building energy exchange Kansas City

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

Commercial Energy Code Basics

Designing and Constructing to 2021 IECC

May 3, 2023

COMMERCIAL ENERGY CODE –IECC SESSION 1

HISTORY OF BUILDING/ENERGY CODES

INSTRUCTOR: MATT BELCHER

WEDNESDAY, MAY 3RD 10:30AM-12:30 PM

CODE OF HAMMURABI – THE FIRST KNOWN BUILDING CODE

- The Code of Hammurabi is a well-preserved Babylonian code of law from ancient Mesopotamia, circa 1754 BCE. The sixth Babylonian king, Hammurabi, enacted the code.

- The basic idea is an eye for an eye. Meaning if you build a building and it collapses and kills someone. The penalty is Death….

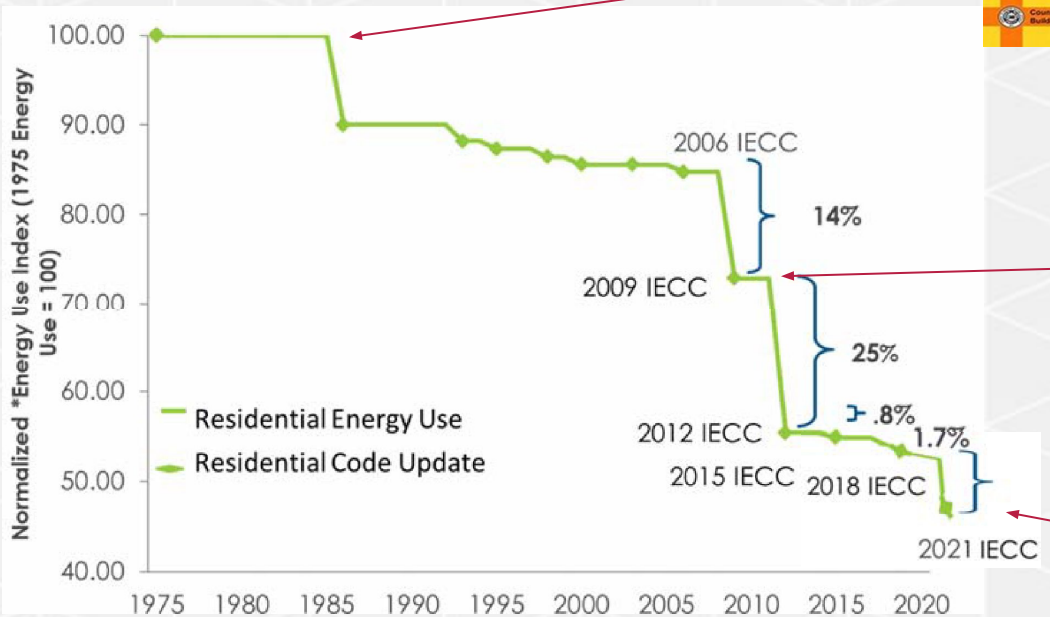
BUILDING CODE HISTORY

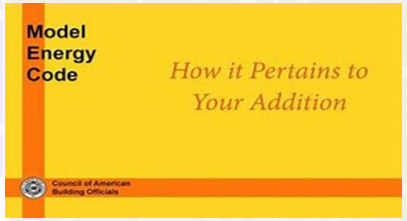
"Legacy Codes"

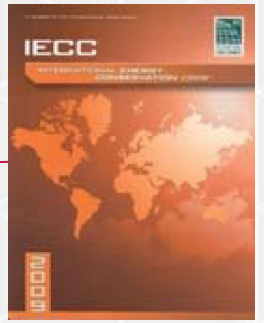
INTERNATIONAL ENERGY CONSERVATION CODE (IECC)

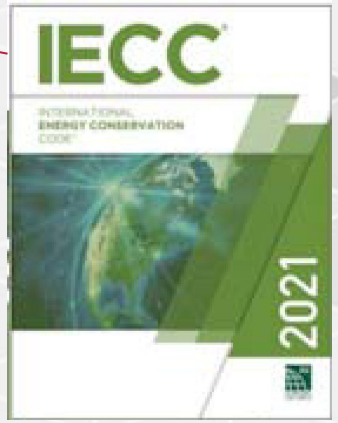
- Developed by the International Code Council
  - Robust stakeholder process
  - Proposed changes accepted from all parties
- New editions published every 3 years

ENERGY CODE BACKGROUND







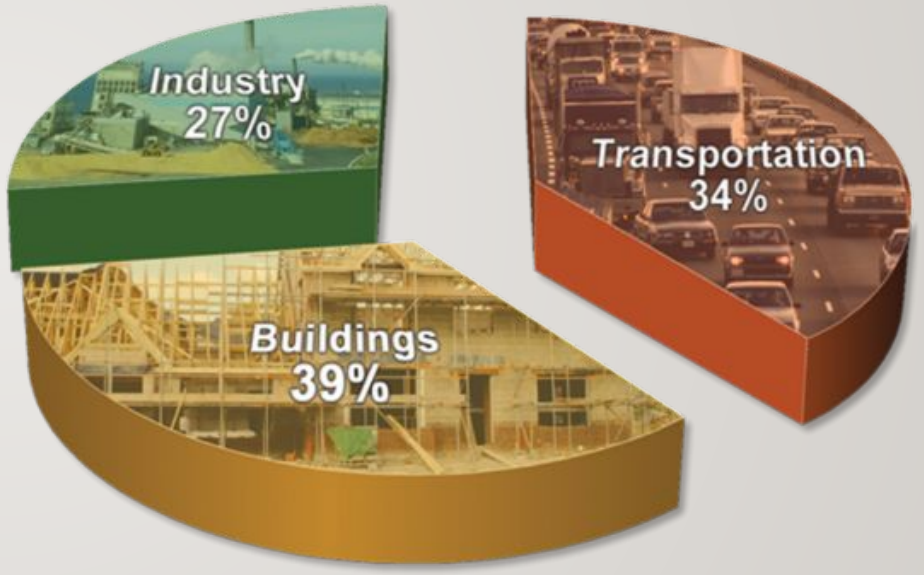


ABOVE CODE PROGRAMS

- National Green Building Standard
- Energy Star
- Building America's Builder's Challenge (Challenge Home)
- Active House
- LEED-H

WHY ARE ENERGY CODES IMPORTANT?

- Reduce energy use of buildings
- Impacts energy use for the life of a building
  - Most cost-effective to implement during initial design and construction
- Benefits building owners and operators by guaranteeing a minimum of efficiency
- Health and resilience benefits to building owners and occupants



MOVING FORWARD

- **2021 IECC & IECC-R**
- Major changes
- ASHRAE as an Alternative, not just a reference.
- More daylighting/Alternative Energy references.

Peeking over the Horizon:

- **2024 Moving from an Energy Code to a National Standard**.
- Updates on progress
- What the new process entails.
- What to expect.
- How to be involved!

LOOKING AHEAD:

- IECC changes to The National Energy Standard as of 2024.
- Uses 2021 IECC as a baseline.
- Introduces Carbon Impact into the conversation.
- On a trajectory for Net Zero Energy as of 2030.

COMMERCIAL ENERGY CODE –IECC SESSION 1 PART 2

ENERGY CODES & BUILDING SCIENCE

INSTRUCTOR: MATT BELCHER

WEDNESDAY, MAY 3RD 10:30 AM-12:30 PM

PART 2 BUILDING SCIENCE

Objectives: Building Science

- Advanced Detailed Physics
- Water (aka: "The Enemy")
- Air & Air Movement
- Temperature & Temperature Transfer
- Building Envelope
- Quality Control
- Tightness testing

WHY THE SCIENCE MATTERS

You can't really appreciate the impact of the building envelope if you don't understand some basic science behind it.

We will briefly mention these topics as they relate to envelope:

- Solar orientation
- Heat transfer (radiation, conduction, convection)
- Thermal mass
- Air pressure (stack effect)
- Moisture flow

BUILDING ENVELOPE

- All of the elements of the envelope and the assembly methods determine how well the building envelope performs.
- The building envelope must be an unbroken boundary surrounding the structure.
- All elements must be in close alignment with each other.

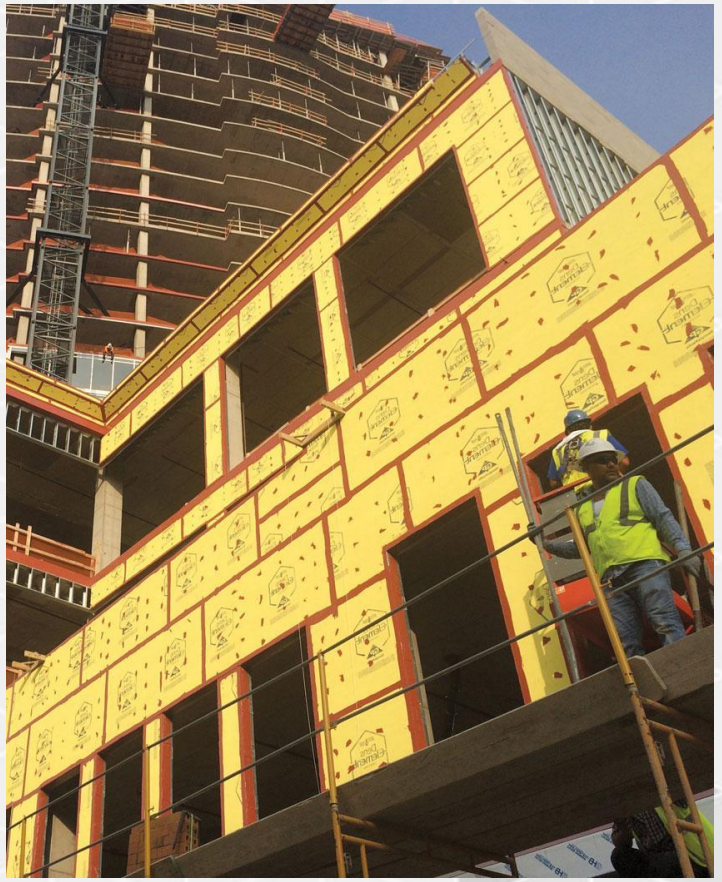


Photo courtesy of U.S. Gypsum

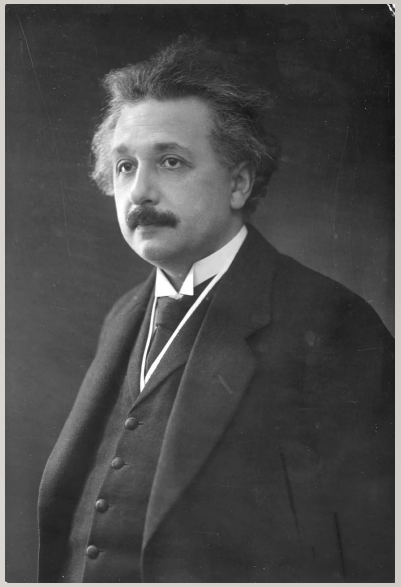
EXISTING BUILDINGS - SCOPE
CHAPTER 5

- Applies to alterations, repairs, additions, and change of occupancy (C501.1)
- Additions must comply with code without requiring unaltered portions to comply (C502.1)
  - Specific requirements for new vertical fenestration and skylights (C502.2.1 and C502.2.2)
- Alterations shall not make building less conforming (C503.1)

