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Moisture Considerations for Insulated Building Assemblies

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Description

- One critical design consideration in residential construction is the interaction of the home and its building enclosure with moisture. During the 2014-15 project year, a project was carried out that analyzed insulation durability as it relates to moisture in various building assemblies. As part of this project, a series of builder briefs was developed that summarized project findings. This webinar will bring the results of the project to a one hour format in order to discuss the implications of building codes, material development, and best practices on the durability of insulated assemblies throughout various Pennsylvania climates. By taking these moisture-related issues into consideration during design, builders and homeowners can experience greater durability and sustainability throughout the life of the home.

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Learning Objectives

- Understand the impact of moisture on the durability of insulated building assemblies.
- Analyze the role of building codes in the construction of homes and enclosures which provide a healthy environment for occupants.
- Apply building science principles to common insulated building assemblies and materials in order to understand the impact that best practice has on affordability, constructability, and code compliance.
- Recognize the risks associated with specific design choices related to insulation systems, cladding systems, and material selection.

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Outline

- Why is moisture important?
- Where does moisture come from?
- How do we design for moisture?
- Roof/attic assemblies
- Wall assemblies

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Why is Moisture Important?

- As residential buildings have become more energy efficient, the building enclosure has become more sensitive to moisture-related damage.
  - This is mainly due to the lack of air and heat flow through various building assemblies that provided insurance against moisture damage in the past. Having less heat and ventilation available to provide drying of damp building systems requires greater attention to the design of the assembly up front.

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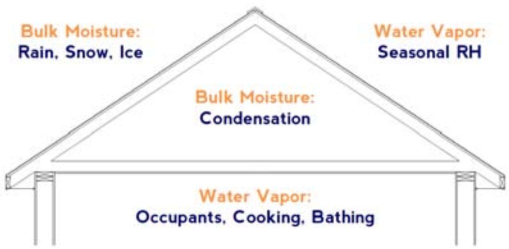
Where Does Moisture Come From?



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Where Does Moisture Come From?

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Moisture in Different Forms - Bulk

- **Bulk Moisture Flow**
  - Gravity
    - Precipitation
    - Condensation
  - Capillary Action (Wicking)
    - Within small pores, molecular attraction between surface and water molecules causes capillary suction
    - Capillary suction is greater in smaller capillaries (water moves from larger to smaller capillaries)

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Moisture in Different Forms – Water Vapor

- **Water vapor = water in gaseous state**
- **Key concepts related to water vapor:**
  - Relative humidity
    - Relative humidity = (Partial Pressure) / (Saturation Pressure)
  - Dew point
    - Temperature at which saturation vapor pressure equals partial pressure
  - Condensation
    - Occurs when RH = 100%
    - Only occurs on a surface cooler than dew point temperature

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Water Vapor Flow

- **Diffusion**
  - Differences in water vapor pressures between inside and outside of the building envelope cause water vapor to move by diffusion through the building envelope and through building materials
- **Convection**
  - Transfer of water vapor through air (for building enclosures)

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How Do We Design For Moisture?

- **Design to:**
  - Prevent excessive wetting
    - Material specification
    - Flashing details
  - Maximize drying potential
    - Material specification
    - Weep details

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Roof/Attic Assemblies

- **Vented roof/attic assembly**
- **Unvented roof/attic assembly with rigid foam**
- **Unvented roof/attic assembly with spray foam**

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Vented Roof/Attic Assembly

- **What is the purpose of roof/attic ventilation?**
  - Keeping the roof surface cold in winter
  - Providing ventilation of water vapor present in the attic space

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Why a Cold Roof?

