Nebraska's New Residential Energy Code

Requirements and Best Practices

Nebraska Energy Code Training Program

Instructor: Matt Belcher

January 20, 2021: 9:30 – 11:00 am CST

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Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box
- Webinar is being recorded – slides and recording will be sent to attendees
- **CEU's will be available upon request (ICC)**
  - **Course:** 26865, **CEUs:** 0.15
- Email nwestfall@mwalliance.org with questions

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About MEEA

- MEEA is a nonprofit membership organization with 160+ members, including:
  - Utilities
  - Research institutions
  - State and local governments
  - Energy efficiency-related businesses
- MEEA helps stakeholders understand and implement cost-effective energy efficiency strategies

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About the Nebraska Training Program

- Goal: prepare the Nebraska workforce for upcoming changes in construction best practices
  - Residential and Commercial Energy Code
  - Building Science
  - Practical Solutions

- Focused on providing training to builders, code officials, design professionals, public officials and students

- For more information, visit: https://www.mwalliance.org/nebraska-energy-codes-training-program

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About Verdatek Solutions

Matt Belcher

VERDATEK SOLUTIONS

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Introduction Poll #1

- What is your profession?
  - Code Official
  - Home Builder
  - State/local government
  - Energy Rater/Consultant
  - Architect/Engineer
  - Non-profit
  - Academic/Student
  - Utility
  - Other (type in chat)

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Introduction Poll #2

- How long have you been in the construction industry?
  - 0-5 years
  - 5-10 years
  - 11-15 years
  - 16-20 years
  - 21+ years

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Introduction Poll #3

- How familiar are you with the residential provisions in the 2018 IECC?
  - Extremely Familiar
  - Somewhat Familiar
  - Somewhat Unfamiliar
  - Not familiar at all

Training Objectives

- What is the 2018 Energy Code?
- Inside the Energy Code:
  - Building Envelope
  - Interior Comfort/Health
  - Remodeling
- Marketing Energy Efficient/High Performance Buildings

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Today's Agenda

- Code Requirements in the 2018 IECC
- Moisture Management
- Air Movement
- Heat Transfer
- Performance Testing
- HVAC System
- Key Takeaways

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What is the 2018 IECC?

(Nothing scary, really!)

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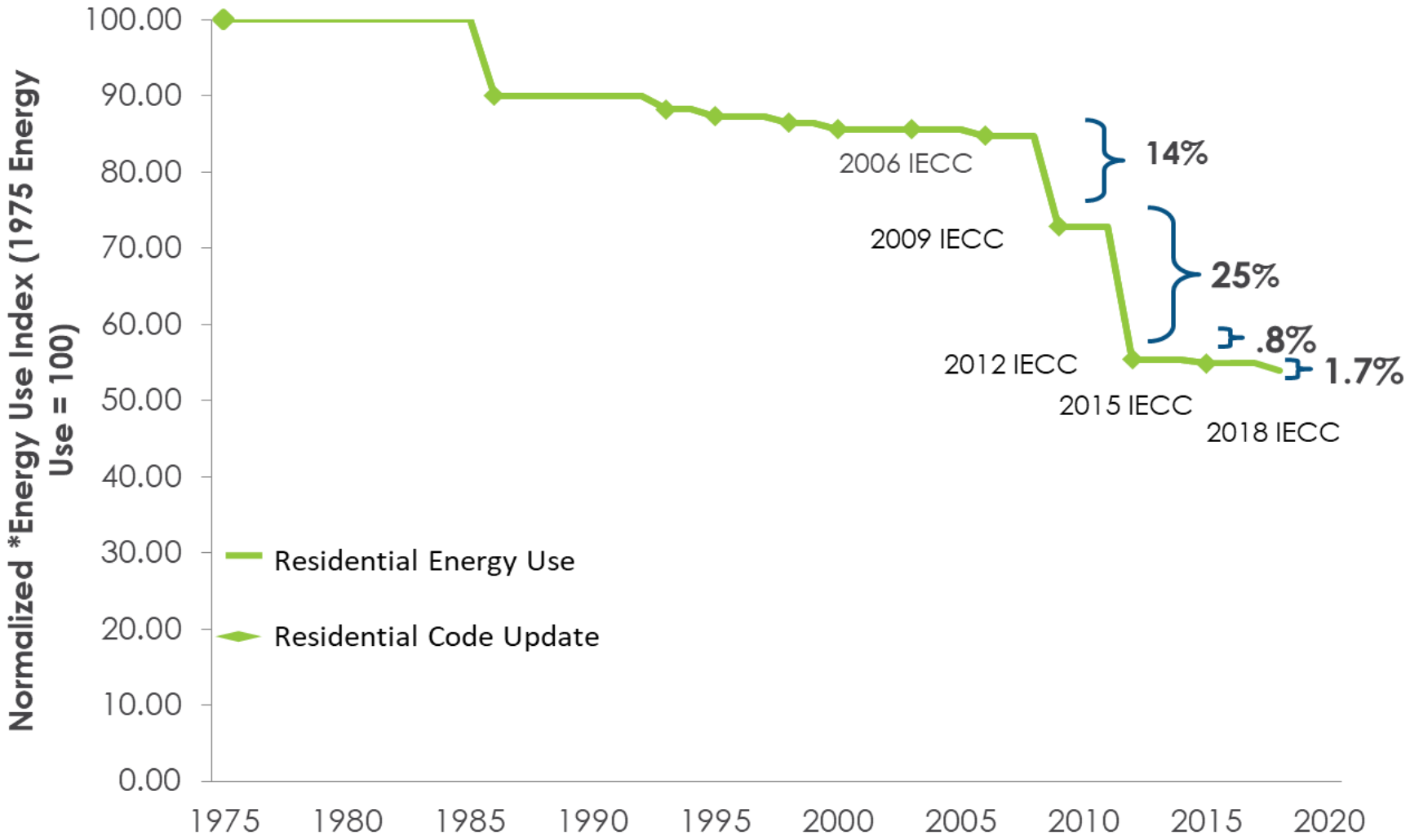
Model Energy Code Efficiency



* Energy Use Index: National average energy use by building type and size.

Source: MEEA based on PNNL Analysis

Nebraska Residential Field Study

- Conducted in 2017 by Nebraska Department of Environment and Energy. 2009 IECC was the baseline.
- Collected and Analyzed Several Data Points for new homes, including:
  - Envelope air leakage
  - Efficacy in lighting
  - Duct leakage
  - Ceiling & exterior wall insulation
  - Basement & slab insulation
  - Windows

For More Information and Data:

https://www.energycodes.gov/sites/default/files/documents/Nebraska_Residential_Compliance_Evaluation_final.pdf

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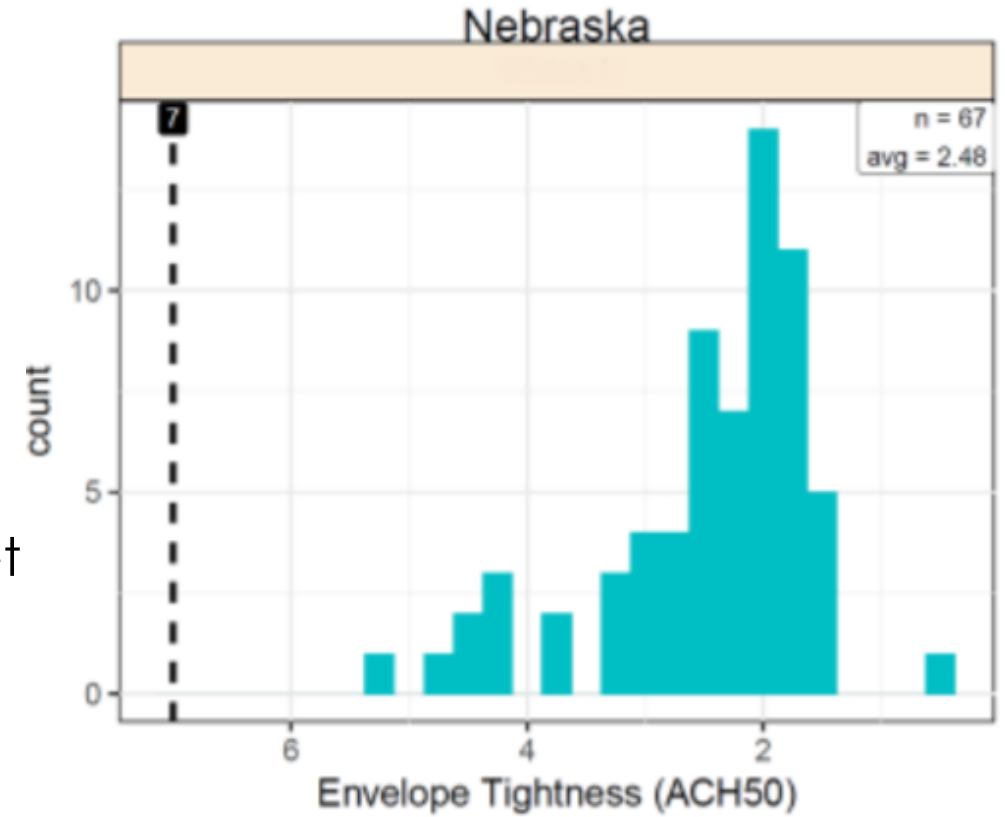
Nebraska Residential Field Study - Results

- Overall, not too bad! But room to improve.
  - **Envelope Air Leakage**: Better than code(7 ACH50)
    - Not all would meet 2018 IECC
  - **Efficacy in Lighting**: Average; some good, some not
  - **Duct Leakage**: Ugh!
    - Needs significant improvement to meet 2018 IECC
  - **Ceiling Insulation**:
    - Amount: Good+ (Average: R-42.5)
    - Install: Not as good. Reduces compliance (R-factor)