Image: MontgomeryCountyMD.gov


Subarctic/Arctic
Very Cold
Marine
Cold
Mixed-Humid
Mixed-Dry
Hot-Humid
Hot-Dry

ADVANCED PHYSICS IN BUILDING SCIENCE:



Hot □ **Cold**

Wet □ **Dry**

THE MAJOR "DAMAGE FUNCTIONS"

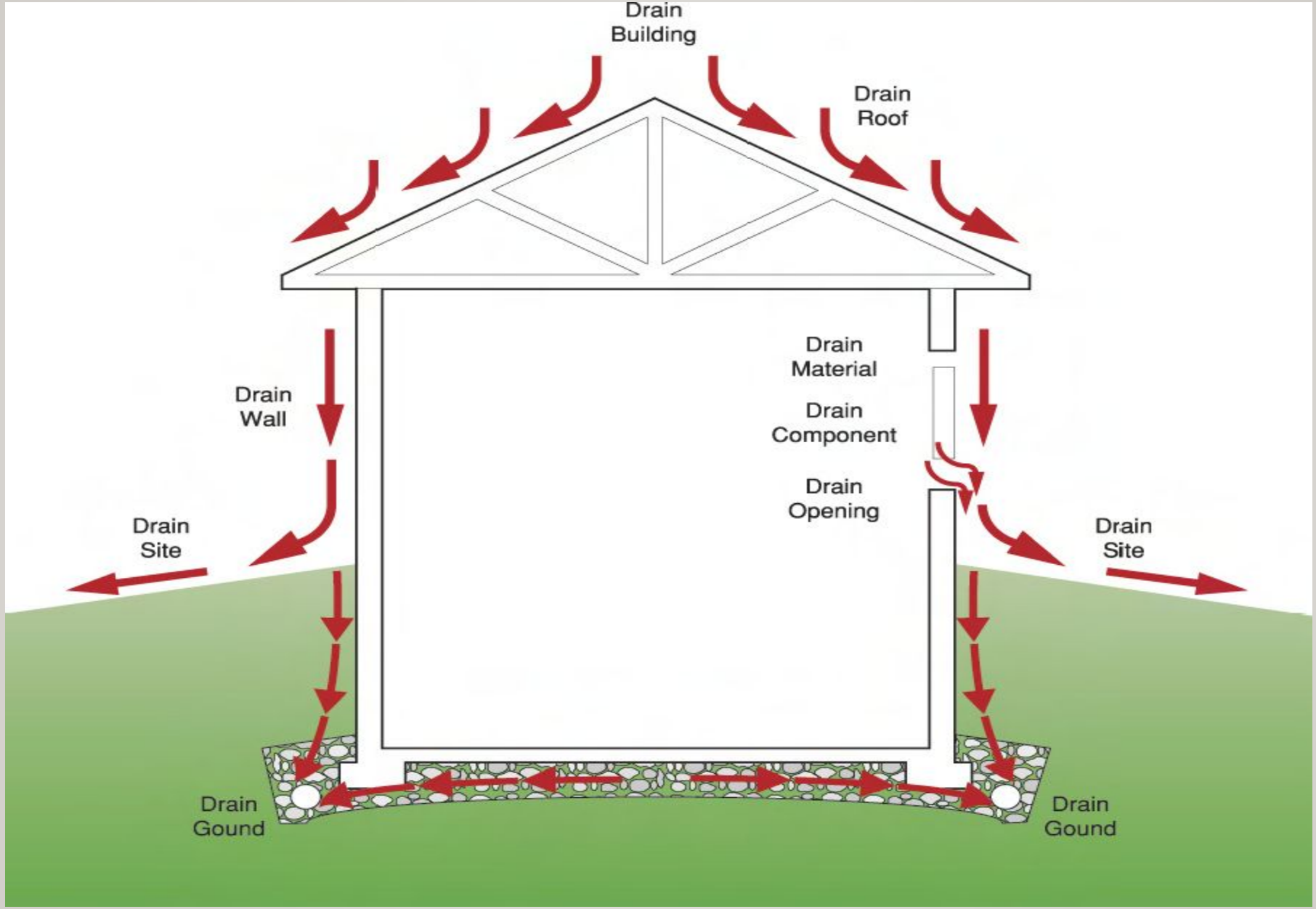
- Liquid water (bulk and capillary)
- Air-borne water
- Vapor
- Radiation (uv degradation)
- Pests
- People

IECC MANDATORY REQUIREMENTS

- Air Leakage
- Air barriers
- Fenestration air leakage
- Rooms Containing Fuel-burning Appliances
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weather seals
- Vestibules
- Recessed lighting
- Commissioning

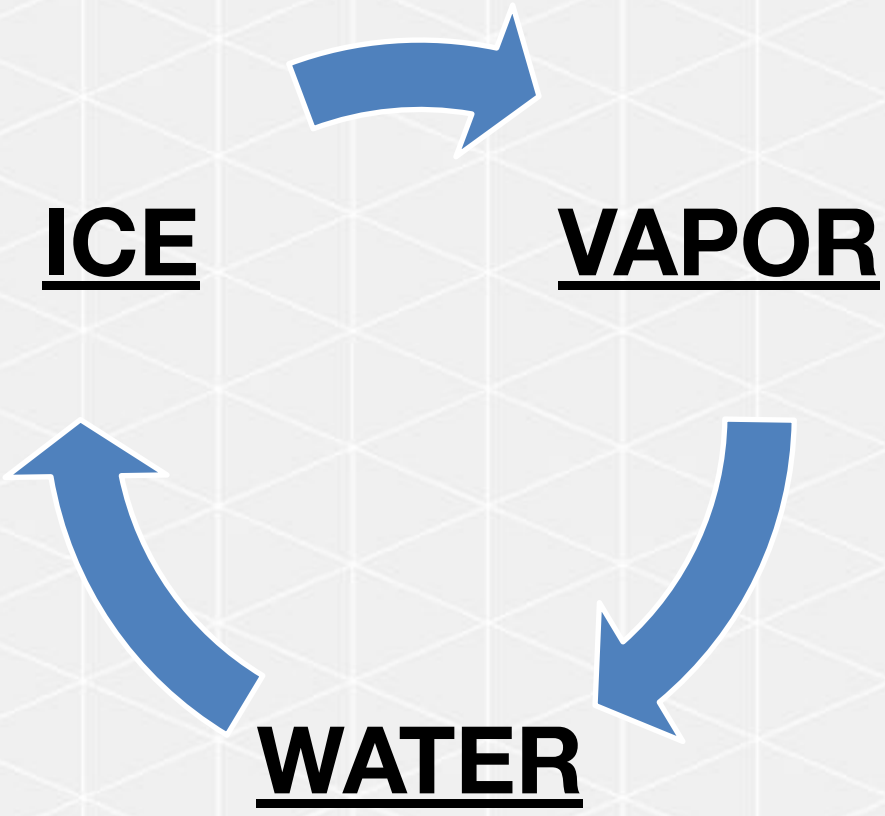
THE MAJOR BUILDING ENVELOPE PROTECTION SYSTEMS

- Water Barrier
- Air Barrier
- Thermal Barrier
- Vapor Profile (not just the designated vapor retarder)
- Finishes (UV protection)
- Commissioning & Maintenance documents

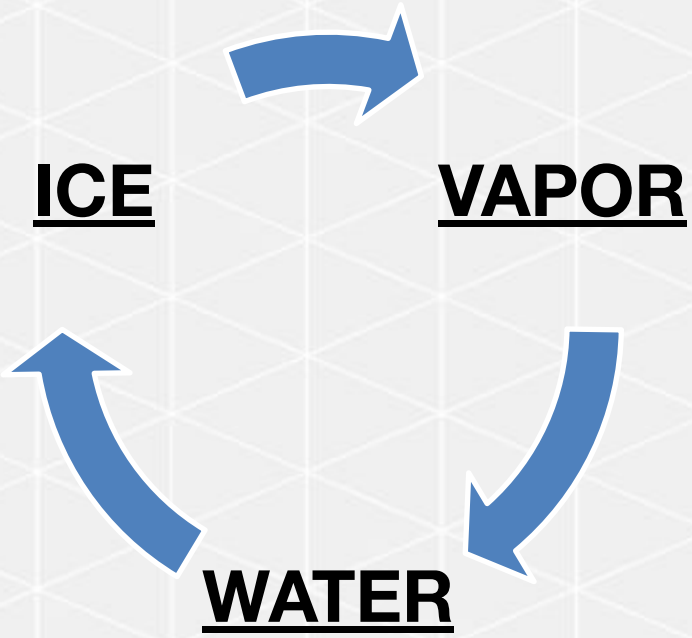


WATER: A Builder's (and Buildings) worst enemy!

Moisture Movement



Moisture Movement



FILMS!

