METROPOLITAN
Community College

Residential Energy Code – Session 4

Energy Code Basics

Instructor – Matt Belcher

February 16, 2021: 6:30 – 8:30 pm

Today’s Agenda

- Energy Code Development
- Requirements in the 2018 IECC
- Nebraska's Residential Field Study Results
- Building Performance Testing
- Mechanical Systems in the Code
- Building Thermal Envelope and the 2018 IECC
- Key Takeaways, Q&A and Review

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)
  - Information at end of presentation
- Email nwestfall@mwalliance.org with questions

ENERGY CODE DEVELOPMENT

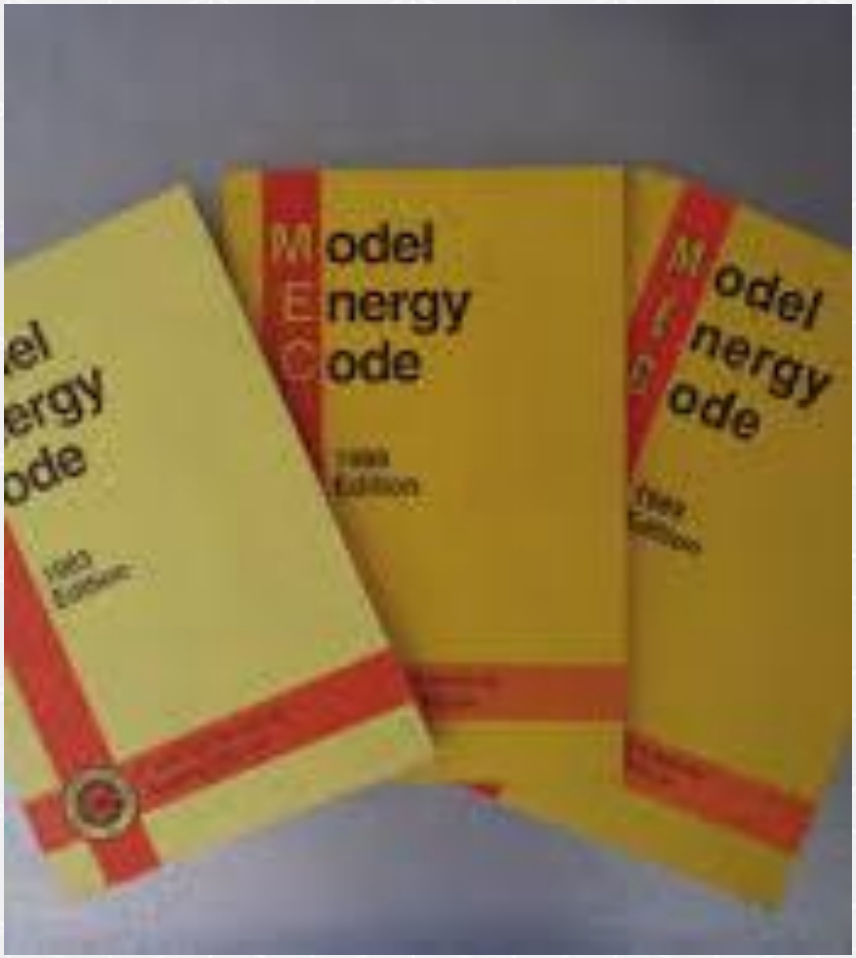
Review: Code of Hammurabi

- The Code of Hammurabi is a well-preserved Babylonian code of law of ancient Mesopotamia, dated to about 1754 BC (Middle Chronology). It is one of the oldest deciphered writings of significant length in the world. The sixth Babylonian king, Hammurabi, enacted the code.

- The code was ***severe***, basically: If you build a building and it collapses and kills someone. The penalty is Death….

Source: alchetron.com

Building Energy Code History



Source: shop.iccsafe.org

- 1983 Model Energy Code introduced as a response to the Energy Crisis of the 1970's