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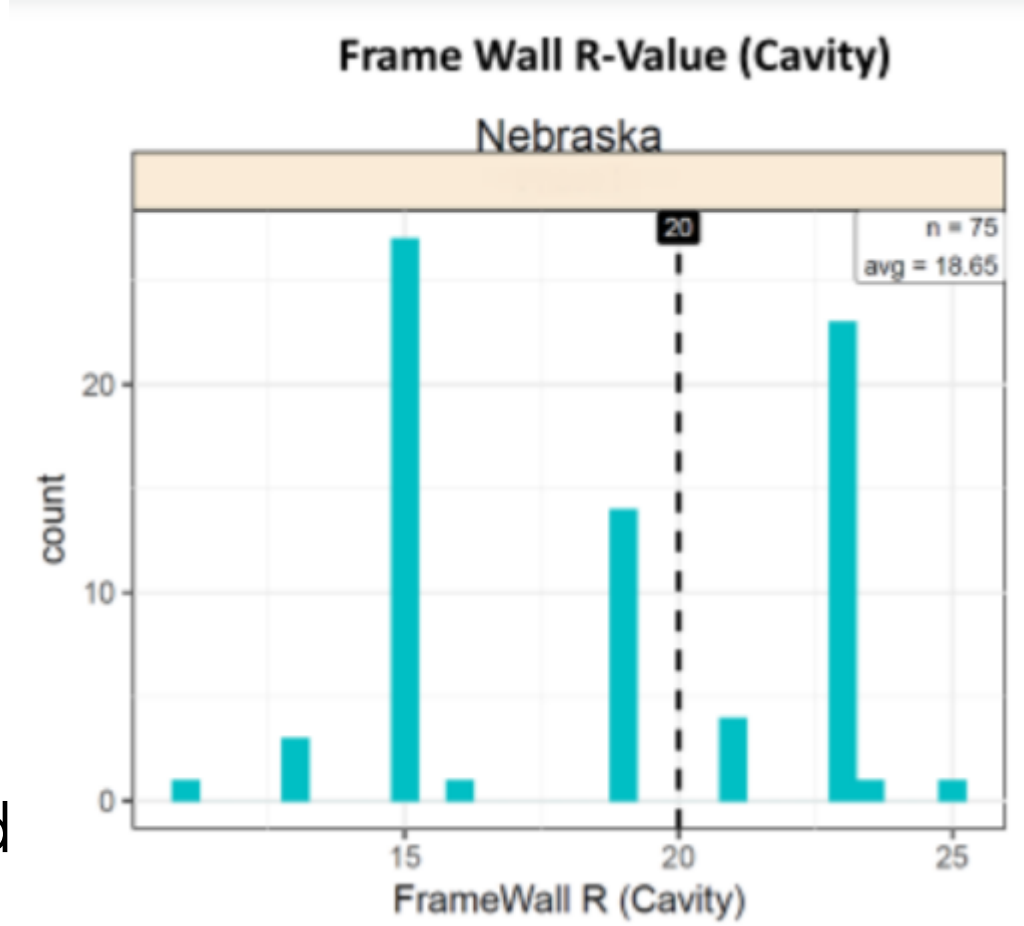
Nebraska Residential Field Study - Results

- Frame Wall Insulation: Most common installation was below code
  - Even continuous insulation < Code
  - Quality of Installation an issue
- Basement Insulation: Meets code(average), but room to improve
- Slab insulation: Meets or exceeds code
- Windows: Meets code but will need to upgrade to meet 2018 IECC



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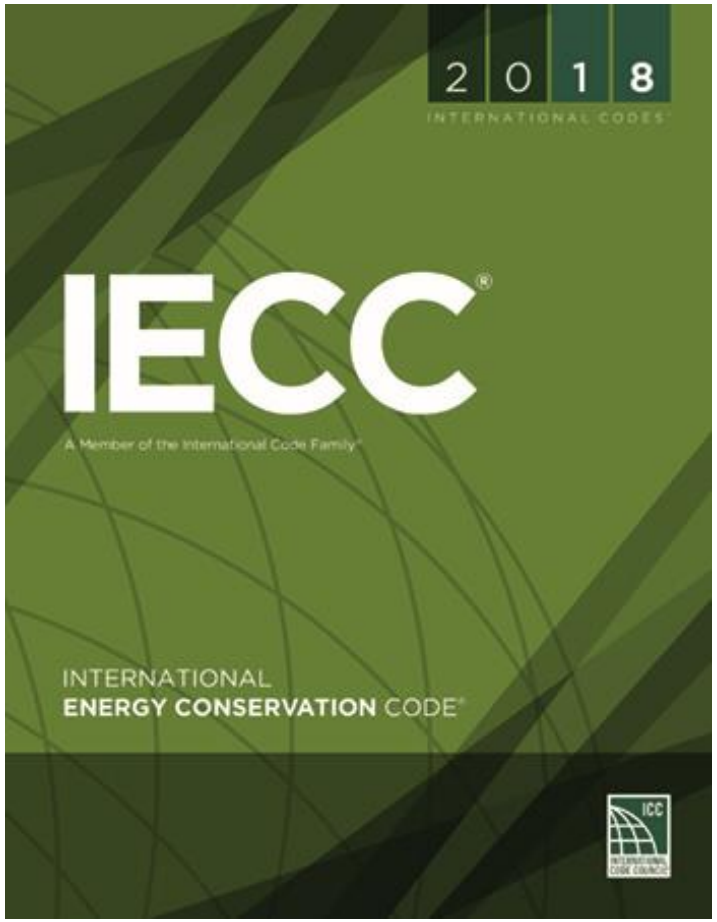
So, What's Changed since 2009?



2018 IECC / IRC Section 11

- Creates a Residential Energy Code separate from the Commercial Energy Code
- Adds testing and verification requirements
- Promotes Innovation through Energy Ratings Index (ERI)
  - Uses a HERS-type index as an "equivalent" for residential applications
  - Mandatory requirements still apply

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2018 IECC Mandatory Requirements

Energy Certificate

- Energy Certificate located on circuit breaker box includes key energy efficiency measures and is signed by the builder

Air Sealing

- All holes between floors and through exterior walls/ceilings have been sealed in **accordance with table R402.4.1.1**
- Building or dwelling unit is **tested to verify air leakage rate of ≤ 3 Air Changes per Hour (ACH)**
- Building or dwelling unit must have continuous air barrier installed

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2018 IECC Mandatory Requirements

Ducts

- All ducts are sealed with approved materials (e.g. mastic or UL 181 tape) - duct tape is not acceptable
- All ducts outside conditioned space are tested to verify duct leakage with a total duct leakage or leakage to the outside test
- Supply & return ducts in attic insulated to ≥ R-6 when ducts are outside conditioned space and ≥ R-8 when ducts are outside the building thermal envelope

Building Cavities

- **Building framing cavities shall not be used as supply ducts or plenums**

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2018 IECC Mandatory Requirements

Heating and Cooling

- Controls: Programmable thermostat installed
- Equipment sized per ACCA Manuals S & J

Lighting

- Minimum of **90% high-efficacy lamps** installed
- Recessed lighting in thermal envelope IC-rated and airtight

Mechanical Ventilation

- **Installed according to requirements in the International Mechanical Code**
- **Required for all homes ≤ 5 ACH per Section M303.4 (3 ACH is a 2018 IECC mandatory requirement)**

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2018 IECC Mandatory Requirements

Other requirements

- Wood-burning fireplaces have tight flue dampers or doors, and outdoor combustion air
- Mechanical system piping insulated to min R-3 for fluids >105° F or <55° F
- Circulating hot water systems shall be insulated to at least R-2. Systems shall include an automatic, or readily accessible, off-switch.

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Energy Code Compliance Pathways

Prescriptive Method Requirements

- All mandatory and prescriptive requirements must be met

Total UA Method Requirements

- All mandatory and prescriptive requirements (other than Table R402.1.2) must be met
- Include documentation to demonstrate compliance with the UA Trade-off method. Compliance software submittal must include completed compliance form, inspection checklist and certificate demonstrating compliance with 2018 IECC levels

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Energy Code Compliance Pathways

Simulated Performance Requirements (Section R405)

- All mandatory requirements must be met
- Submit an energy cost analysis report which demonstrates that the proposed design (as built) home is more efficient than the standard reference design home

Energy Rating Index Requirements (Section R406)

- All Mandatory requirements met. Meet or exceed 2009 IECC prescriptive envelope requirements
- ERI score of 61 or lower. Submit report demonstrating compliance

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2018 IECC Prescriptive Requirements

Indicates Change

Table R402.1.2 Insulation Requirements By Component

Requirement	2009 IECC	2018 IECC
Ceiling R-value	R-38	**R-49**
Wall R-value	R-20 or R-13+5	R-20 or R-13+5
Floors over unconditioned space	R-30	R-30
Basement R-value	10/13	**15/19**
Slab R-value and depth	10, 2 ft.	10, 2 ft. ***R-5 insulation shall be provided under the full area of a heated slab**
Crawl space wall R-value	10/13	**15/19**

2018 IECC Prescriptive Requirements

Indicates Change

Table R402.1.2 Fenestration Requirements By Component

Requirement	2009 IECC	2018 IECC
Fenestration U-factor (windows, glass, opaque and swinging doors with <50% glazing)	.35	**0.30**
Skylight U-factor	.60	**0.55**

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2018 IECC Prescriptive Requirements

Indicates Change

Requirement	2009 IECC	2018 IECC
Eave Baffle	NO REQUIREMENT	For air permeable insulations in vented attics, **a baffle shall be installed adjacent to soffit and eave vents**. Baffles shall maintain an opening equal or greater size than the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material. (402.2.3)
Hot water pipe insulation	NO REQUIREMENT	**Insulated to R-3**, ¾ or larger pipes with exceptions (403.5.3)

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2018 IECC Prescriptive Requirements

Indicates Change

Requirement	2009 IECC	2018 IECC
Duct Insulation	Supply ducts in attics shall be insulated to a minimum of R-4. Exception: Ducts or portions thereof in conditioned space (403.2.1)	Supply and Return ducts in attics shall be insulated to a **minimum of R-6 or R-8**, depending on diameter. All other ducts shall be insulated to a **minimum of R-6 or R-4.** Exception: Ducts or portions in conditioned space (403.3.1)
Duct Testing	Post construction: Leakage to Outdoors: 8 cfm/100 sq. ft. Total Leakage: 12 cfm/100 sq. ft. Rough-in: Total Leakage: 6 cfm/100 sq. ft. Exception: Duct tightness test not required if most ducts located entirely within building envelope. (403.2.2)	Ducts tested to the following leakage rates: Post construction: Total Leakage: **4 cfm/100 sq. ft.** Rough-in: Total Leakage: **4 cfm/100 sq. ft.** Exception: Duct tightness test not required if all ducts located entirely within building envelope. (403.3.4)

Other changes in the 2018 IECC

Indicates Change

Requirement	2009 IECC	2018 IECC
Thermally Isolated sunroom U-factor	Maximum fenestration U-factor shall be 0.50 and maximum skylight U-factor shall be 0.75. (402.3.5)	Maximum fenestration **U-factor shall be 0.45** and maximum skylight U-factor shall be 0.70. (402.3.5)
Buried Ducts in Attic	Not referenced	Ducts tested to have a maximum leakage rate of 1.5 cfm25/100 sq. ft. to the outside, are insulated with ≥ R-8 insulation, and have at least R-19 insulation above and to the sides of the ducts, **count as being in conditioned space**. (403.3.6)

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The Science Behind the Code

- Building science helps create the energy code and its requirements
- Goal: to protect building stability and durability and protect human health
- Next: we'll discuss the science behind moisture management and why it's so important

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Moisture Management

It Connects EVERYTHING!