-Lateral Cohesive movement

How Moisture Affects & Moves Through Common Building Materials

- Vapor permeability and “perms”
- Vapor permeability variability
- Following are examples of when all this can be critical

Vapor permeance:

Perm = grain/(hr • in Hg • ft^2)

Building Envelope: Control Layers

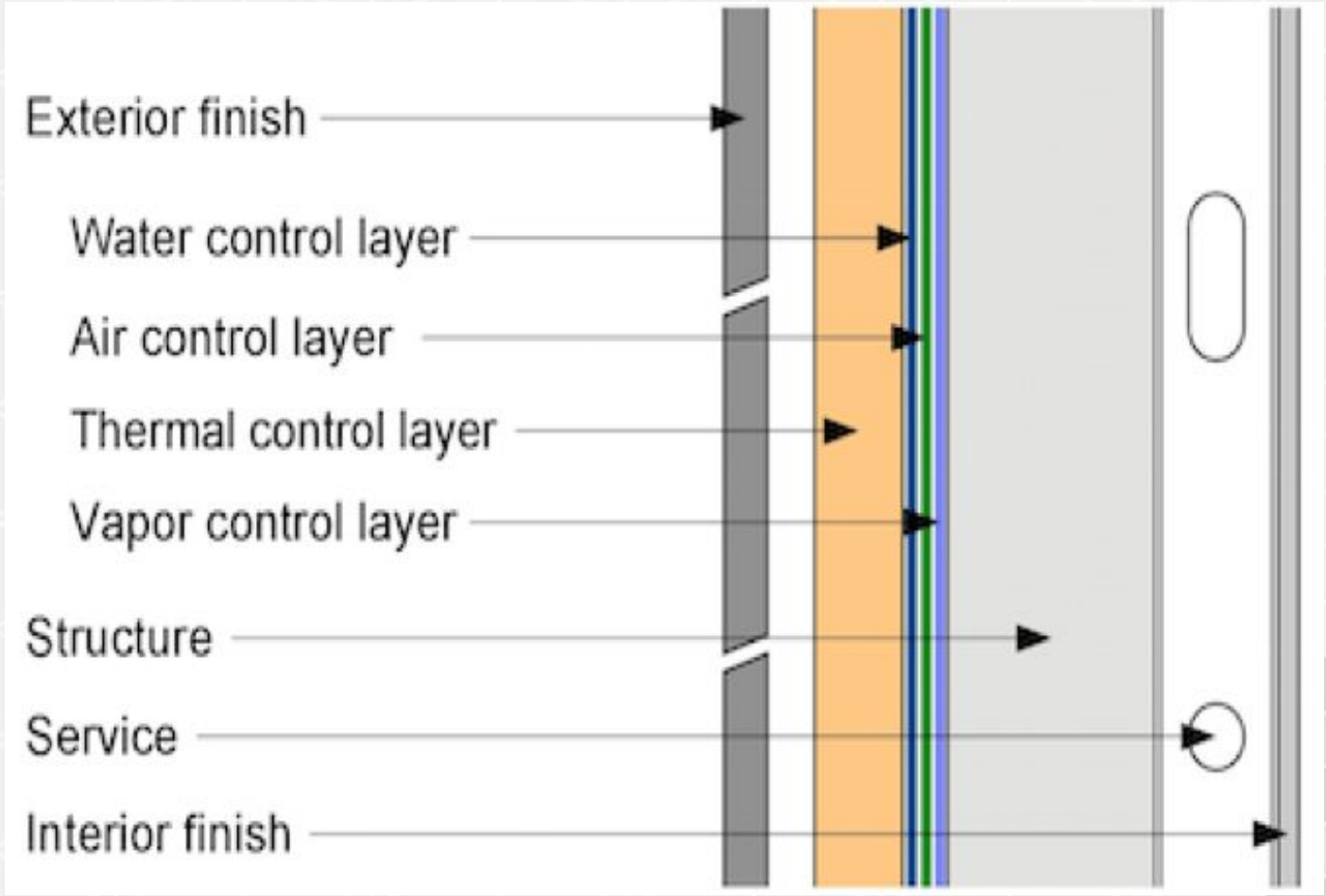


Image: Green Building Solutions

Exterior Conditions

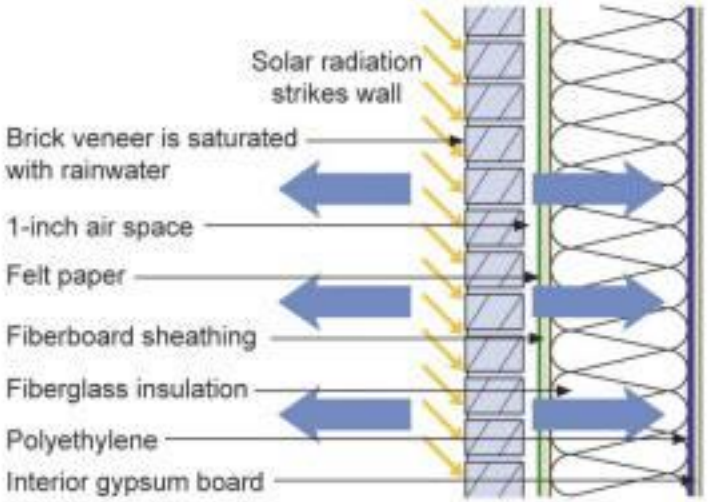
Temperature: 80°F
Relative humidity: 75%
Vapor pressure: 2.49 kPa

Conditions within Cavity:

Temperature: 120°F
Relative humidity: 100%
Vapor pressure: 11.74 kPa

Interior Conditions

Temperature: 75°F
Relative humidity: 60%
Vapor pressure: 1.82 kPa



Vapor is driven both inward and outward by a high vapor pressure differential between the brick and the interior and the brick and the exterior.

- Do not install a vapor barrier on the inside of an air conditioned assembly. Vinyl wall coverings, foil-backed batt cavity insulation and polyethylene vapor barriers should be avoided.
- Vapor permeable exterior sheathings, housewraps or building papers should not be used with absorptive claddings such as brick veneers unless a ventilated cavity is provided in conjunction with high inward drying potentials (i.e. no polyethylene vapor barriers).
- Failure will occur when brick is installed over a frame wall constructed with felt paper, fiberboard sheathing and a polyethylene vapor barrier. Kraft-faced fiberglass batts should be used in place of unfaced batts and a polyethylene vapor barrier. OSB, plywood or foam sheathing should be used in place of the fiberboard sheathing.
- Similar problems occur with stucco.

The black mason's flashing was installed after and in front of the green housewrap. This is reverse flashing that will do more to trap than drain water that gets past the brick veneer.