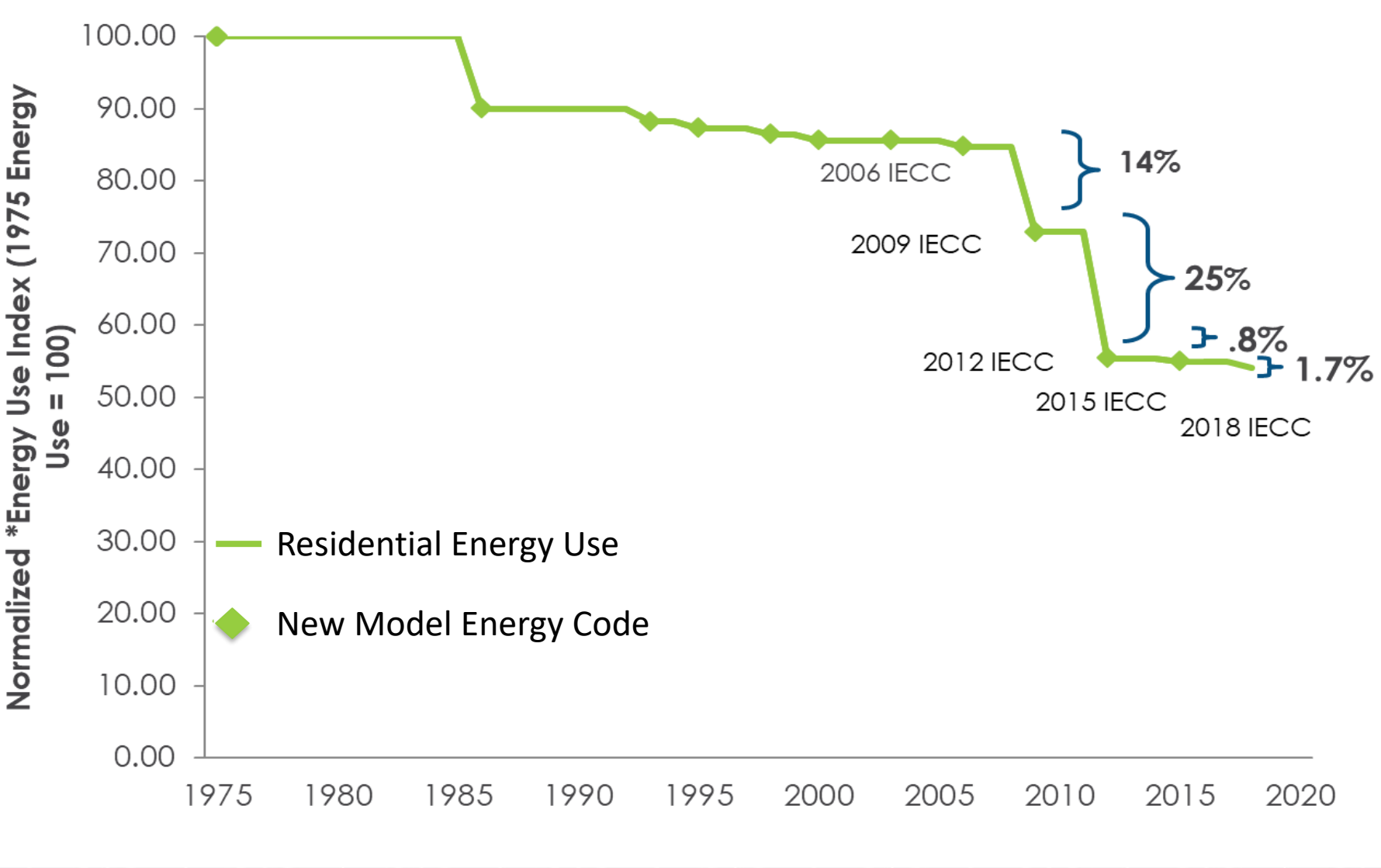
How We Got Here - Energy Standards (and/or Green Building)

EPA's ***Energy Star*** program;