The Major "Damage Functions"

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

Moisture Management & Energy

- Moisture management is achieved through the selection and arrangement of the materials comprising building enclosures in order to safely manage the moisture loads.
- Not directly addressed in the Energy Code
- The result of the tightness required by the 2018 IECC-R makes moisture a major factor in the design and construction of the home
- Not only for performance but also for occupant health

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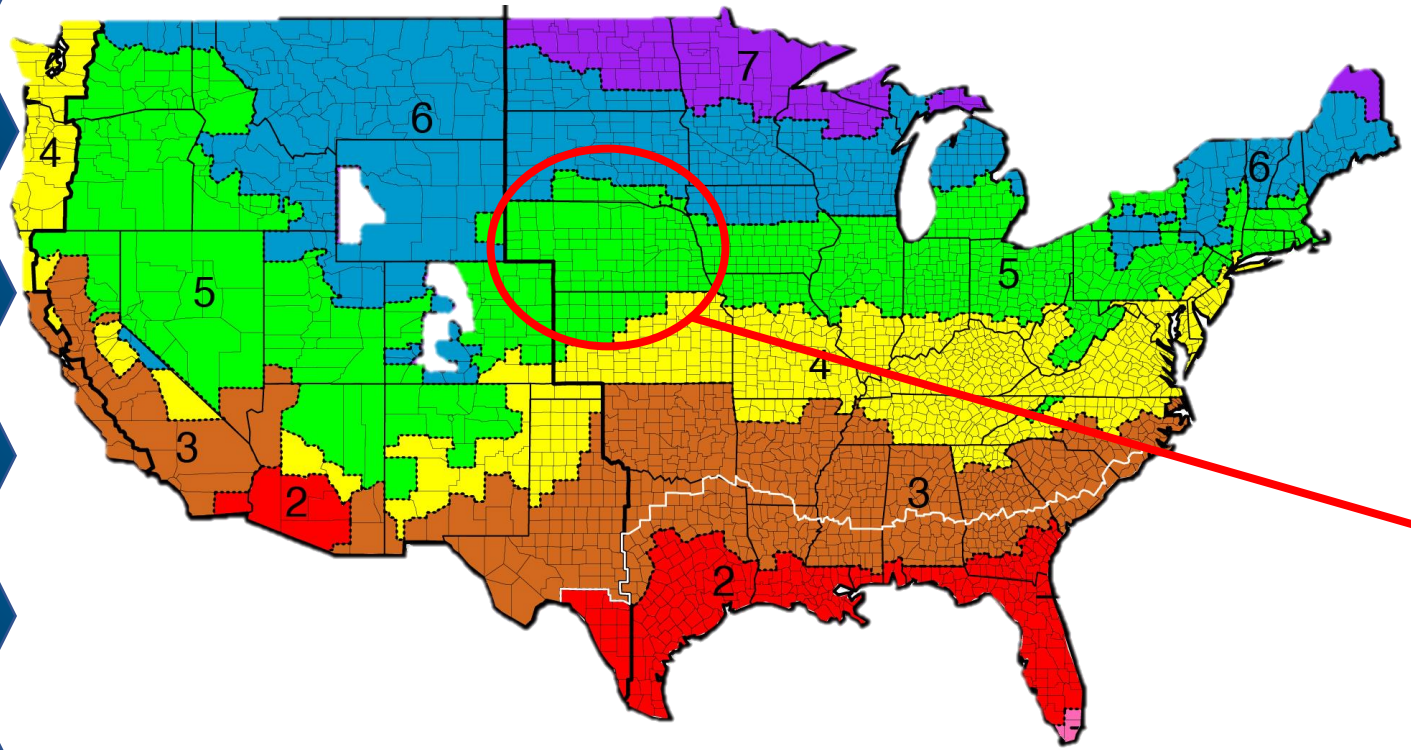
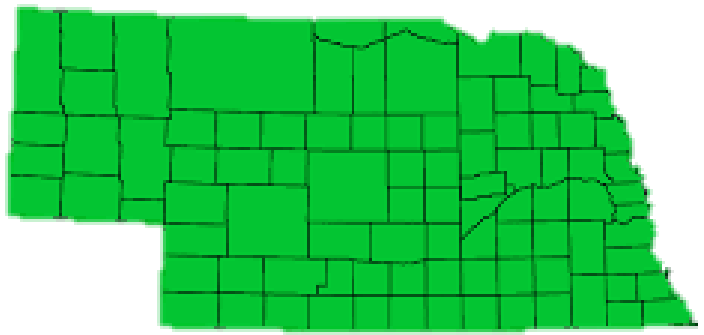
Climate Zones



- Nebraska has only one climate zone – 5A
- Cold & Moist climate



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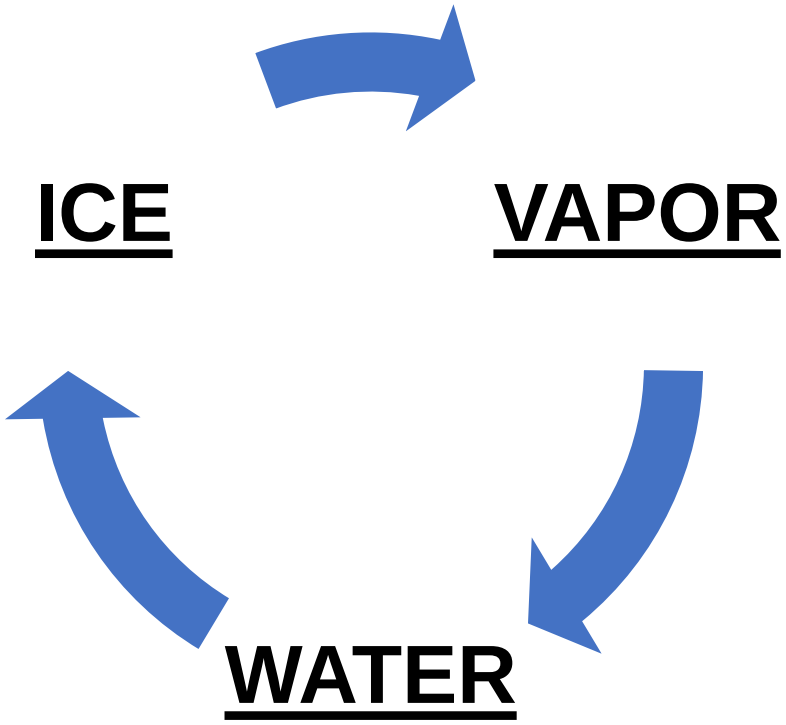
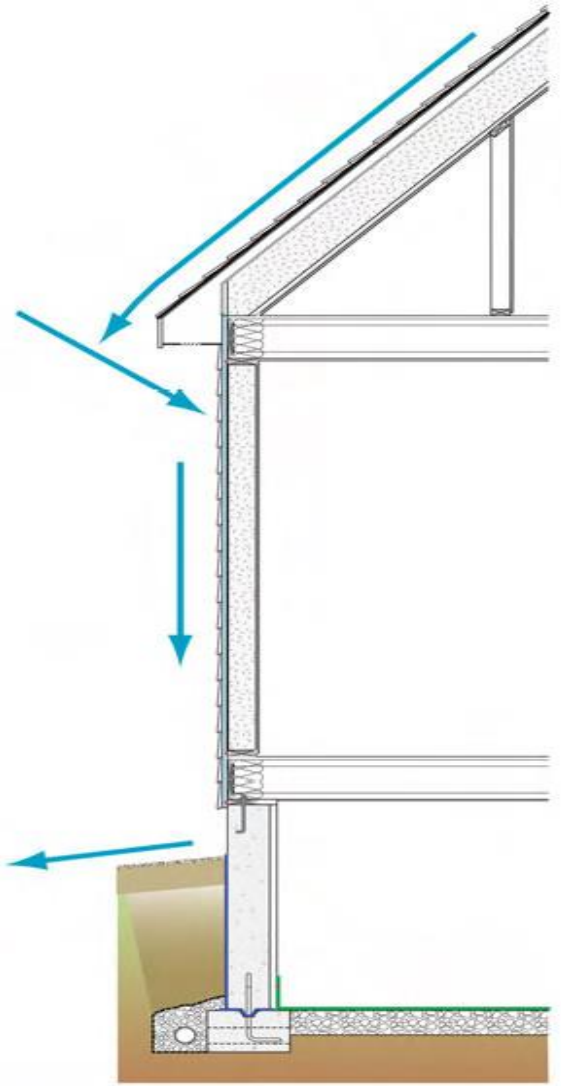
Prioritizing Moisture Movement

#1 – Bulk Water
#2 – Capillary Water
#3 – Air-Transported Moisture
#4 – Diffusive Moisture Movement



Bulk Water Management – Priority #1

The key is proper
drainage!



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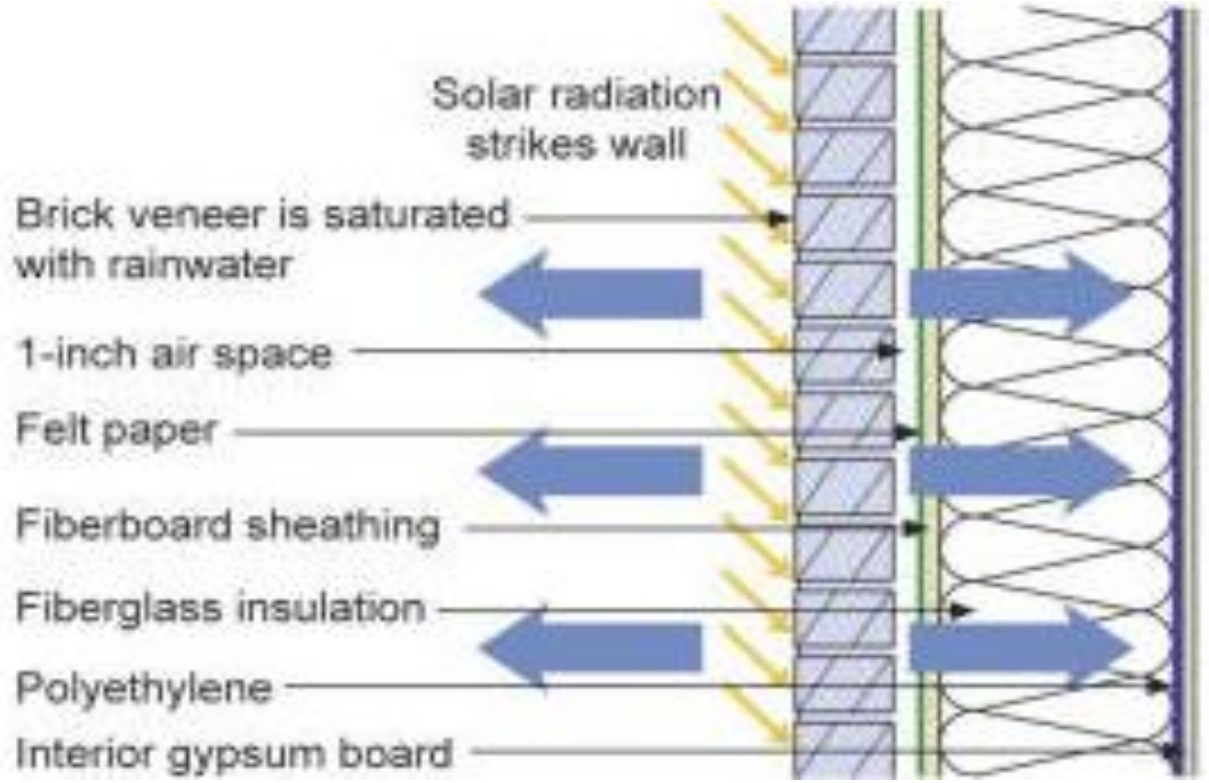
Always Allow For Drying

