Insulation: Free of compression

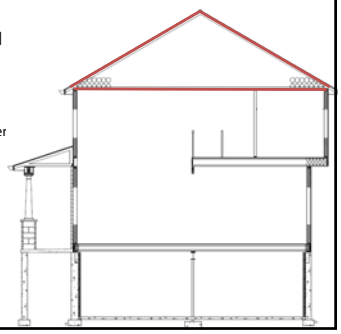
- **Insulation should be free of compression caused by obstructions in the stud bay.**

Images from Oikos.com

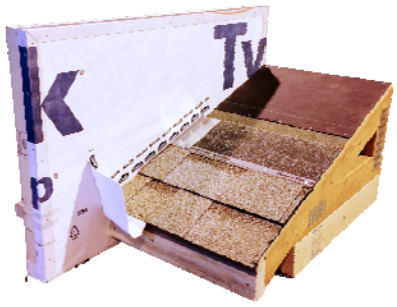
Attic floor / Conditioned space ceiling

- The thermal boundary in an attic floor / conditioned space ceiling:
  - Bulk water
    - Roofing system / Shingles
    - Underlayment / ice & water shield
    - Flashing
  - Heat
    - Insulation
    - Thermal Alignment
  - Air infiltration
    - Air barrier
    - Penetrations



40

Roofing System: Shingles, felt paper & flashing

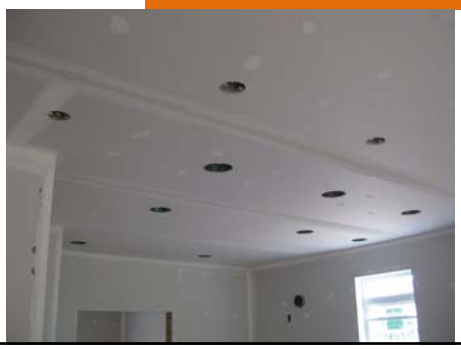


41

Attic floor: Insulation

42

Attic floor: Air barrier / Penetrations



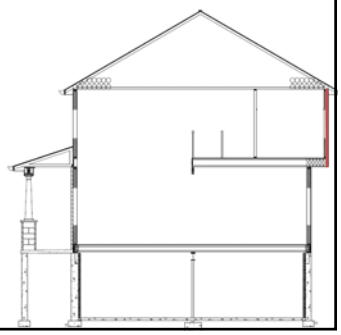
43

Conditioned attic: Insulation

44

Exterior wall / Rim Joist

- The thermal boundary at the Rim Joist:
  - Bulk water
    - Cladding
    - Water-resistive barrier
  - Heat
    - Insulation
    - Thermal Alignment
  - Air infiltration
    - Air barrier
    - Penetrations
    - Framing joints



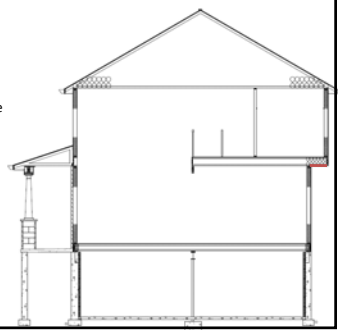
45

Rim joist insulation

46

Exterior: Joist cantilever

- The thermal boundary at Joist Cantilever:
  - Bulk water
    - Soffit
    - Continuous Water-resistive barrier
  - Heat
    - Insulation
    - Thermal Alignment
  - Air infiltration
    - Air barrier
    - Penetrations
    - Flashing

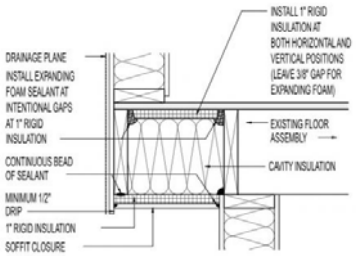


47

Air barrier: Cantilever

48

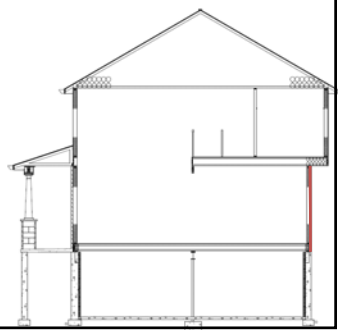
Cantilever



49

Exterior wall / Rim Joist

- The thermal boundary at the Rim Joist:
  - Bulk water
    - Cladding
    - Water-resistive barrier
  - Heat
    - Insulation
    - Thermal Alignment
  - Air infiltration
    - Air barrier
    - Penetrations



50

Rim joist: Air barrier

51

Rim joist: Insulation

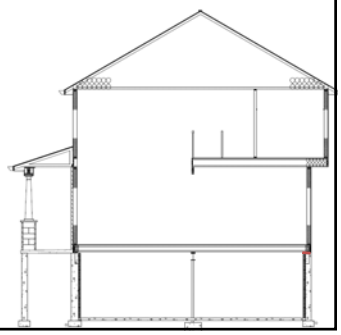
52

Rim joist: Insulation

53

Sill Plate

- The thermal boundary at the Sill Plate:
  - Bulk water
    - Cladding
    - Water-resistive barrier
  - Air infiltration
    - Air barrier