- **Prevention of ice dams**
  - Air sealing drywall at attic floor
    - Seams
    - Penetrations (ceiling fixtures, recessed lights)
    - Mechanical runs in interior partition walls
  - Adequate ventilation

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Roof/Attic Ventilation

- **Ventilation principles**
  - Vent distribution
    - Higher concentration in upper portion = Depressurized attic
      - Encourages exfiltration of conditioned air to attic
      - 2009 IRC
    - Higher concentration in lower portion = Pressurized attic
      - Encourages infiltration of unconditioned air into conditioned space
      - 2012 IRC

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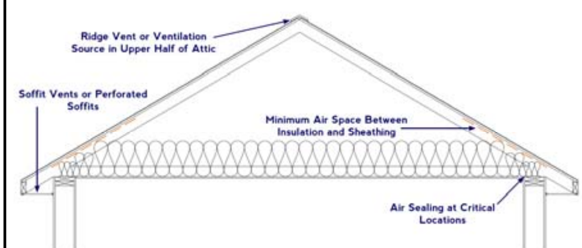
Vented Roof/Attic Summary



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Unvented Roof/Attic w/Rigid Foam

- **Installation of rigid foam on top side or underside of roof sheathing to create semi-conditioned or tempered attic space**
- **Main moisture consideration = Condensation prevention**
  - Must raise temperature of underside of rigid foam (or sheathing) above dew point
  - Requires a minimum amount of air-impermeable insulation based on climate zone

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2009 IRC Insulation Requirements

Table 1: Rigid insulation requirements for condensation control in PA (based on 2009 IRC)

Climate Zone	Minimum Rigid Foam or Air-Impermeable Insulation R-Value
4	R-15
5	R-20
6	R-25

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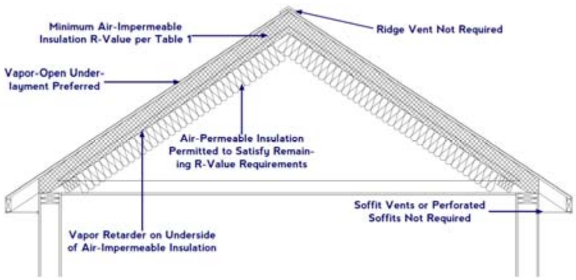
Unvented w/Rigid Foam Summary



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Unvented Roof/Attic w/Spray Foam

- **Open-Cell vs. Closed-Cell Foam**
  - Both considered air-impermeable, therefore condensation risk low
  - Water vapor transmission should be considered
    - Source of water vapor = interior space
- **Main consideration = prevent moisture accumulation in roof sheathing**
  - *In climate zones 5, 6, 7 and 8, any air-impermeable insulation shall be a vapor retarder, or shall have a vapor retarder coating or covering in direct contact with the underside of the insulation.*

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Open-Cell Spray Foam

- **Half pound foam = 0.5 PCF**
- **R-Value = 3.5 – 3.6 / inch**
- **Vapor semi-permeable or vapor permeable**
- **Often requires interior vapor retarder**
  - Remember: vapor semi-permeable = Class III

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Closed-Cell Spray Foam

- **Two pound foam = 2.0 PCF**
- **R-Value = 6.0 – 6.5 / inch**
- **Vapor semi-impermeable**
  - Class II vapor retarder

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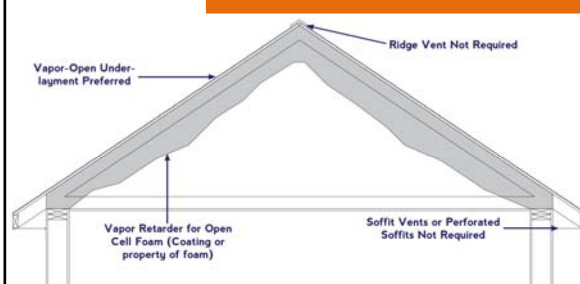
Unvented w/Spray Foam Summary



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Wall Assemblies

- Cavity insulation w/vented cladding
- Cavity insulation w/reservoir cladding
- Cavity and exterior continuous insulation

Vapor Retarder Requirements

Table 1: Vapor retarder classifications

Permeance (perms)	Vapor Retarder Description	Vapor Retarder Class
< 0.1	Impermeable	Class I
0.1 - 1.0	Semi-Impermeable	Class II
1.0 - 10.0	Semi-Permeable	Class III