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

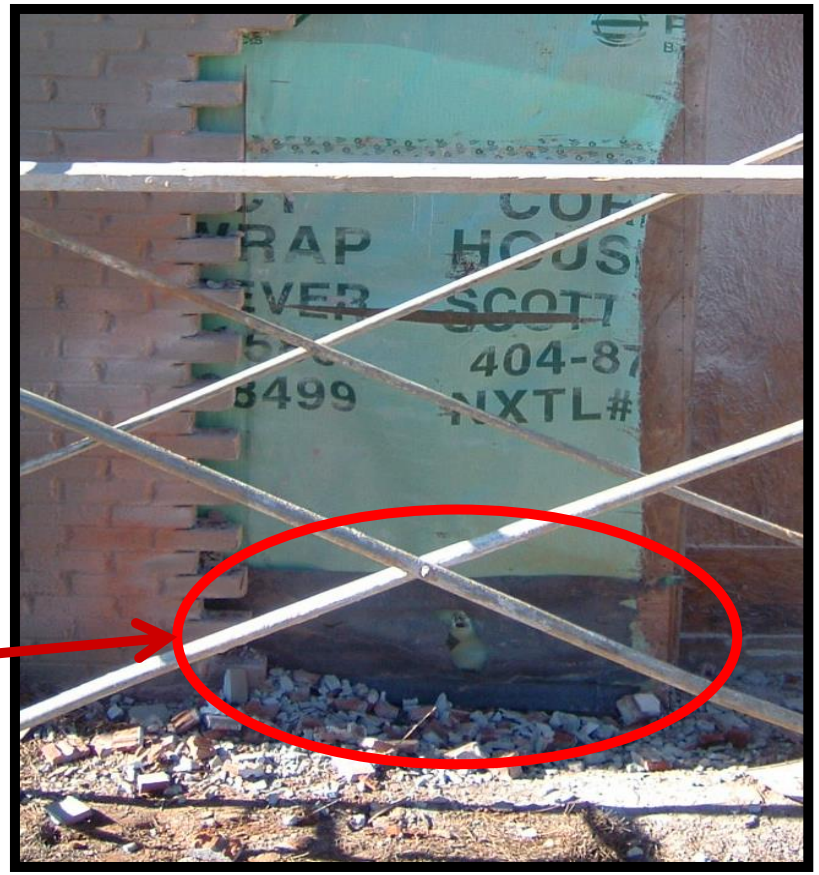


Vapor is driven both inward and outward by a high vapor pressure differential between the brick and interior and the brick and exterior

Image by Building Science Corp.

Properly Lap Flashing

- The mason's flashing (black) was installed after and in front of the house wrap (green). This is reverse flashing that will trap any drain water that gets past the brick veneer.



Direct Water Away From Corners

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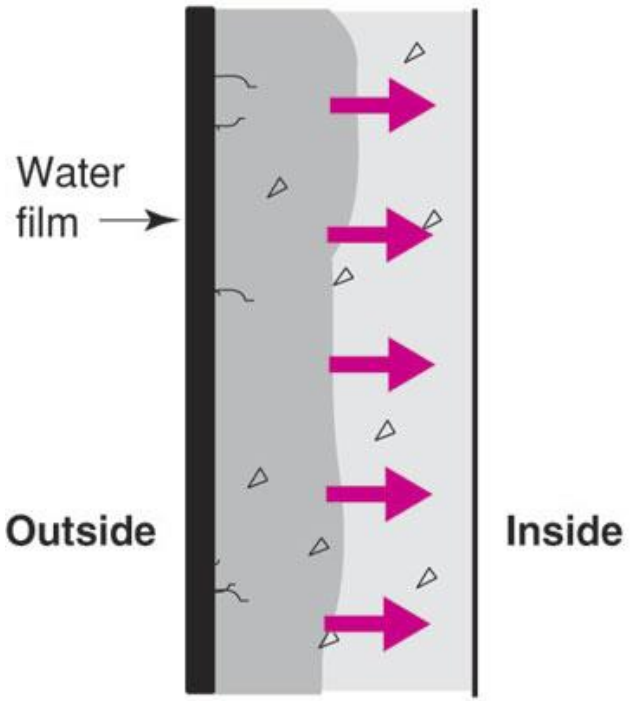
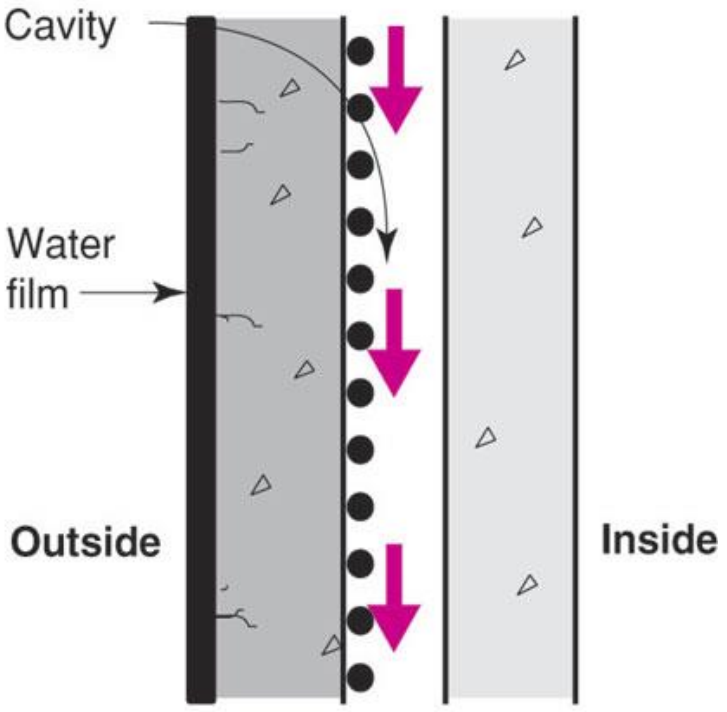
Capillary Moisture Flows - Priority #2



Capillary suction draws water into porous material and tiny cracks



Cavity acts as capillary break and receptor for capillary water interrupting flow

Image courtesy of Building Science Corp.

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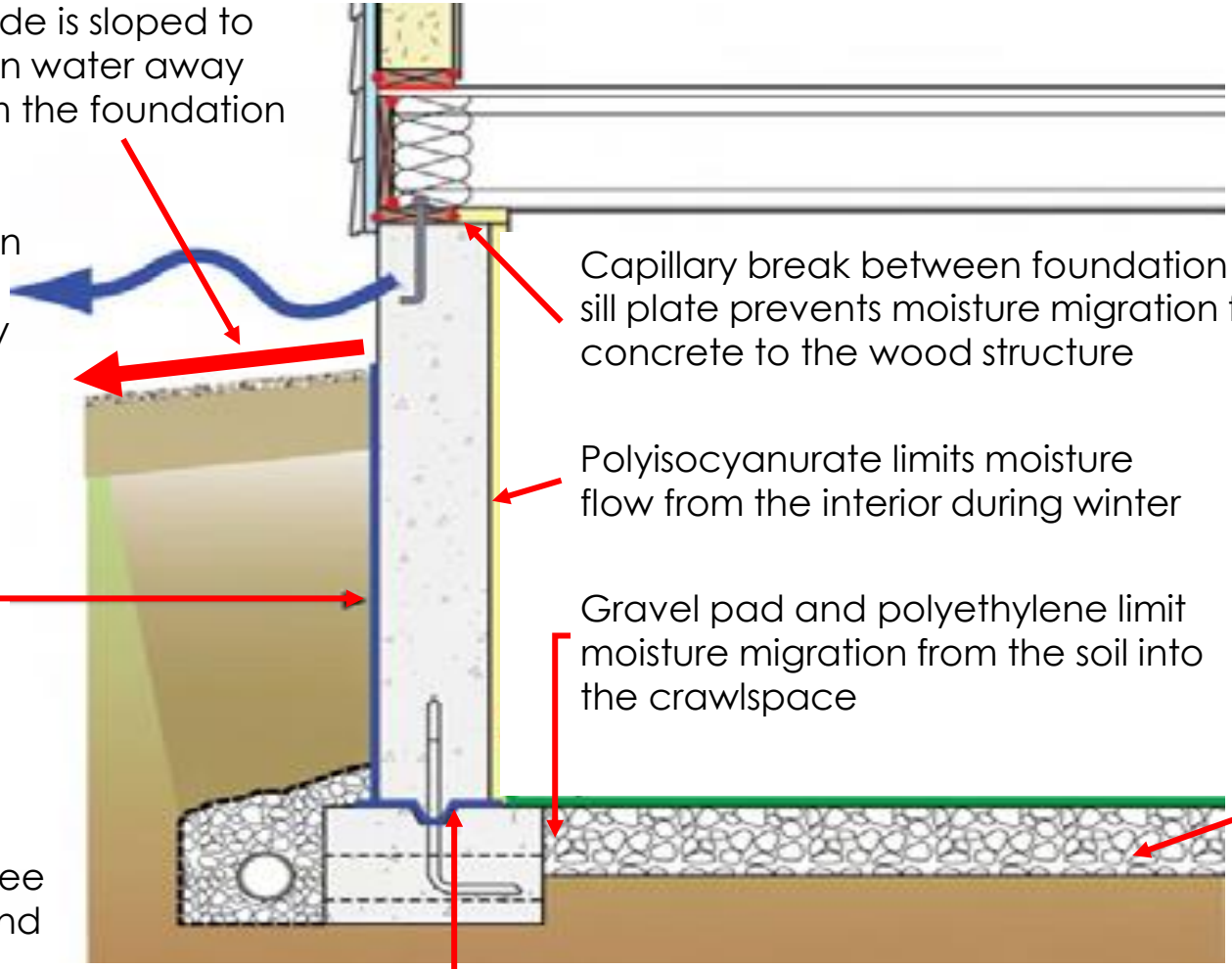
Foundation Moisture Management