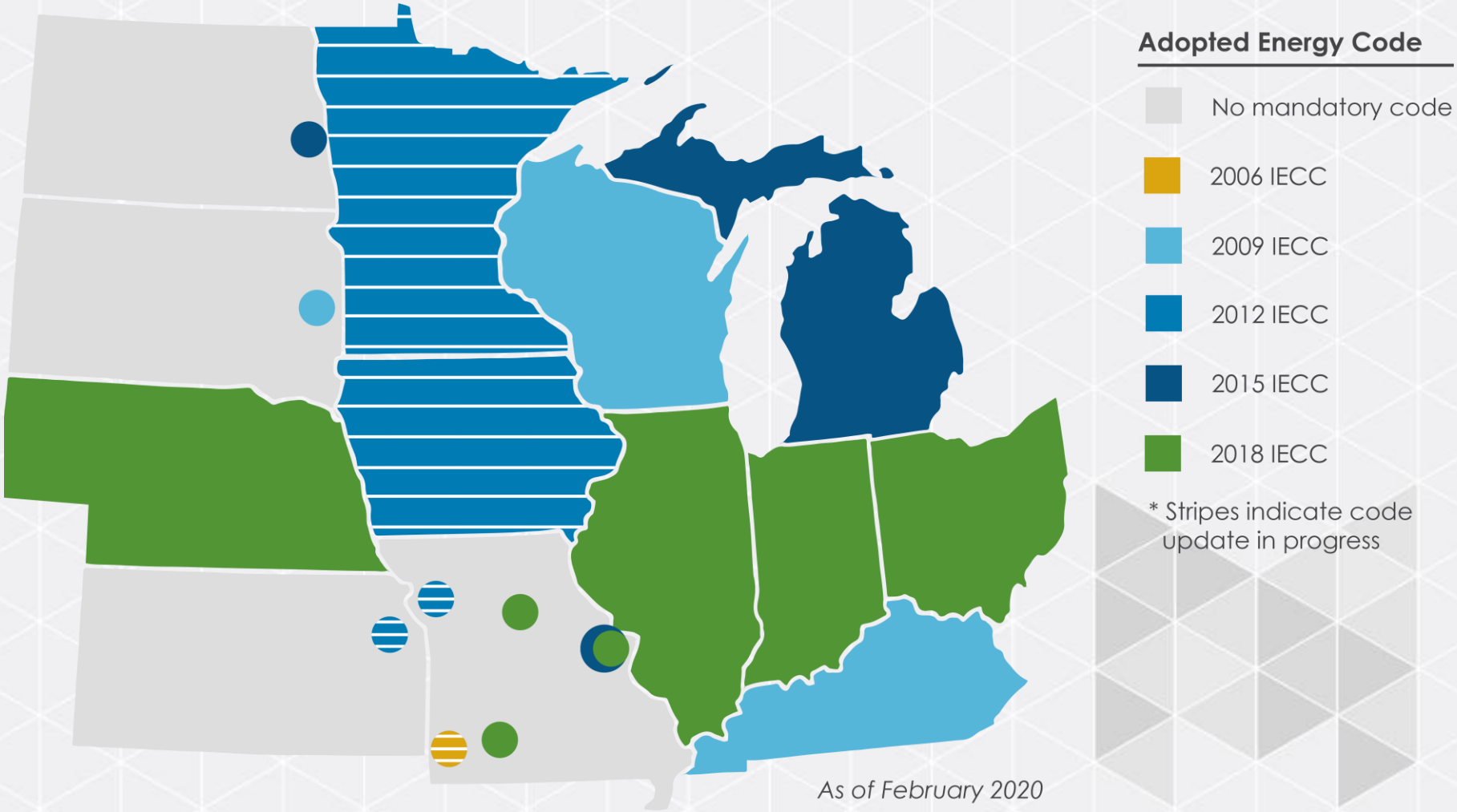
- Launched in 1992 for Appliances
- In 1995 EPA launched Energy Star for Homes
  - Homes Built 30% more efficient than the Model Energy code
- In 1996 Energy Star became formal partnership between EPA and D.O.E.
- Austin Energy Green Building Program; Began in Austin TX in 1991

Source: energystar.gov

Model Energy Code Improvement



Adopted Energy Codes in the Midwest



Source: Midwest Energy Efficiency Alliance

IECC Development Process

Source: Iccsafe.org

- Codes are updated every three years
- The Code Council uses a governmental consensus process
- Public may submit code change proposals
- Final determination of code provisions in the hands of public safety officials
  - Legitimately represents the public interest
  - No vested financial interest, can legitimately represent the public interest

THE 2018 IECC RESIDENTIAL PROVISIONS

Purview of the Code

Residential Code

- 3 stories or less
- Residential use

Commercial Code

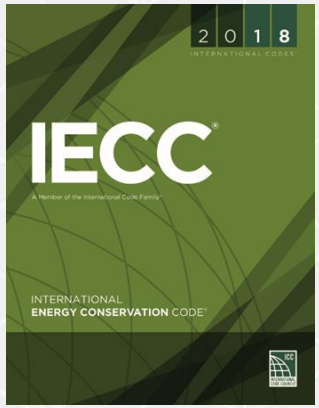
- All non-residential buildings
- Residential buildings over 3 stories

Both Codes apply to

- New Construction
- Existing Buildings - additions and major alterations
- *Several exceptions, including historic buildings and minor repairs*

2018 IECC / IRC Section 11 Basics

- Separates Commercial and Residential
- ~2.5% more efficient than 2012 IECC
- Testing and verification requirements
- Relaxes Energy Ratings Index (ERI) requirements
- *Fun Fact*: 2021 IECC-R (just published last week) will be ~10% more efficient that the 2018



Source: iccsafe.org

2018 IECC Mandatory Requirements

All mandatory requirements **must** be met, regardless of compliance path

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

Image: amazon.com

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

Image: skeltonsair.com

Building Cavities

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

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

Image: energystar.gov

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)

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.