Moisture Flows – 4 Ways:
Capillarity – Priority #2

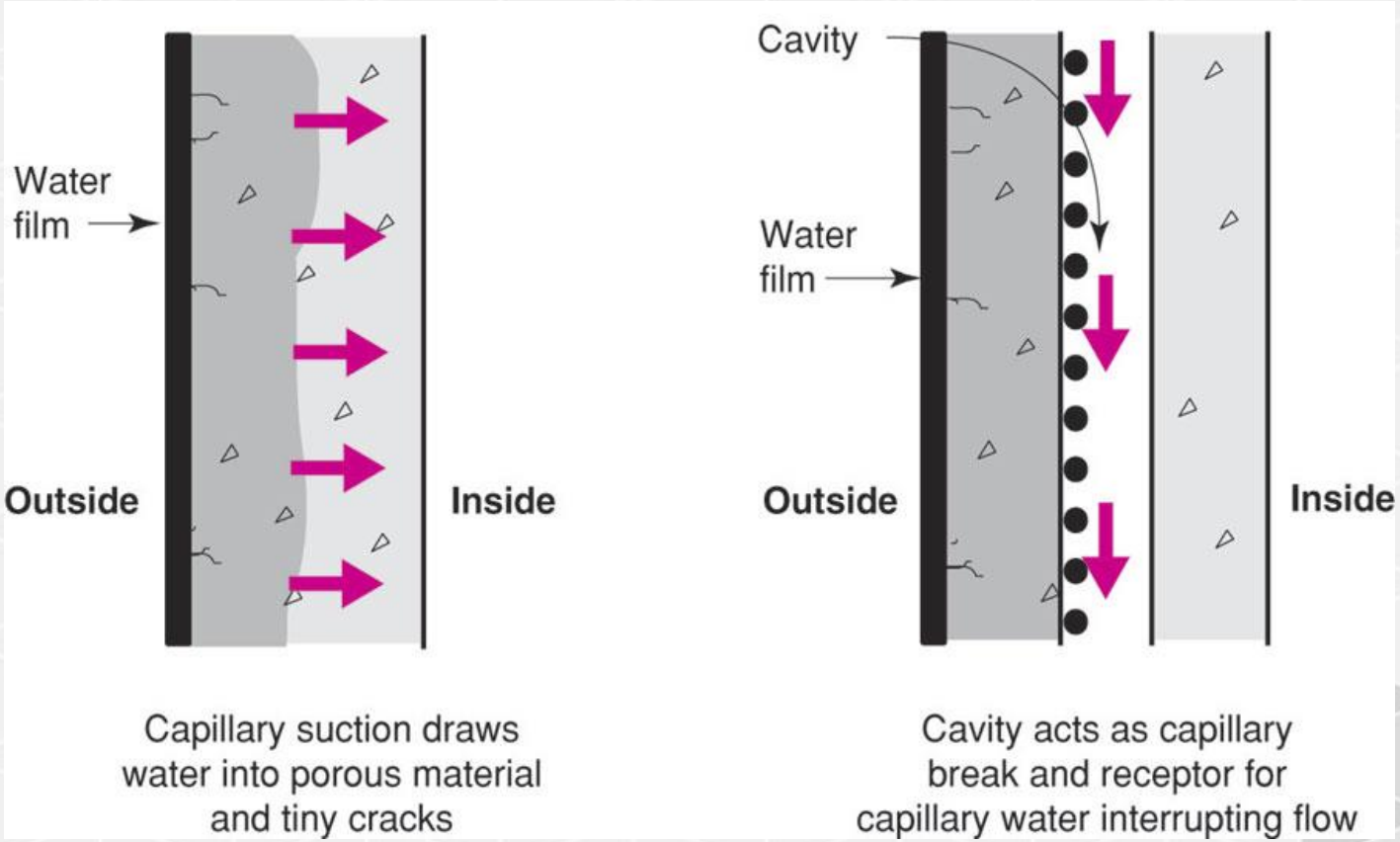
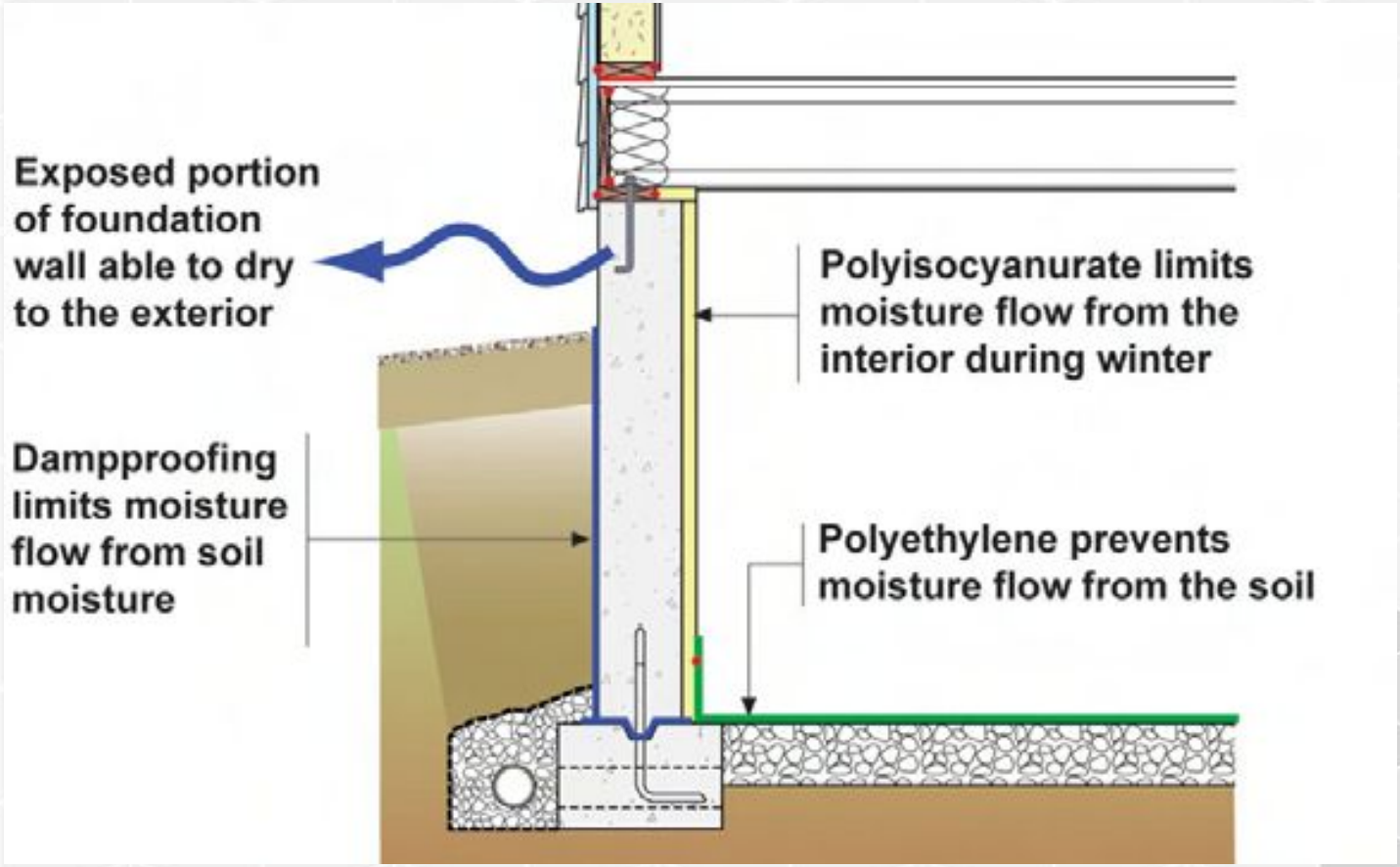


Image courtesy of Building Science Corp.

Foundation Moisture Management



Belcher Homes

Basement Walls – Capillary Breaks


40.0

QUALITY MANAGEMENT

- Moisture Control testing prior to cover up.

AIR TRANSPORT OF WATER VAPOR – PRIORITY #3

- Air leakage
  - Moisture flow
    - 4X8 Drywall
    - 70 F
    - 40% RH
    - 1 square inch hole
- Flow quantity
  - 30 Quarts of water!!

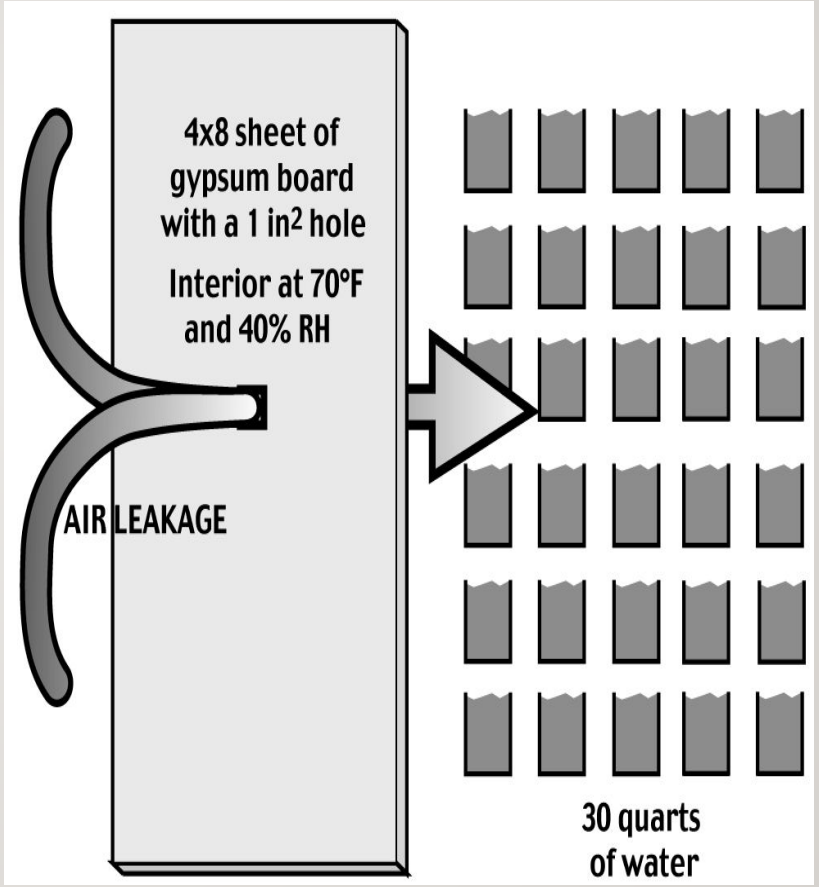


Image courtesy of Building Science Corp.

Diffusion – Priority #4

- Diffusion
  - Migration of moisture by means of vapor pressure differential
  - Occurs in either direction based on climate conditions and exterior/interior levels of humidity

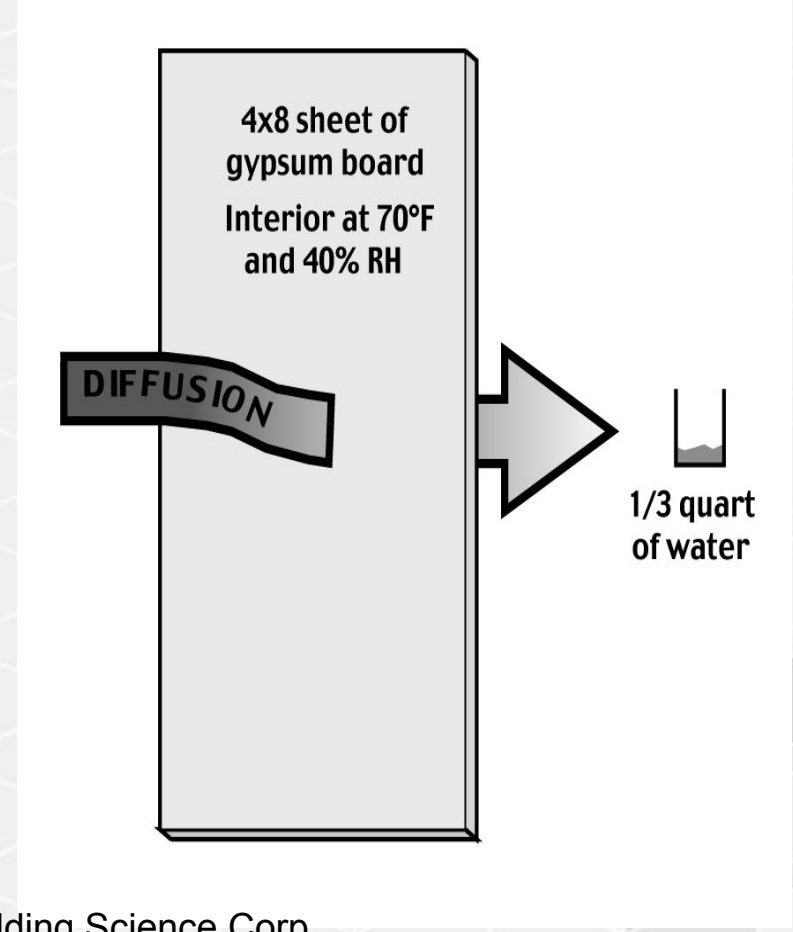
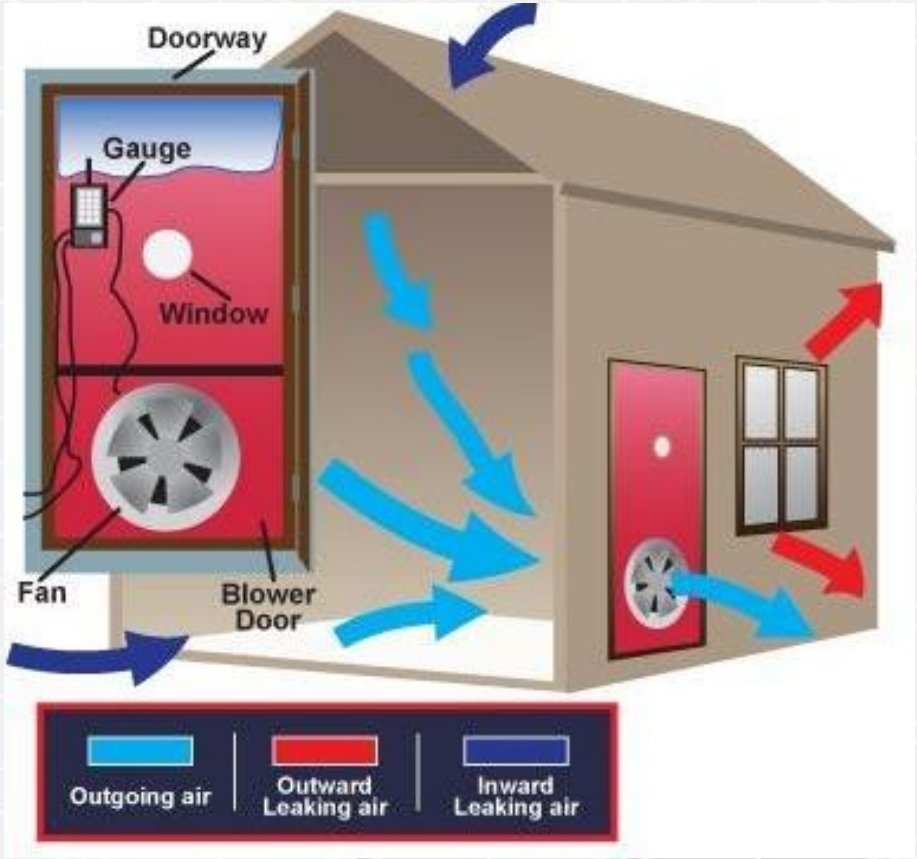