Grade is sloped to drain water away from the foundation

Exposed portion of foundation wall able to dry to exterior

Capillary break between foundation wall and sill plate prevents moisture migration from the concrete to the wood structure

Polyisocyanurate limits moisture flow from the interior during winter

Damp-proofing limits moisture flow from soil

Gravel pad and polyethylene limit moisture migration from the soil into the crawlspace

Gravel pad is connected to the perimeter drain through pipes cast into the footing

Water against the foundation wall drains down the free draining backfill and out the perimeter drain at the footing

Capillary break between footing and foundation wall

Sill Plates Need Capillary Breaks

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Air Transport of Moisture – Priority #3

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

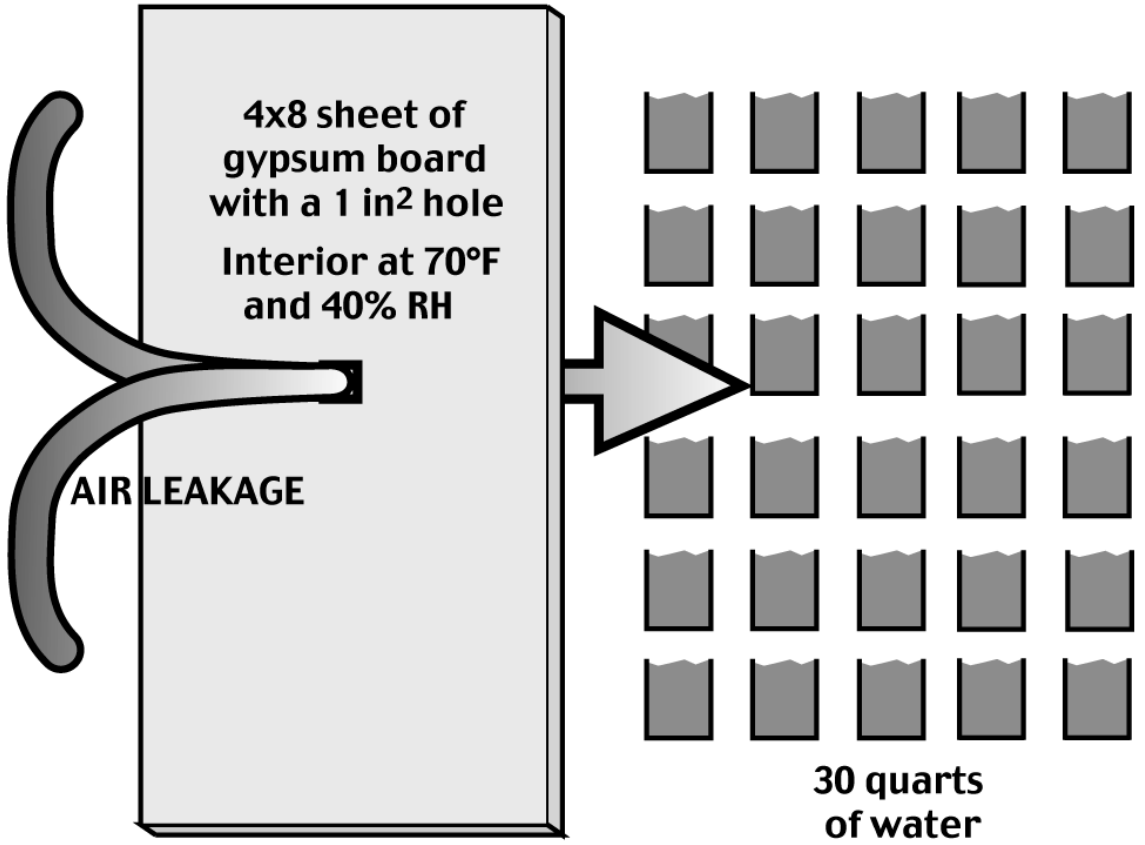
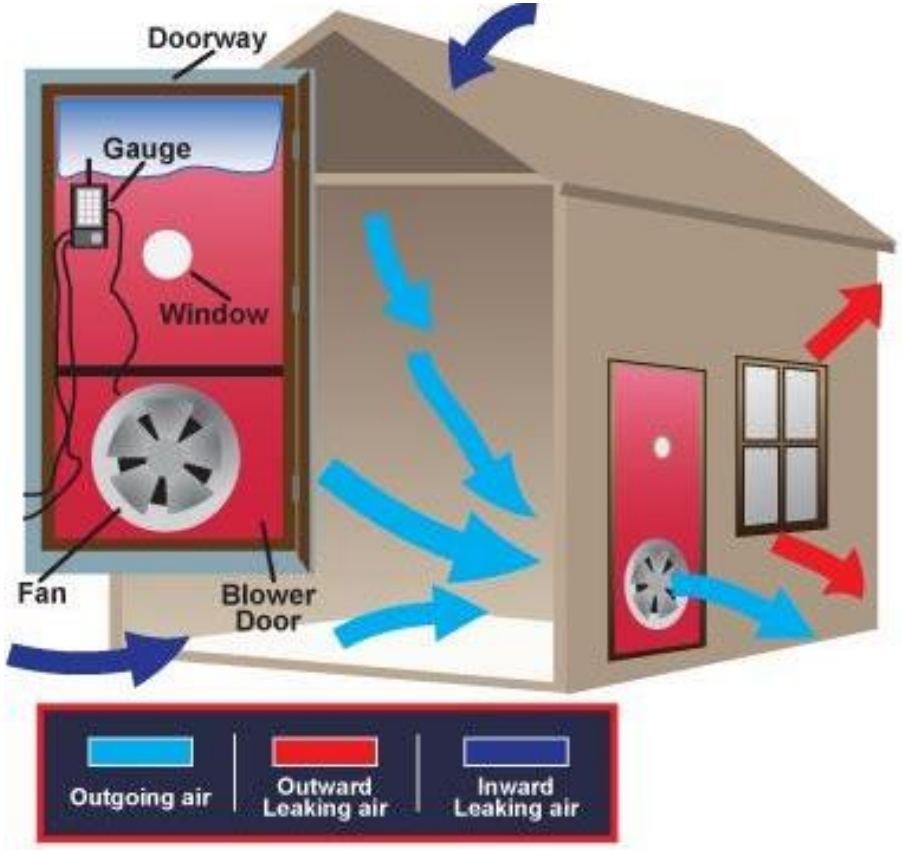


Image courtesy of Building Science Corp.

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



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Diffusion – Priority #4

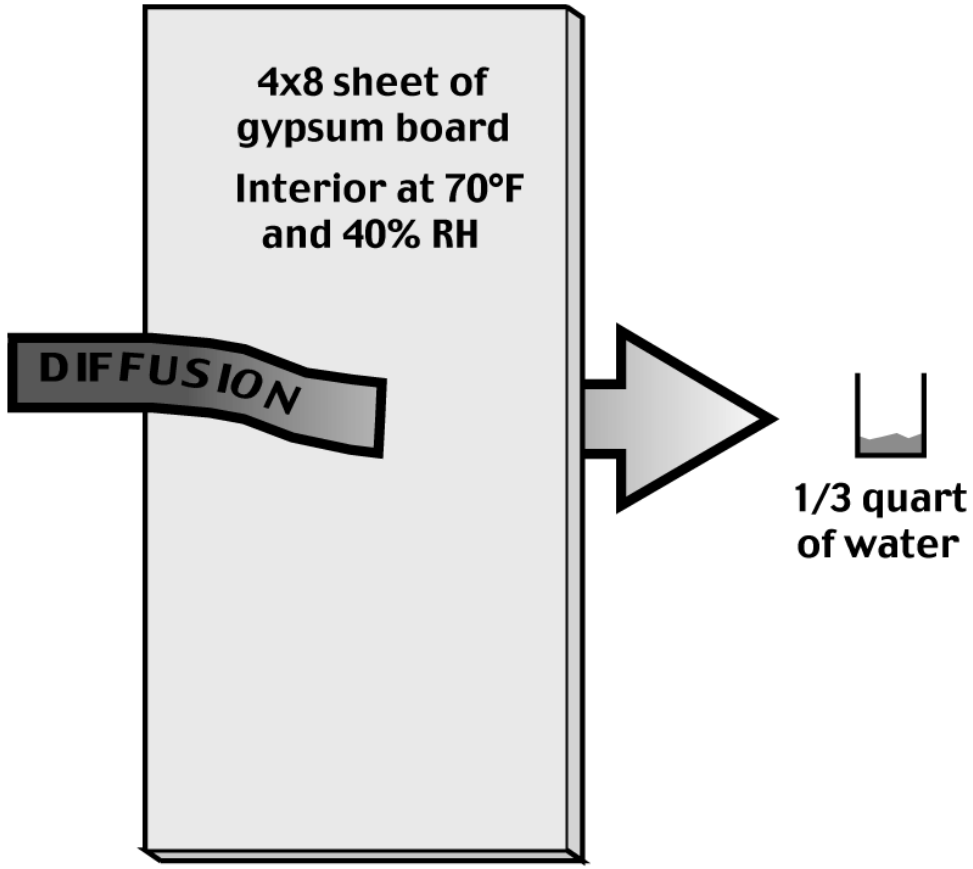


Image courtesy of Building Science Corp.