Energy Code Compliance Pathways

Prescriptive Method Requirements

- All mandatory and prescriptive requirements must be met
- Use values in tables

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
  - REScheck

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 in Climate Zone 5.
- Submit report demonstrating compliance

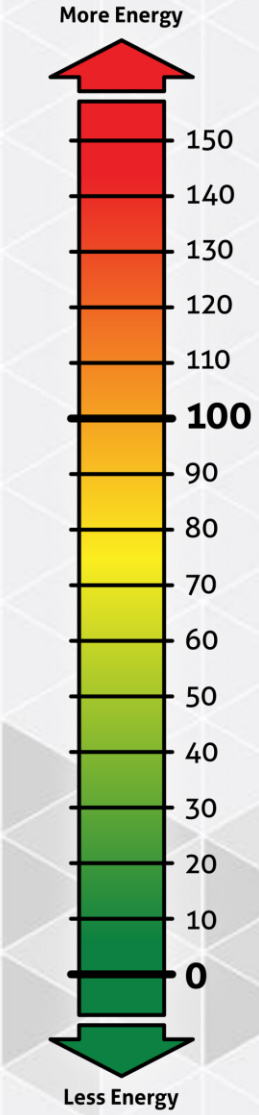


Image: hersindex.com

2018 IECC Prescriptive Requirements

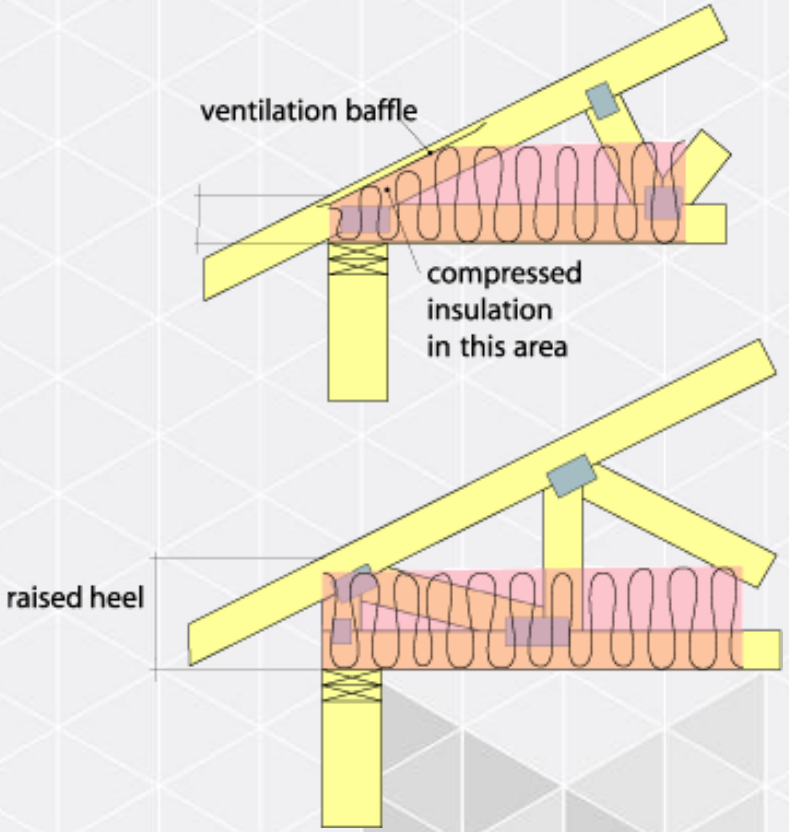
Indicates Change

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**

Two Really Good Insulating Ideas!