Image courtesy of Building Science Corp.

A Critical Tool in the Fight Against Moisture

- Blower door tests quantify a home's air tightness
- Proper building tightness will help:
  - Reduce energy consumption
  - Avoid moisture condensation
  - Avoid uncomfortable drafts caused by cold air leaking in
  - Maximize proper HVAC performance



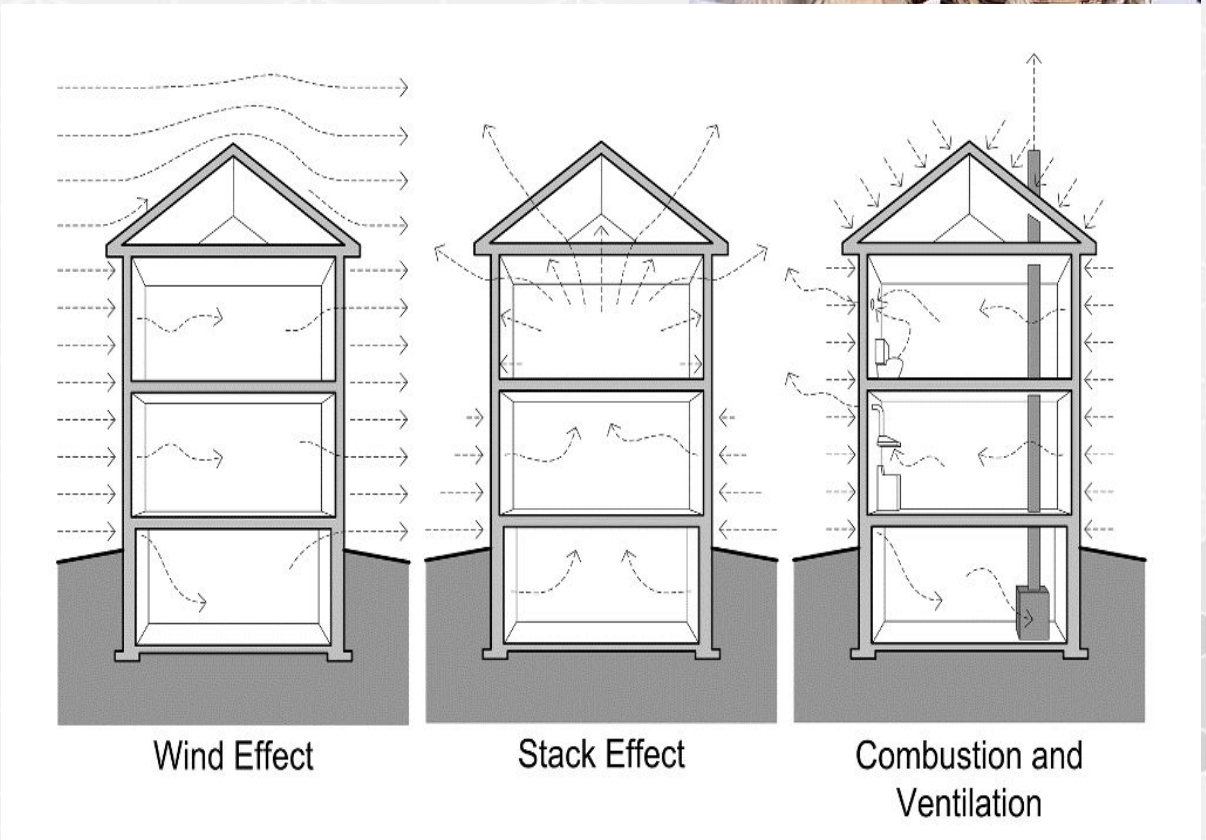
Air Movement Seeks Balance

AIR MOVEMENT

How Does ***Air*** Get Around?
Air in = Air out

For Air movement:

- A hole
- A driving force
- Another hole



Air Barrier

- Air movement leads to both **energy loss and moisture transmission**.
- An **integrated air barrier prevents air movement** through the insulation and must be continuous and contiguous with the insulation.
- Air barrier must be **continuous** across walls, ceilings, and floors.
  - You should be able to trace the air barrier in a building cross section and never lift your pencil!

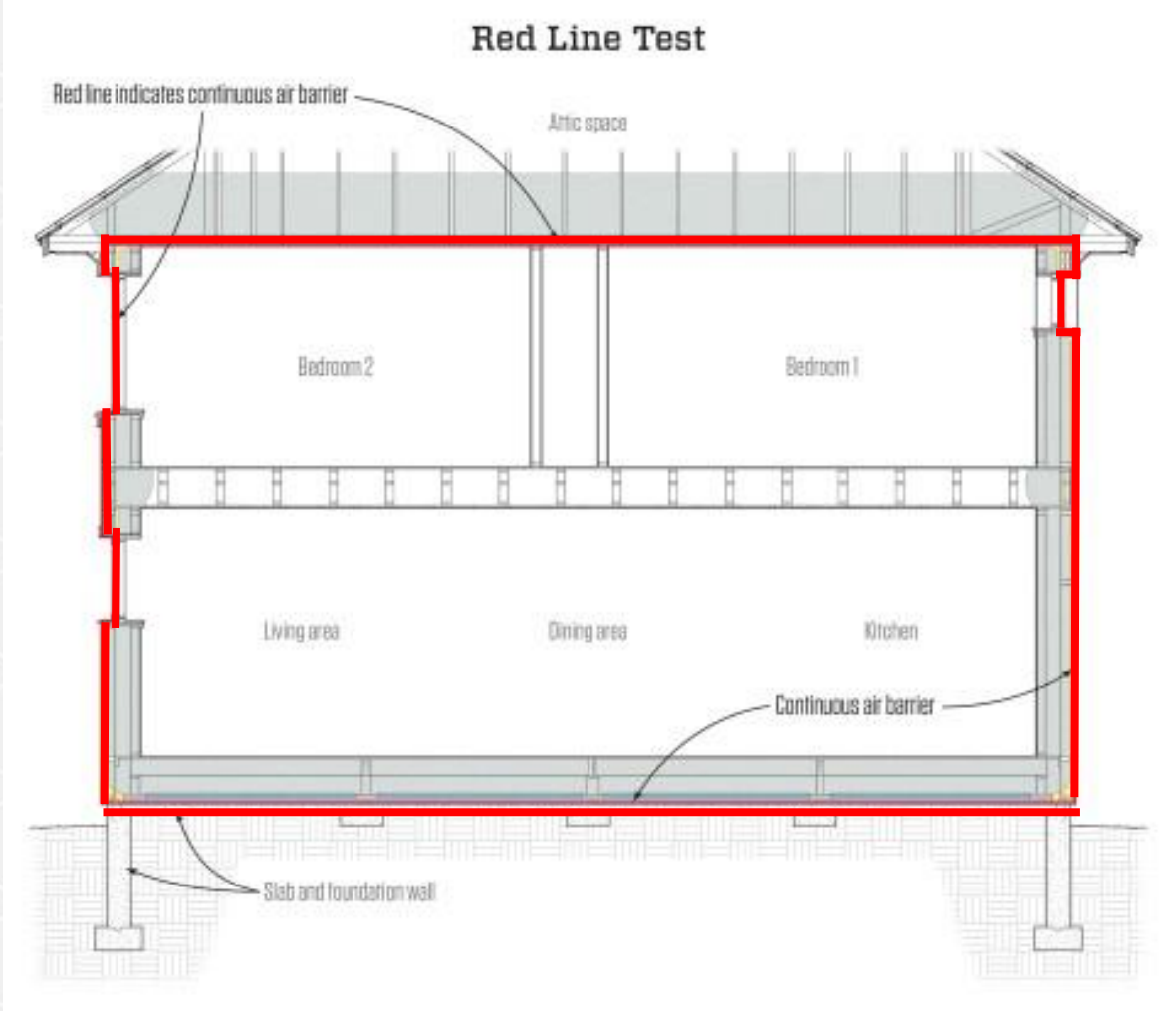


Image: jlconline.com

Pressures / Driving Forces

- **Mechanical Fans**
- Mechanical fans in a building can create significant pressure differences which drive air exchanges.