- Migration of moisture by means of vapor pressure differential
- Occurs in either direction based on climate conditions and exterior/interior levels of humidity
- Different building materials have different permeability

Air Movement

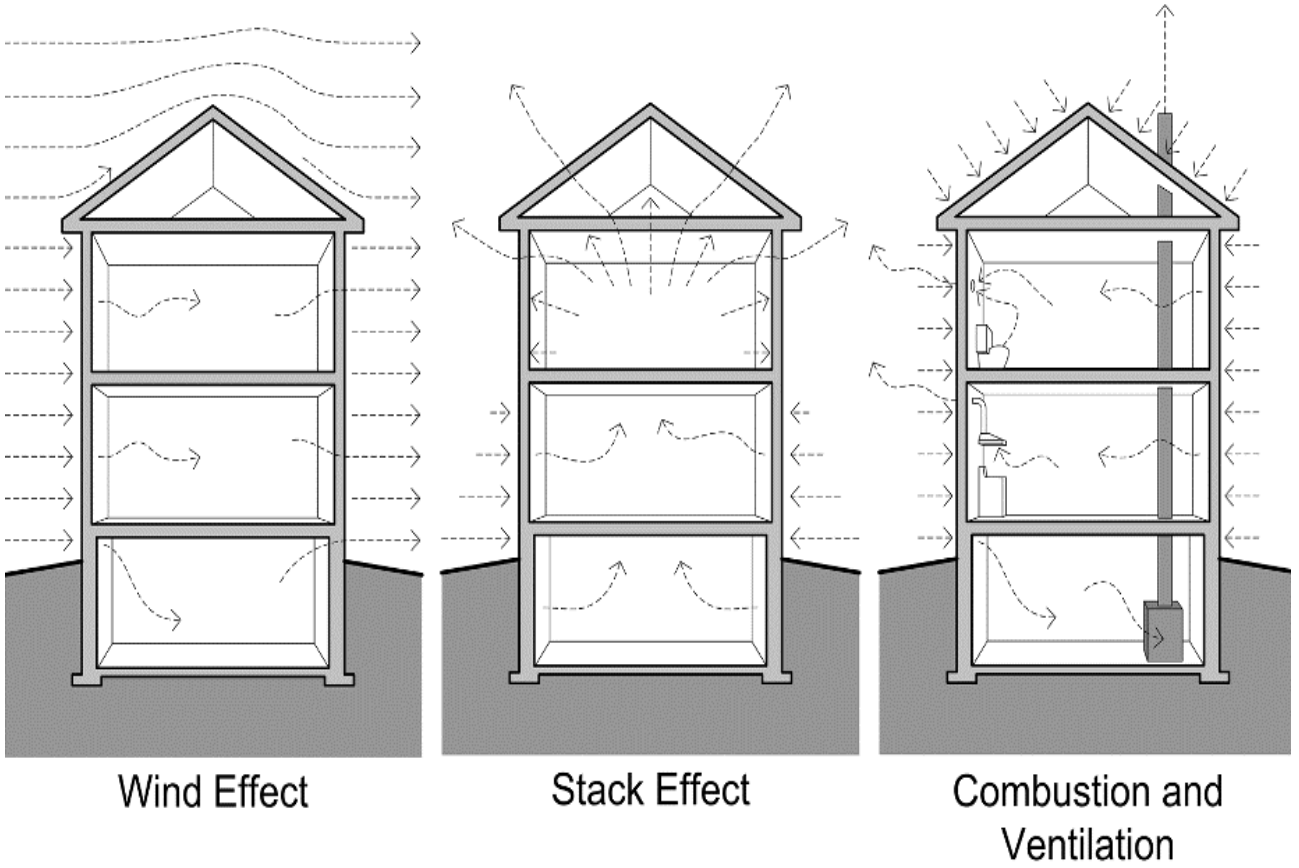
Air Movement Seeks Balance

How Does Air Get Around?

Air In = Air Out

For air movement you need:

- A hole
- A driving force
- Another hole



Internally Generated Air Pressure

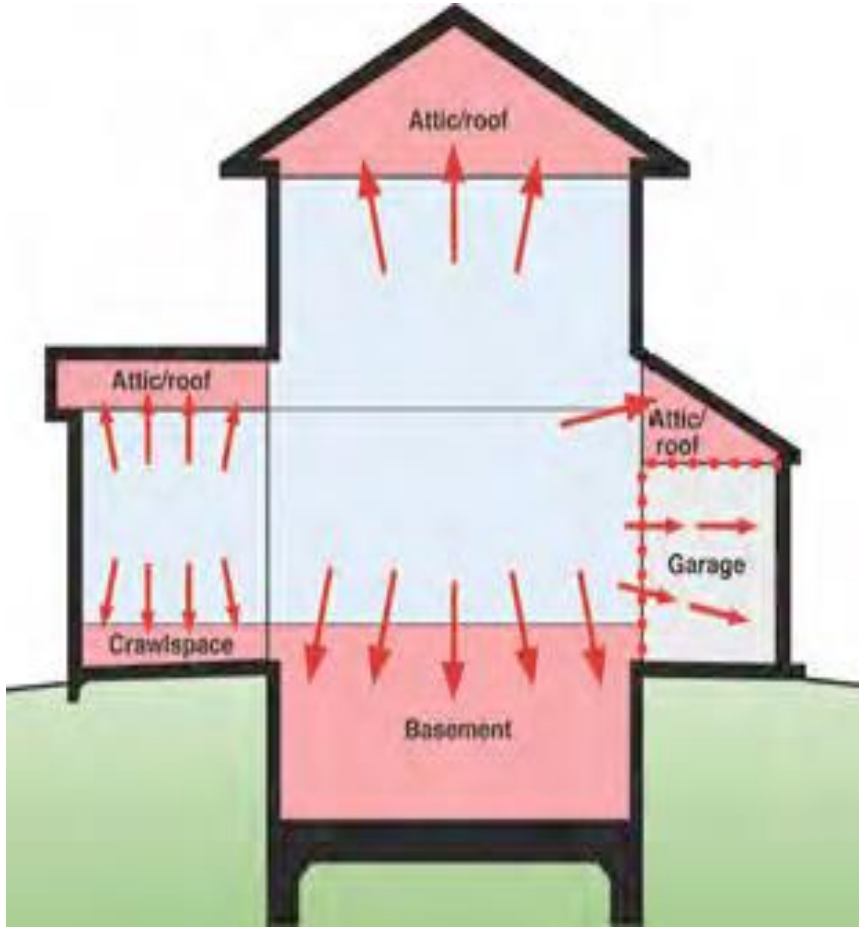


Image by Belcher Homes

Expansion of Conditioned Space

- Conditioned space boundaries moving towards exterior surfaces of building
- Garage isolated from house by air barrier/pressure boundary
- Garage ventilated and conditioned independently of rest of conditioned spaces

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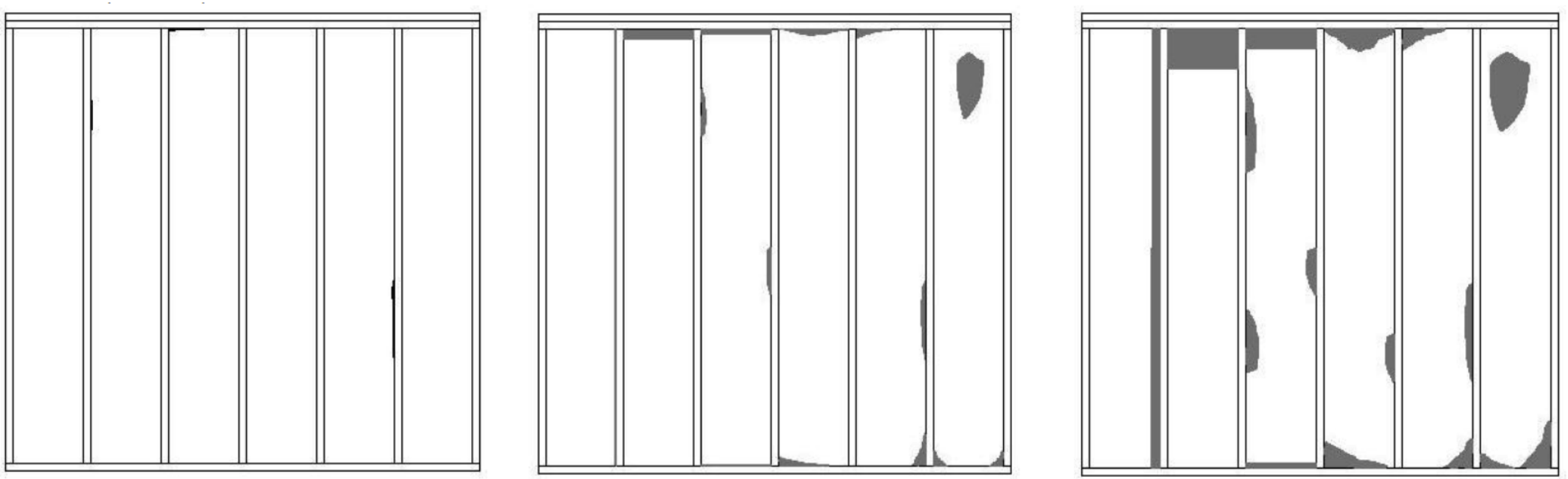
Batt Insulation Grading

Code Compliant ——— **Not Acceptable** ———



Grade I: Almost no gaps

Grade II: Up to 2%

Grade III: 2% - 5%

RESNET protocol for the effect of missing insulation on installation grade

Diagrams from the HERS Standards

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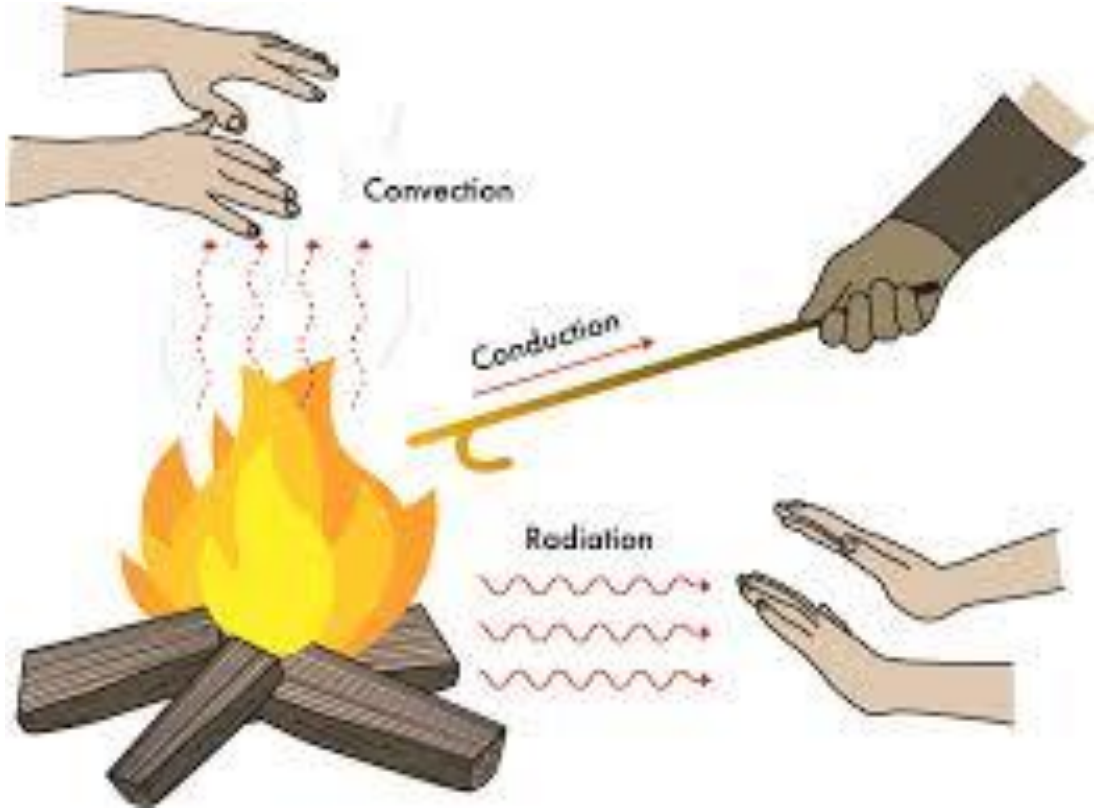
Heat Transfer