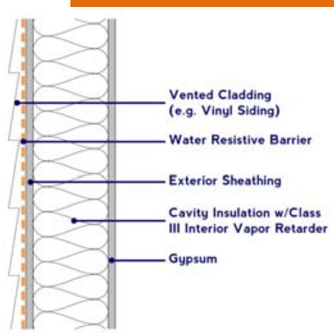
Cavity Insulation w/Vented Cladding

- **What is vented cladding?**
  - ***R601.3.3 Minimum clear air spaces and vented openings for vented cladding.*** *For the purposes of this section, vented cladding shall include the following minimum clear air spaces. Other openings with the equivalent vent area shall be permitted.*
    1. *Vinyl lap or horizontal aluminum siding applied over a weather resistive barrier as specified in Table R703.4.*
    2. *Brick veneer with a clear airspace as specified in Section R703.7.4.2.*
    3. *Other approved vented claddings.*

Benefits of Vented Cladding

- **How does cladding ventilation help?**
  - Risk mitigation
  - Increased rate of drying once wet
  - Creation of drainage plan for penetrating water
- **Class III vapor retarder permitted**

Cavity w/Vented Cladding Summary



Cavity Insulation w/Reservoir Cladding

- **What is a reservoir cladding?**
  - Materials that absorb moisture from the surrounding environment and have significant moisture storage capacity
  - Examples:
    - Brick veneer
    - Adhered manufactured stone masonry veneer
    - Hardcoat stucco
    - Wood

What Changes w/Reservoir Claddings?

- **Higher perm interior vapor retarder should be selected**
  - Drying potential
  - Vapor retarder requirements
    - Where required, Class I or II permitted
    - Class II should be selected (i.e. NO vapor barrier)
    - If back-venting is provided, Class III may be permitted

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What Changes w/Reservoir Claddings?

- **Back-venting of cladding should be considered**
  - Required by code behind brick veneer
  - Other claddings, such as exterior plaster, are not required to have a ventilation gap
    - Providing a ventilation gap (or rainscreen, or designed drainage space) will mitigate moisture risk
  - Ventilation gaps
    - Can be provided using furring strips or mesh products
    - Sizes range from ¼" to ¾" or larger

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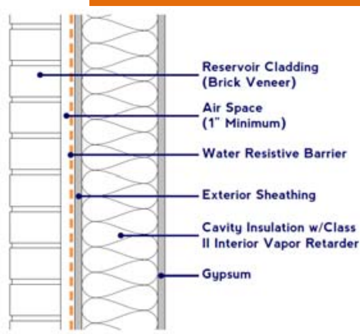
Cavity w/Reservoir Cladding Summary



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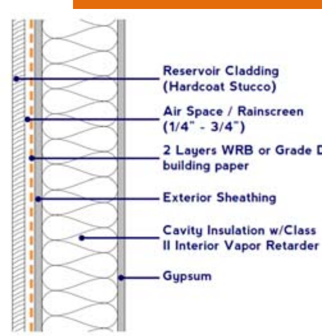
Cavity w/Reservoir Cladding Summary



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Cavity & Exterior Continuous Insulation

- **Adding insulation to the exterior of a wall assembly for the purpose of enhancing energy efficiency will also reduce the drying potential of the wall, which must be accounted for**
- **Adding exterior insulation (to prescribed minimum levels) permits the installation of a Class III vapor retarder – Why?**
  - Insulated sheathing raises the temperature of the interior side of the exterior sheathing
  - Exterior rigid foam is often a Class I, II, or III vapor retarder

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Exterior Foam for Condensation Control

- **Insulated sheathing raises the temperature of the interior side of the exterior sheathing**
  - BUT, enough insulation must be provided on the outside of the wall system in order to raise the temperature high enough
    - If not enough insulation provided, condensation is still a risk, but the drying potential of the wall has now been reduced
    - *Value-engineering* should take this into consideration

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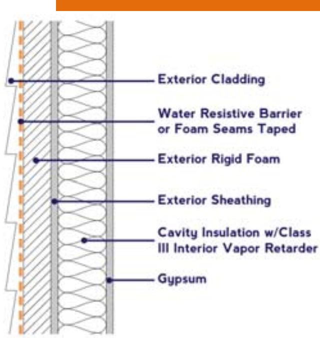
Cavity & Exterior Continuous Summary



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Conclusions

- **Adding insulation to roof/attic and wall assemblies to meet code requirements can have a significant effect on the interaction between the assembly and moisture**
- **Simple design principles should be incorporated during design and construction of these systems**
- **Sometimes code minimum requirements are sufficient, other instances may warrant consideration of above-code practices**

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