Major Air Leakage Locations

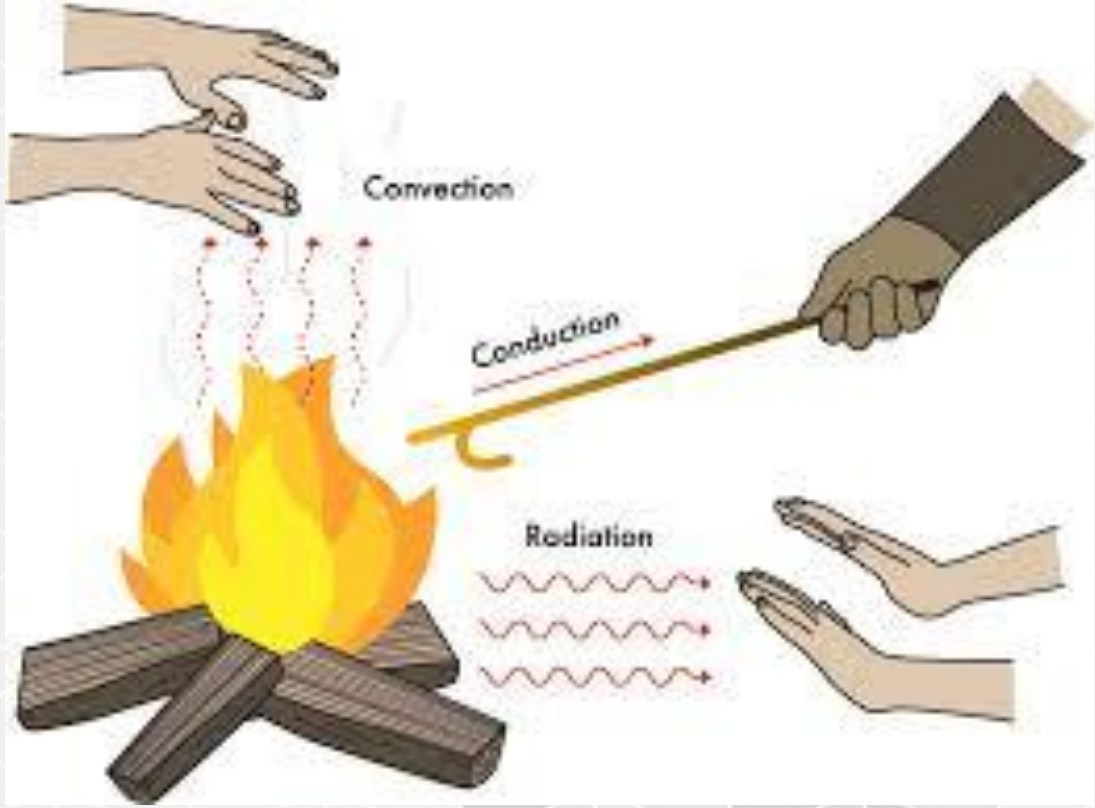
- Cavities above suspended ceilings
- Plenum return spaces (Highly depressurized)
- Ventilated walls
- Equipment tunnels and chases
- Mechanical rooms and mezzanines
- Unconditioned adjacent space (storage, plant, warehouse, etc.)

A Triple Threat

HEAT TRANSFER

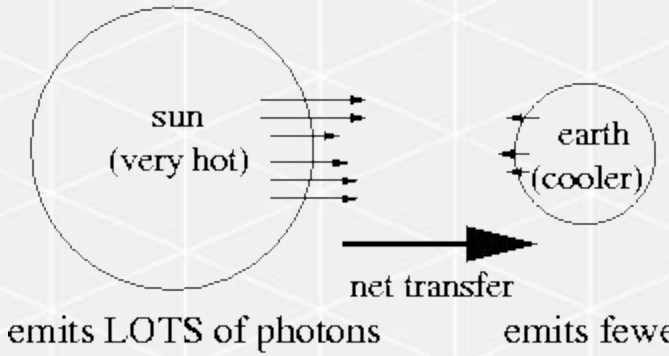
Heat Transfers in 3 Ways

- ***Convection*** - Through fluids (liquid or gas)
- ***Conduction*** - Through solids
- ***Radiation*** - Mostly windows

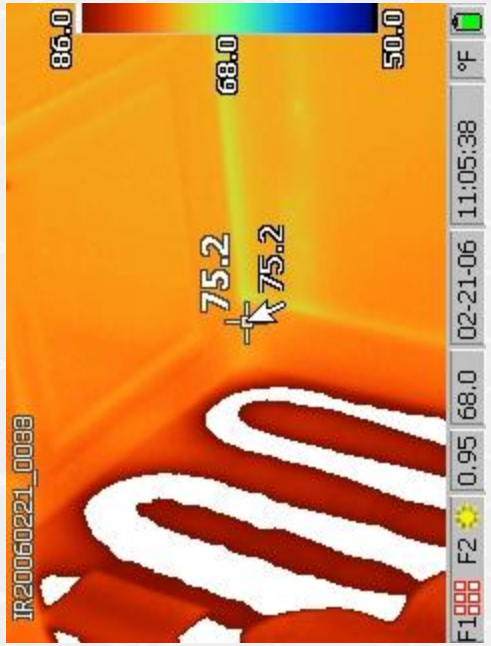


Heat Transfer

– 3 ways



$$W = \epsilon(T) \cdot \sigma \cdot A \cdot T^4$$

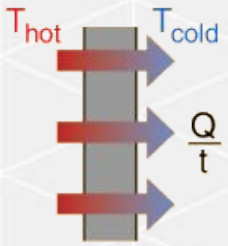


radiation

Electromagnetic waves—from high to low through empty space;
Once this energy strikes an object, the energy can be transmitted, reflected or absorbed.

Heat Transfer

– 3 ways



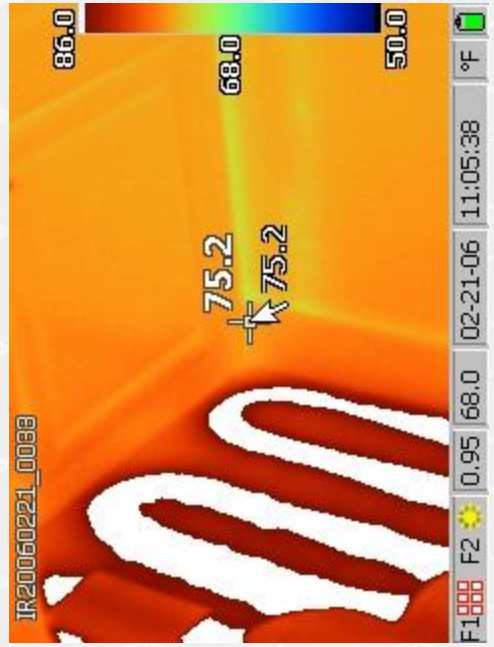
For standard R11 wall insulation, you lose 1/11 BTU/hr per square foot of wall space, per degree Fahrenheit temperature difference.

$$\text{Heat loss rate} = \frac{Q}{t} = \frac{(\text{Area}) \times (T_{inside} - T_{outside})}{\text{Thermal resistance of wall}}$$

if Q/t is in BTU/hr
Area in ft^2
$T_{in} - T_{out}$ in °F

then the thermal resistance is the "R-factor" quoted by insulation manufacturers. The units of the "R-factor" are

$$\frac{ft^2 \times °F}{BTU/hr}$$

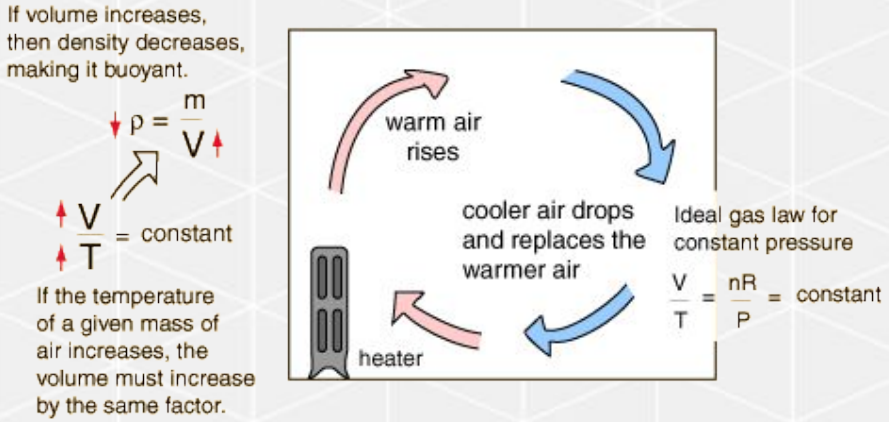


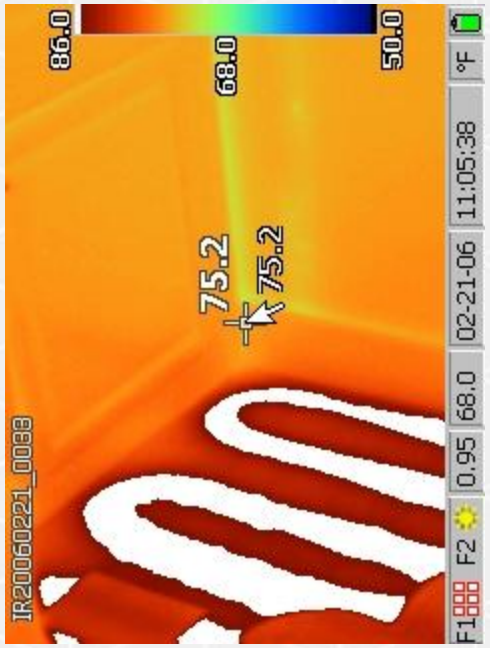
conduction

Direct transfer of kinetic (vibrational) energy; from high to low in solids (and fluids).