A Triple Threat

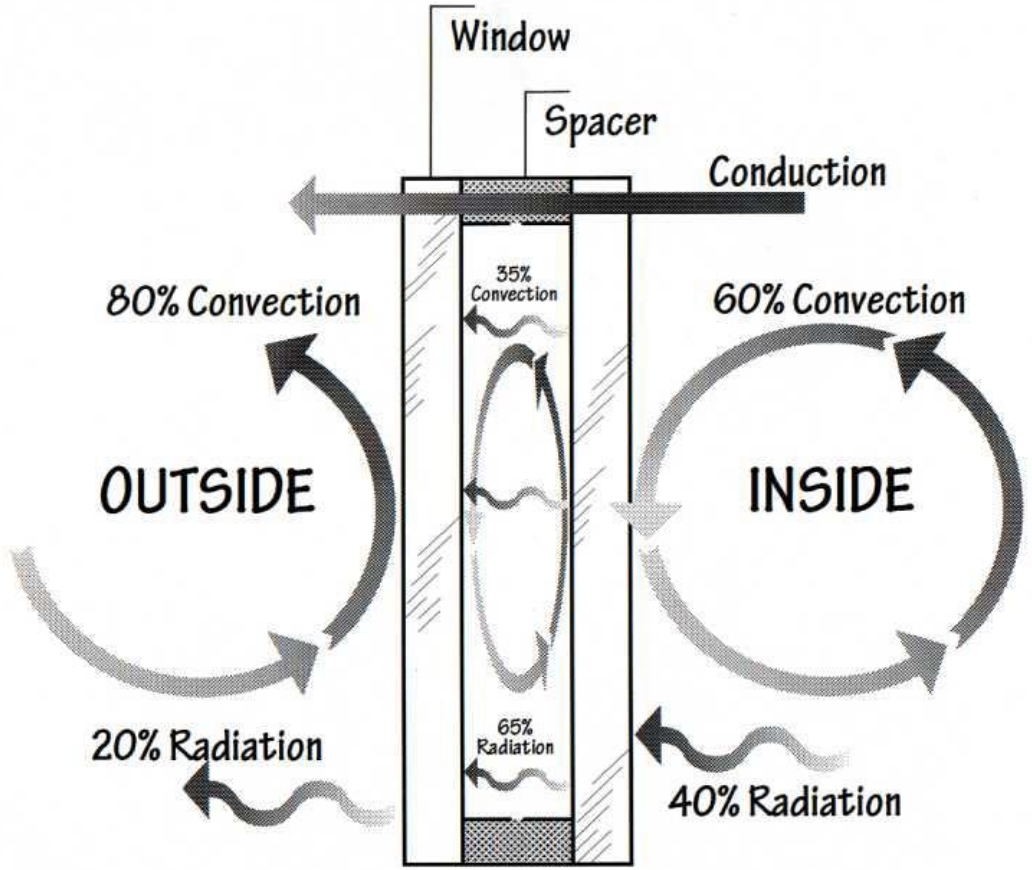
Heat Transfers in 3 Ways

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



Practical Application - Windows

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



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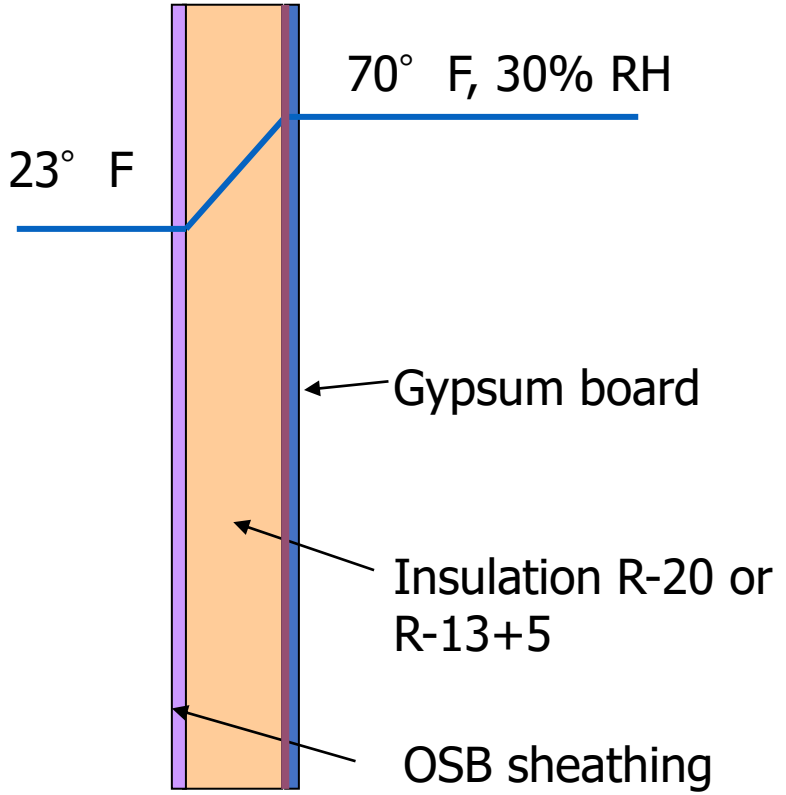
Condensing Surface Temperatures

- Dewpoint of interior air = 37°F
- Where will condensation occur?
  Inside surface of exterior sheathing
- One Solution?
  Interior vapor retarder, but what type and at what "cost?"



Major Building Envelope Protection Systems

- Water Barrier
- Air Barrier
- Thermal Barrier
- Vapor Profile (not just the designated vapor retarder)
- Maintenance documents

“You don’t get what you expect, you get what you inspect!”

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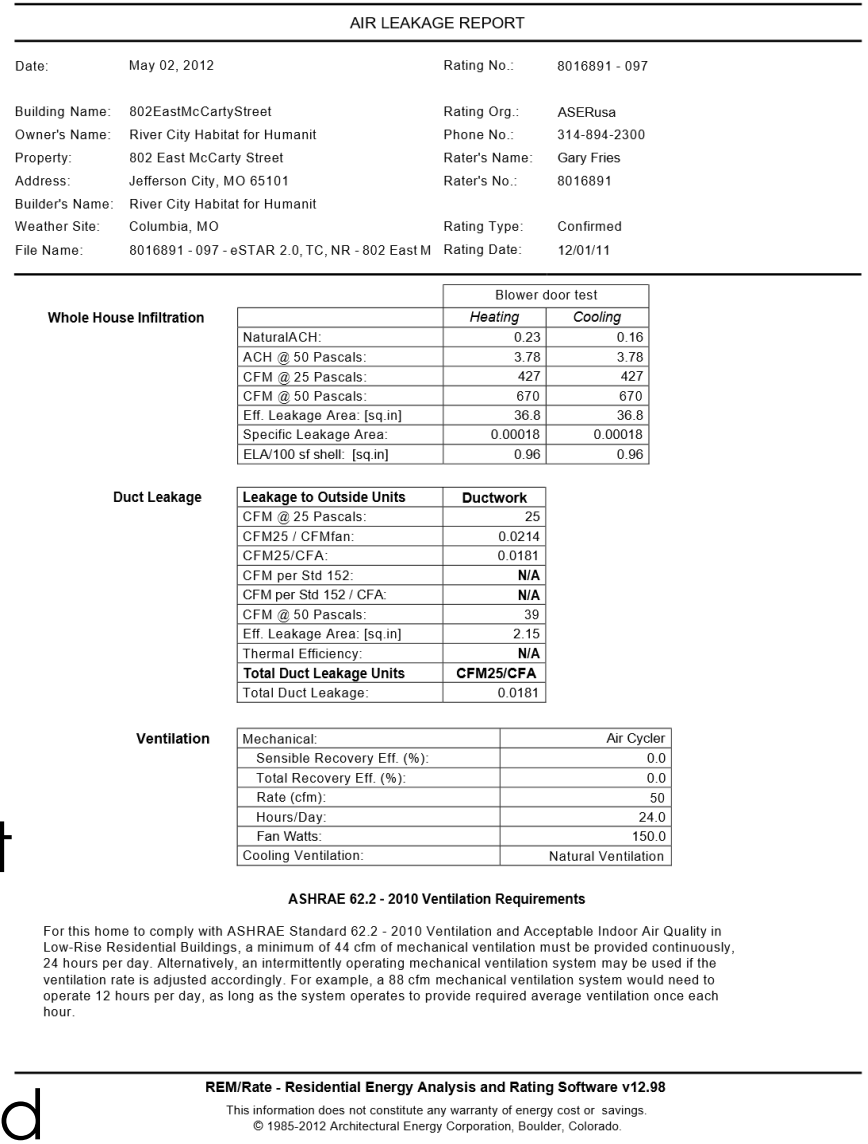
Performance Testing

A Great Benefit
(and a new code requirement)

Air Leakage Report

- Blower door test documents a home's air leakage performance
- Required by code
- Third party verification (some areas; performed by Inspectors)
- Provides solid data for final equipment adjustment and energy use/cost forecast
- Great liability protection for all involved



AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit		
Weather Site:	Columbia, MO	Rating Type:	Confirmed
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage

Leakage to Outside Units	**Ductwork**
CFM @ 25 Pascals:	25
CFM25 / CFMfan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	**N/A**
CFM per Std 152 / CFA:	**N/A**
CFM @ 50 Pascals:	39
Eff. Leakage Area: [sq.in]	2.15
Thermal Efficiency:	**N/A**
Total Duct Leakage Units	**CFM25/CFA**
Total Duct Leakage:	0.0181