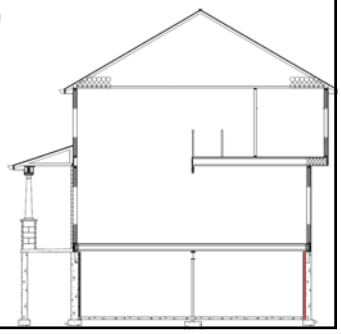
54

Sill Plate: Sill sealer

55

Conditioned basement

- The thermal boundary at a Conditioned Basement:
  - Bulk water
    - Foundation wall / Water proofing
  - Heat
    - Insulation
    - Thermal Alignment
  - Air infiltration
    - Foundation Wall



56

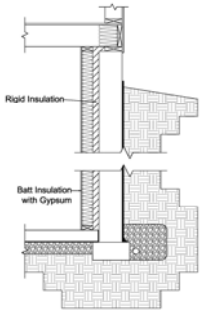
Basement: Waterproofing

57

Conditioned Basement: Insulation

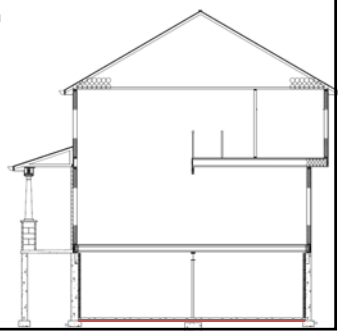
58

Finished Basement: Rigid / Stud wall



Basement Slab

- The thermal boundary at a Basement Slab:
  - Bulk water
    - Class I Vapor Retarder (vapor barrier)
  - Air infiltration
    - Class I Vapor Retarder (vapor barrier)
    - Concrete Slab



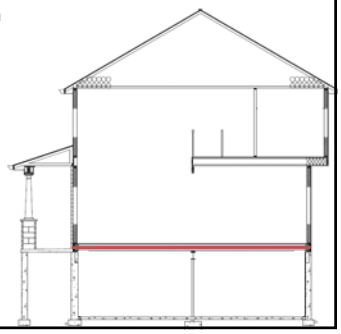
60

Basement Slab: Vapor Retarder

61

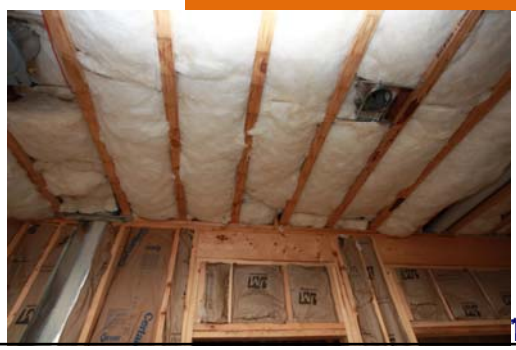
Unconditioned Basement

- The thermal boundary at a Basement Ceiling:
  - Heat
    - Insulation
    - Thermal Alignment
  - Air infiltration
    - Subfloor
    - Concrete Slab



62

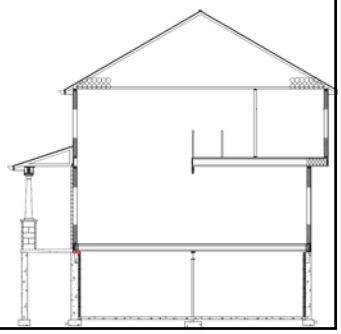
Unconditioned Basement: Ceiling Insulation



63

Sill Plate

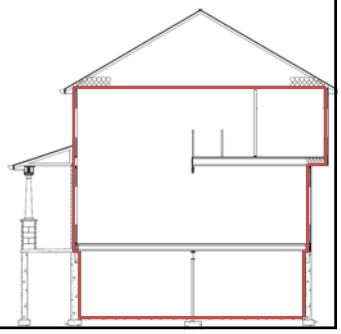
- The thermal boundary at the Sill Plate:
  - Bulk water
    - Cladding
    - Water-resistive barrier
  - Air infiltration
    - Air barrier



64

Pen Test

- The thermal boundary at the Sill Plate:
  - Bulk water
  - Air infiltration
  - Insulation



65

Conclusions

- **A thermal boundary carries many different responsibilities.**
  - Water Barrier
  - Air Barrier
  - Thermal Barrier
- **Not every component is needed at every critical area, but the pen test will help flush out weakness within the thermal boundary.**
- **This test should be performed during design along with plan reviews with various subcontractors.**

66

Evaluations / Certificate / Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

Link to Certificate:

Link

Join us next month on Tuesday, November 10th at 1pm for the webinar titled
"Moisture Considerations for Insulated Building Assemblies"

67