Heat Transfer

– 3 ways





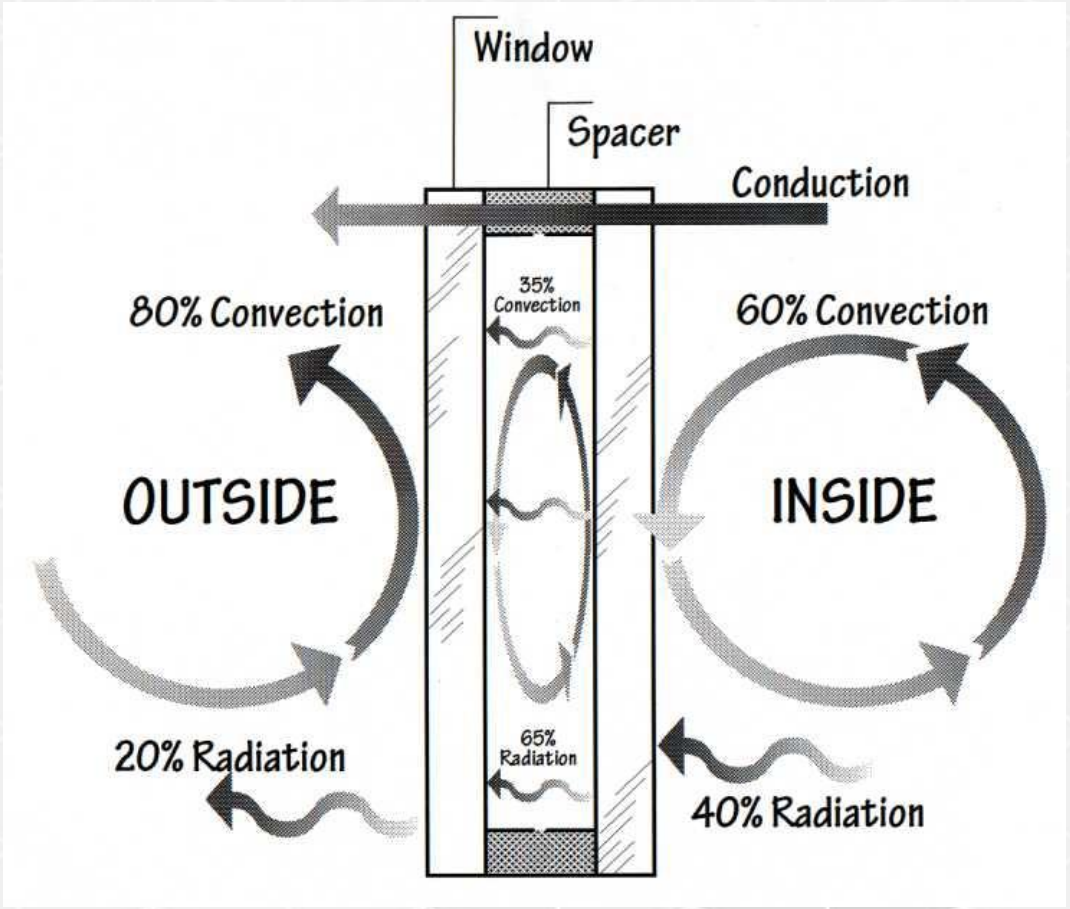
convection

Transfer of thermal energy by a medium—typically fluids like air and water.

(By the way: heat does not rise, hot air does)

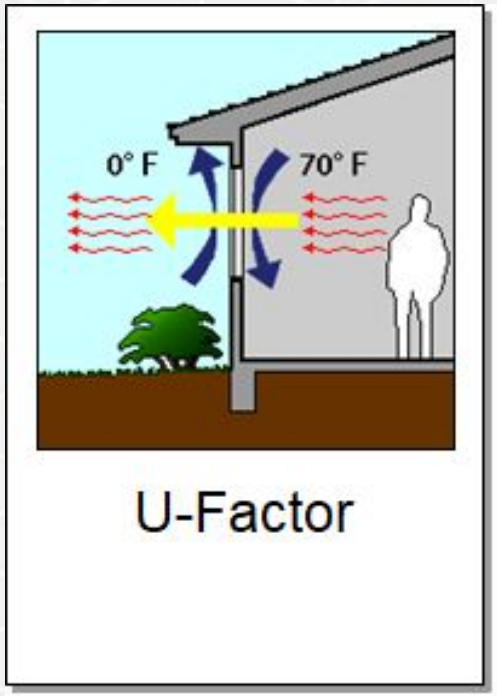
Practical Application - Windows

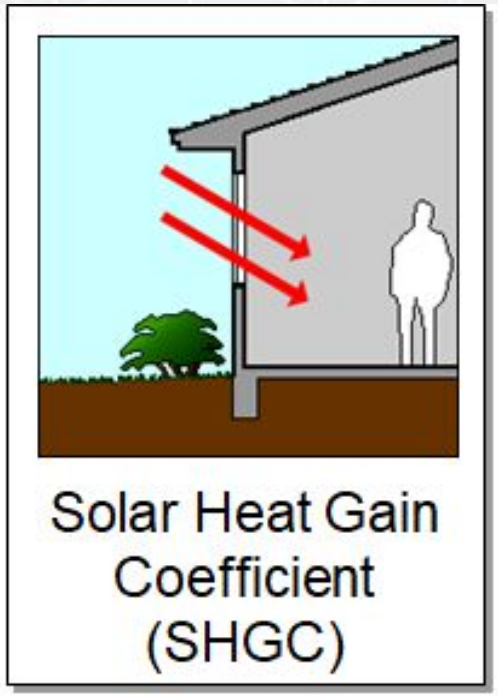
- Heat always moves from hot to cold
- Always a mix of transfers
- Different rates of transfer can be important

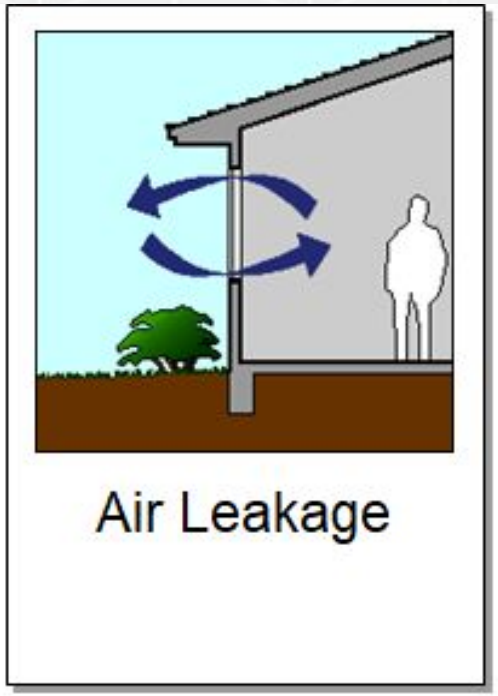


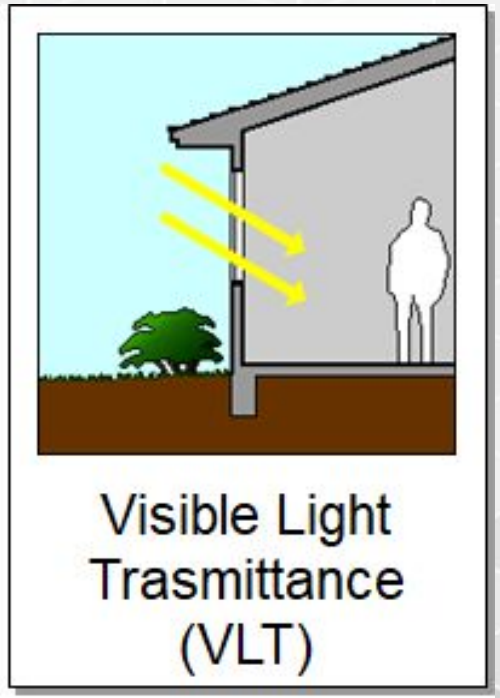
Energy Performance of Glazing

- **Fenestration Terminology**







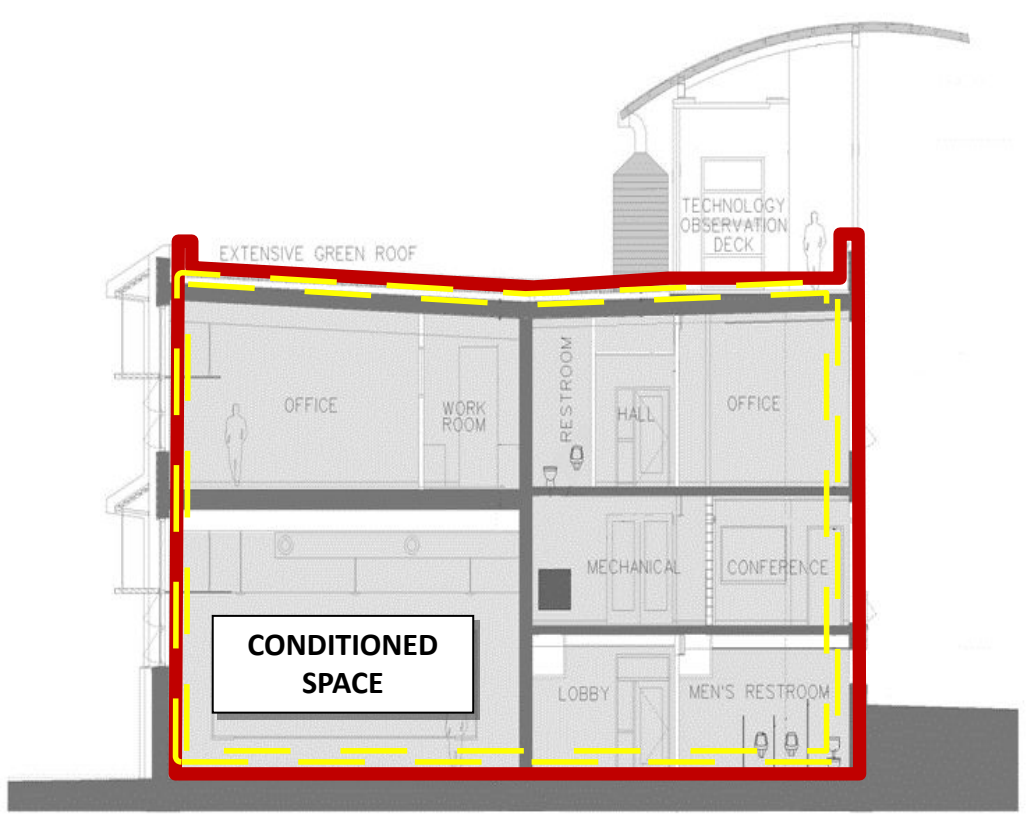


Building Thermal Envelope

- A well-designed building envelope promotes energy conservation through proper placement and appropriate use of materials for effective:
  - Air barrier
  - Insulation
  - Moisture control
  - Windows, doors and skylights

What is the Building Thermal Envelope?