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

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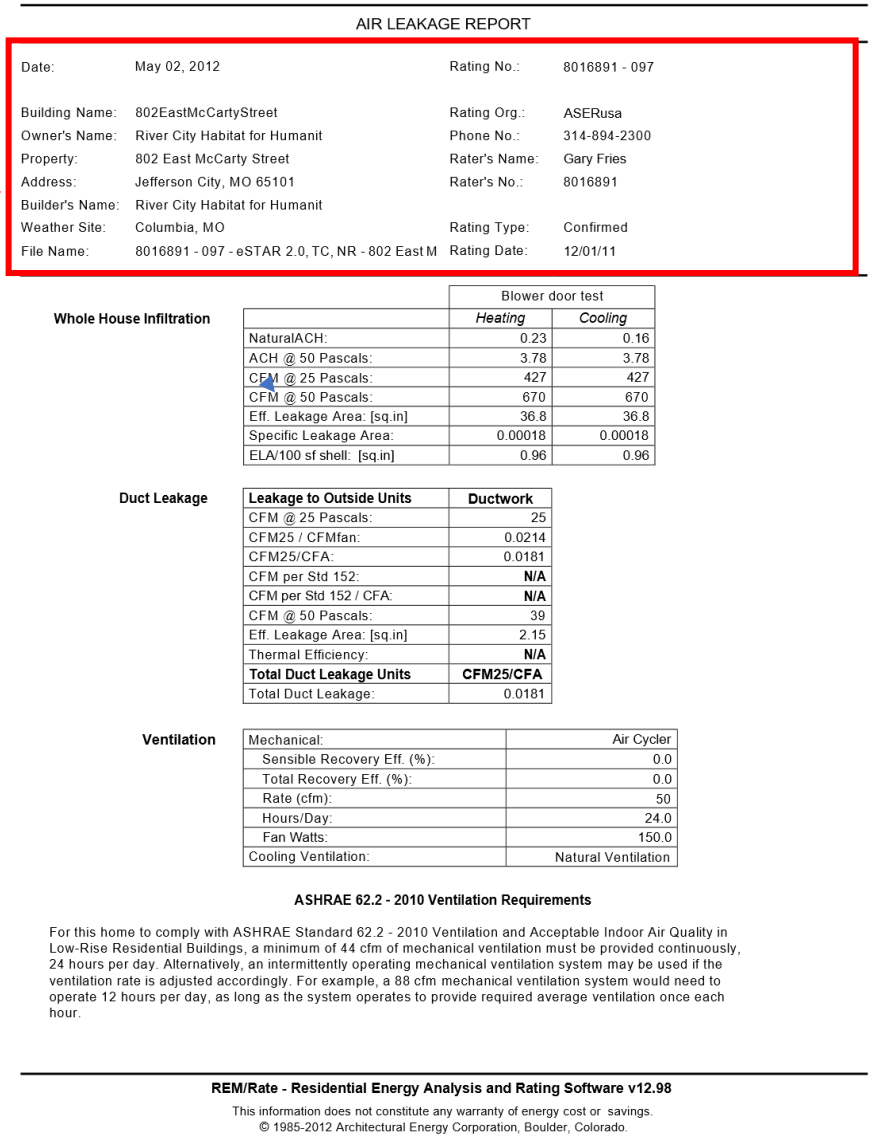
Air Leakage Report

Date:	May 02, 2012	**Rating No.:**	81158891-901
Building Name:	123 Main Street	**Rating Org.:**	Raters USA
Owners Name:	Jane Smith	**Phone:**	555-555-5555
Property Address:	123 Main Street Omaha, NE 68007	**Rater's Name:**	John Williams
Builder's Name:	ABC Construction	**Rater's No:**	1234567
Weather Site:	Omaha, NE	**Rating Type:**	Confirmed
File Name:	101682391-097 eSTAR	**Rating Date:**	12/01/20



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Address:	Jefferson City, MO 65101	Rater's No.:	8016891
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File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

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Air Leakage Report

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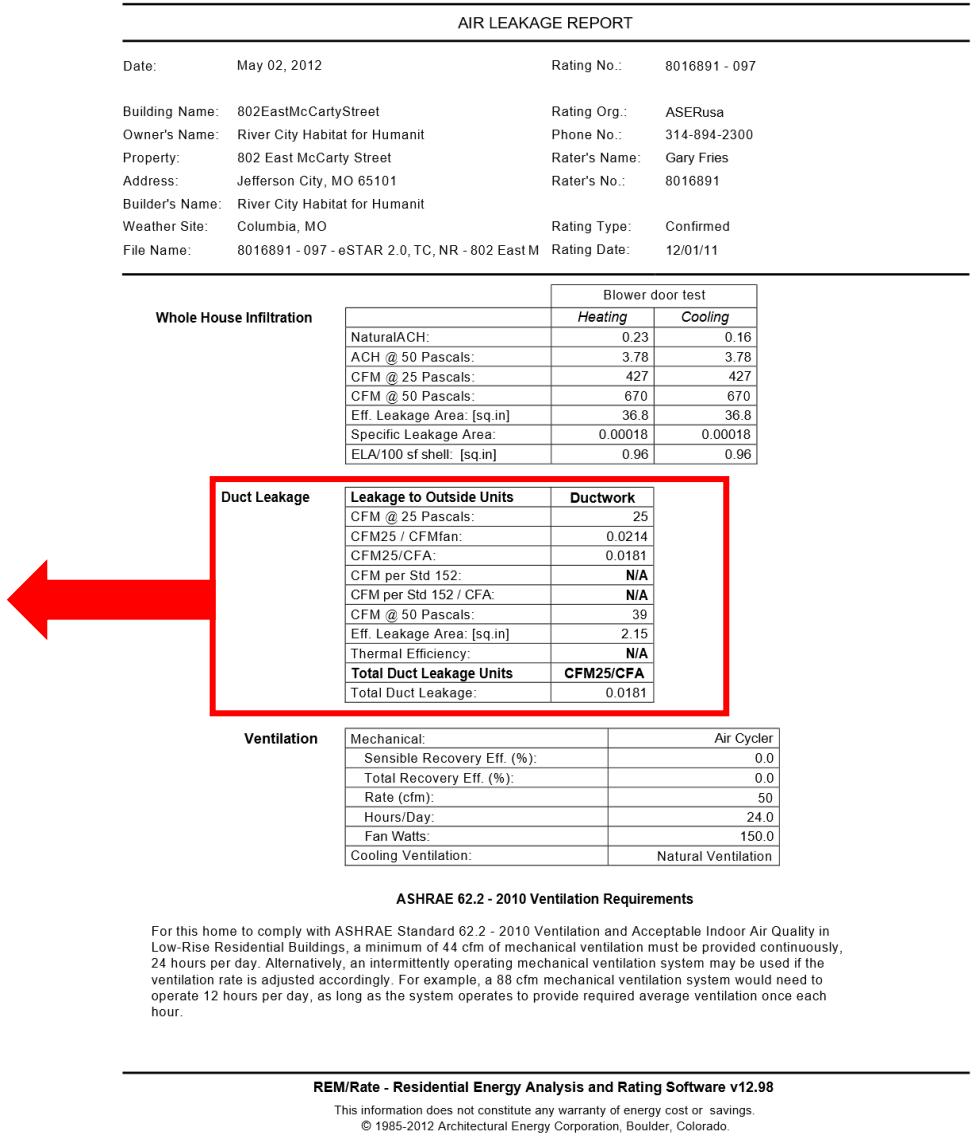

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Ventilation and I.A.Q.

Building Envelope +

Air Sealing Package +

HVAC Design, Equipment & Installation +

ERV/HRV +

Water Heating Design

= Occupant Comfort

HVAC System

*Don't Forget the **"V"***

Right-Size the HVAC System

A correctly sized system:

- Provides **maximum comfort**
- **Required** by code (ACCA Manual J)
- Promotes **healthy** indoor environmental quality
- **Handles moisture** properly
- **Most efficient** system

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HVAC Design and Loads

Oversized systems:

- Less comfort
- Less efficient
- Poorly handles moisture
- Premature equipment failure

Right-sized systems:

- Better operating efficiencies
- Greater comfort
- Healthier indoor environments
- Better moisture control

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HVAC Design and Loads

- Properly designed HVAC systems rely on scientific criteria and a systematic method to match the loads required for health and comfort:
  - *ACCA Manual J – Residential Load Calculation*
  - *ACCA Manual S – Residential Equipment Selection*
  - *ACCA Manual D – Residential Duct Systems*
- Reports should be submitted with permit application

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HVAC Design and Loads

Today's homes risk health problems for occupants because:

- They are not properly ventilated:
  - < 3 ACH
- More chemicals and products are used in and around a house:
  - Concentration levels are often 2 to100 times higher than outside.

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Balanced Ventilation

- Blows air into and out of the house
- Is cost effective by reclaiming energy from exhaust and supply airflows (60%-80%!)
- Balances exhaust and supply flows (minimizes pressure differential)
- Maintains the Minimum Ventilation Guideline automatically with proper set-up

Key Takeaways

- 2018 IECC has new requirements for:
  - Air sealing
  - Duct sealing
  - U-Factor
  - R-Values
  - Performance Testing
- Controlling moisture is *critical*
  - Proper air sealing is key
  - Right-sizing HVAC is required
  - Mechanical ventilation must be installed and takes on new importance

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Thank you!

Questions?

Matt Belcher, Verdatek Solutions
matt@verda-solutions.com

Nicole Westfall, Midwest Energy Efficiency Alliance
nwestfall@mwalliance.org

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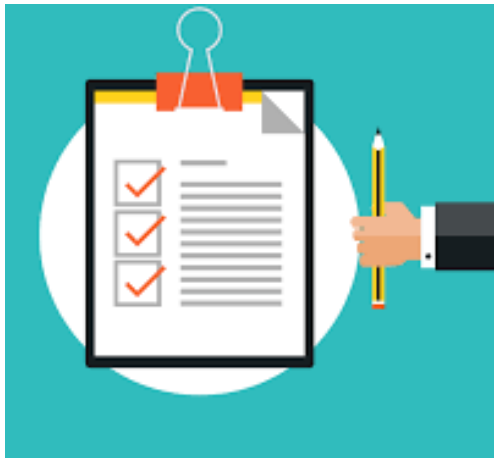
Nebraska Energy Code Stakeholder Survey

- Goal: to better understand how different stakeholders interact with the energy code and energy efficient technologies
- 15-minute survey
- Results will also help identify topics to include in the trainings
- Attendees of this training will receive a link to take this survey (in addition to this training evaluation) – your participation is greatly appreciated!



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Upcoming Training Opportunities

- **January 26-March 16 (Tuesdays, 6:30-8:30pm)** – Nebraska Energy Code Certification Course at Metropolitan Community College
  - For more information and to register, visit: https://www.mccneb.edu/Community-Business/Community-Programs/Continuing-Education/Nebraska-Energy-Codes-Training-Program.aspx

- Other trainings coming soon!

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