

Understanding Air, Vapor, & Thermal Control Layers

RAC Illustrated Technical Guide (example)

Purpose

This guide explains how **building enclosure layers interact as a system**, using real-world assemblies to demonstrate how moisture, air, and heat move through structures.

Section 1 – What Is a “Scenario”?

A **scenario** is a specific combination of materials, layers, and environmental conditions that act together at a given location within a building.

A scenario is **not** a single product failure.
It is how **multiple layers perform collectively**.

Section 2 – Example Scenario: Exterior Wall Assembly

Consider a typical exterior wall:

From exterior to interior:

1. Vinyl siding
2. Water-resistive barrier (WRB)
3. OSB sheathing
4. Wood studs
5. Cavity insulation
6. Drywall
7. Joint compound (drywall mud)
8. Interior paint

Each of these is a **layer with different properties**:

- Vapor permeability

- Air permeability
- Thermal resistance
- Moisture storage capacity

Section 3 – Why Layers Matter

- Vinyl siding sheds bulk water but is air permeable
- WRBs manage water but may allow vapor movement
- OSB absorbs and stores moisture
- Insulation affects temperature and condensation location
- Drywall and paint act as partial vapor retarders

No single layer controls moisture alone.

Section 4 – Scenario Interaction Example

If warm, moist interior air leaks through:

- Electrical boxes
- Framing gaps
- Unsealed penetrations

It may reach cold OSB sheathing, where condensation occurs — **even if the exterior appears intact.**

This is a **scenario-driven failure**, not a defect in one product.

Section 5 – Common Scenario Failures

- Insulation added without air sealing
- Mixed vapor retarders trapping moisture
- Exterior materials upgraded without interior control layers
- Assemblies unable to dry in either direction

Section 6 – Why Scenario Analysis Matters

Scenario-based evaluation:

- Explains delayed damage
- Prevents incorrect blame
- Clarifies causation
- Supports defensible conclusions

Disclaimer

This guide is educational and does not replace project-specific design, testing, or professional evaluation. Water exposure occurs in all buildings. What matters is how an assembly manages water and how quickly it can dry after wetting.

Reference (Informational)

The concepts illustrated in the above guide reflect widely accepted building science principles documented in:

- ASHRAE fundamentals related to heat, air, and moisture movement
- International Energy Conservation Code (thermal and air control layer continuity)
- Building Science Corporation research on enclosure performance and drying
- U.S. Department of Energy Building America resources

These references provide conceptual direction but are not intended as prescriptive design criteria.