- These assemblies can comprise the building thermal envelope if they **separate conditioned from unconditioned space or outside air**
  - Roof/Ceiling Assembly
  - Wall Assembly
  - Vertical Fenestration and Skylights
  - Floor Assembly
  - Slab Edge
  - Below-Grade Wall Assembly



Insulation - Type

The energy code does not require specific types of insulation, only required R-value

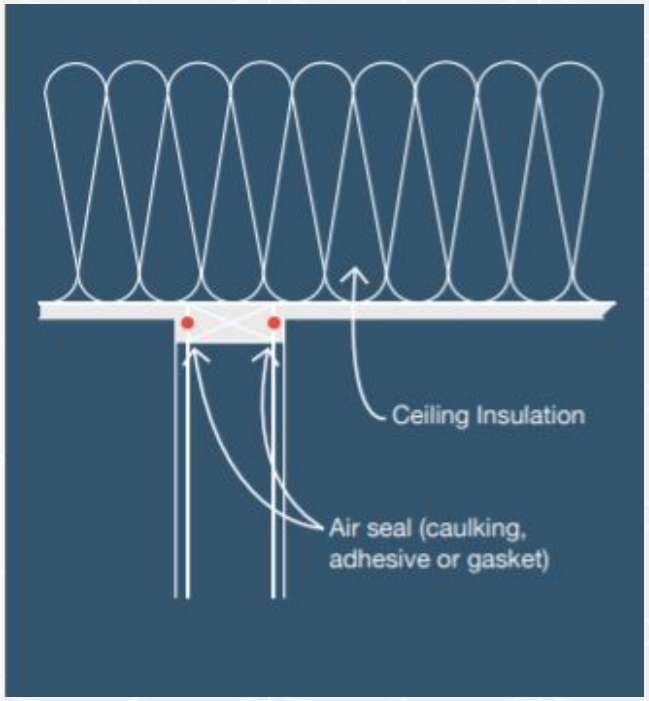
Materials:

- Fiberglass
- Cellulose
- Low-density or open-cell foam
- High-density or closed-cell foam
- Foam sheathing

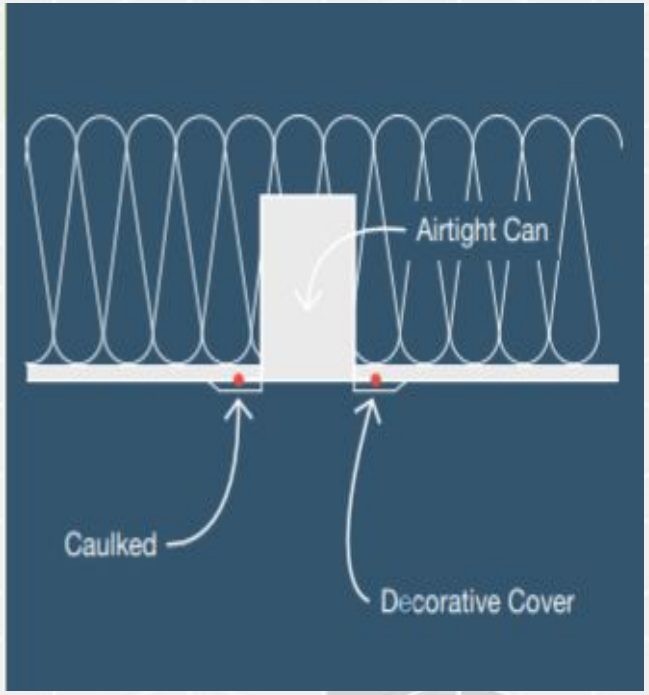
Forms:

- Batts and blankets
- Loose-fill and blown-in
- Damp spray (cellulose, spider micro-filament fiberglass)
- Blown-in batt system (BIBS)
- Dense pack insulation
- Foams (sheet-applied)
- Foams (spray-applied)
- Reflective systems

Priority Locations for Air Sealing



Top Plate to Attic Drywall



Recessed Light to Finished Surface

Source: https://insulationinstitute.org/wp-content/uploads/2018/05/N090-5-Air-Sealing-Locations-for-New-Homes.pdf

No or poor quality Air sealing

Air Leakage & Continuous Air Barrier Testing
Section C402.5

- Continuous Air Barrier Required

- Two Compliance Options
  - –ASTM E 779 (blower door test)
  - –Compliant assemblies
    - C402.5.1 through C402.5.8

Image: energyconservatory.com

Building envelope

Systems Commissioning and Completion Requirements

Section C408

- Commissioning is critical to ensure that buildings are **working as designed**
- Preliminary and final reports required
- Mechanical and lighting commissioning detailed in section C408

Building Controls are Complicated

- Since 2004, about 30% of all new requirements have been related to building controls
- Control requirements can be difficult to implement, and verification is beyond the expertise of most building code officials
- Assumption is that they are implemented and working correctly
- Source: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26348.pdf

Session 2 Building Science
Key Takeaways: Building Science

- Advanced Detailed Physics
- Water (aka: “The Enemy”)
- Air & Air Movement
- Temperature & Temperature Transfer
- Building Envelope
- Quality Control
- Tightness testing
- Quiz

Key Takeaways

- There are several ways to comply with the commercial energy code
- Mandatory requirements must all be met
- System Commissioning is critical to ensure the building is operating as intended

MEEA YouTube Videos

Commercial Air Infiltration

- *https://www.youtube.com/watch?v=as6l1xEMJes*

Commercial Lighting and HVAC

- *https://www.youtube.com/watch?v=FroYByTpu7U*

In Two Weeks:

COMMERCIAL ENERGY CODE –IECC

SESSION 2 PART 1

IECC VS. ASHRAE

SESSION 2 PART 2

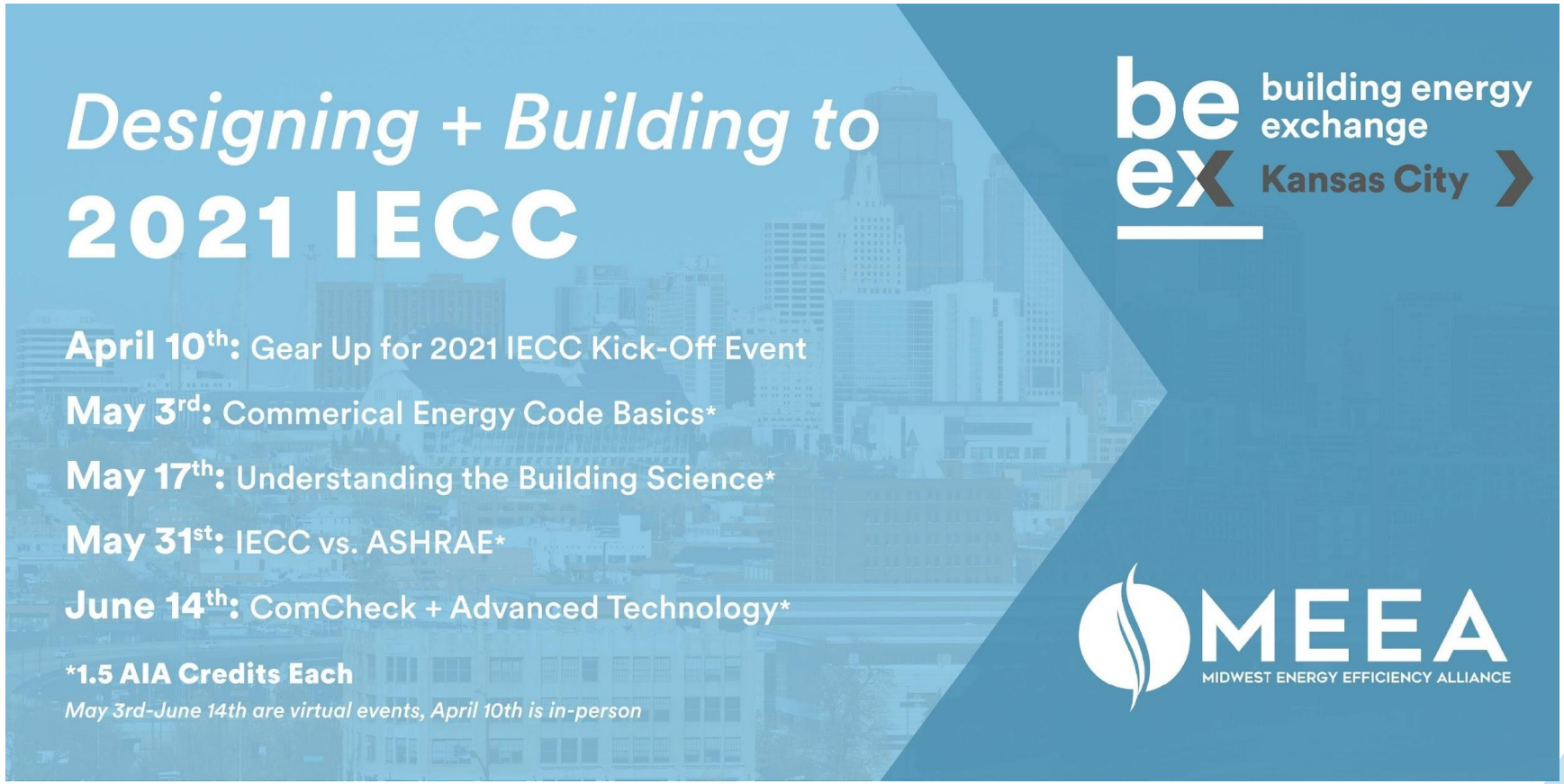
COMMERCIAL ENERGY CODE BASICS

INSTRUCTOR: MATT BELCHER

TUESDAY, MAY 17TH 10:30 AM-12:30 PM

Don’t Forget to Register!

www.be-exkc.org/news



Questions? Contact: Ashley Sadowski, asadowski@be-exkc.org