Continuous Insulation



Raised Heel Truss

**Can use R-38 instead of R-49 with raised heel*

Images: continuousinsulation.org and sbcindustry.com

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**

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)

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)

NEBRASKA RESIDENTIAL FIELD STUDY

Nebraska Residential Field Study

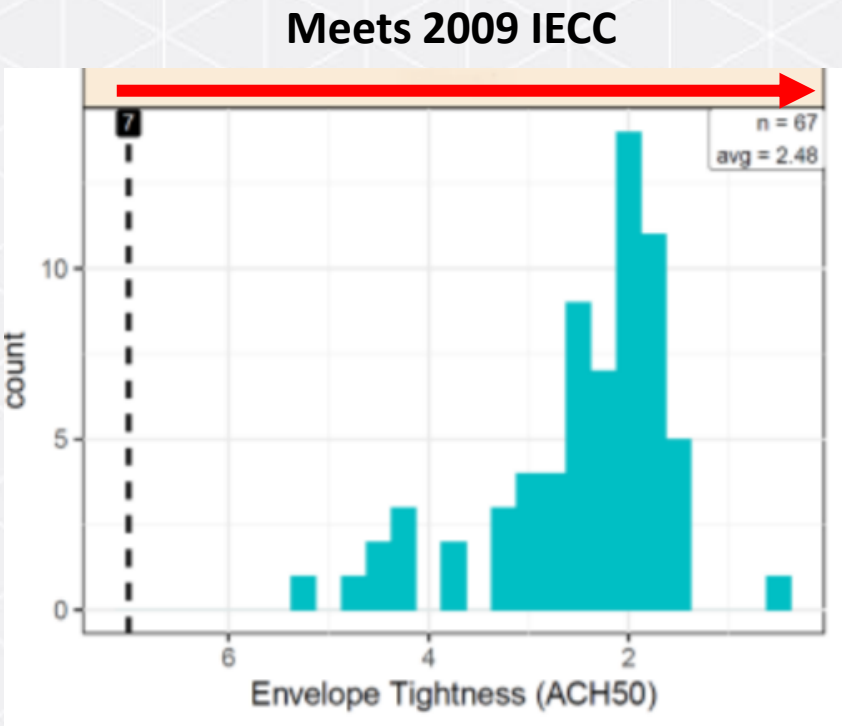
- Conducted in 2017 by Nebraska Department of Environment and Energy.
- 2009 IECC was the baseline.
- Collected and Analyzed Several Data Points for new homes, including:
  - Envelope air leakage
  - Efficacy in lighting
  - Duct leakage
  - Ceiling & exterior wall insulation
  - Basement & slab insulation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

For More Information and Data:

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

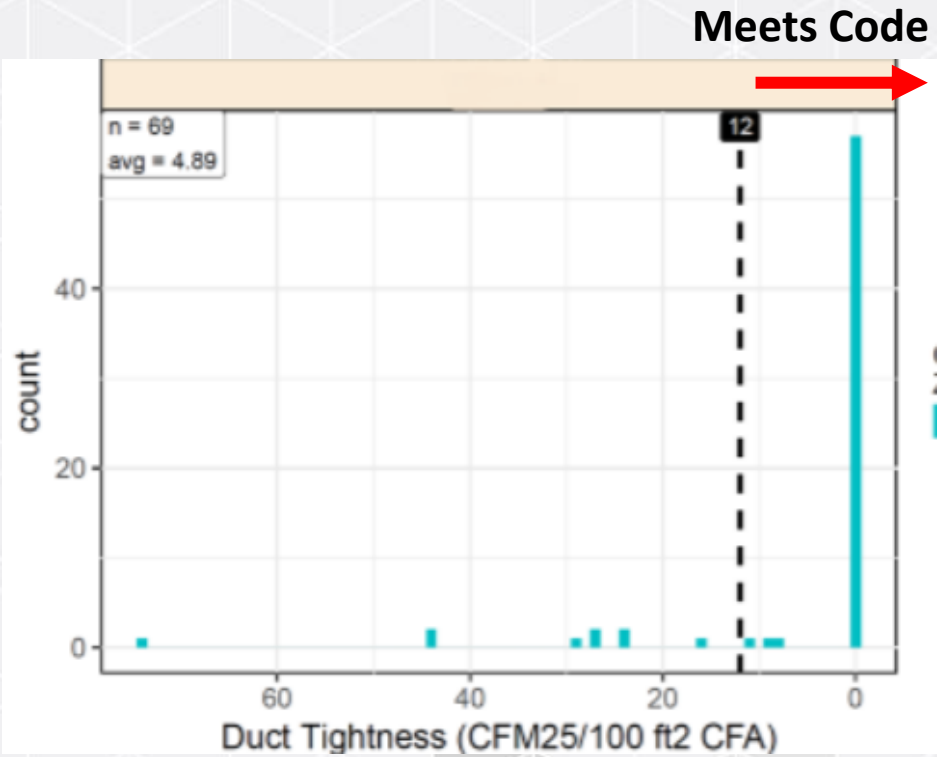
Residential Field Study - Results

- 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



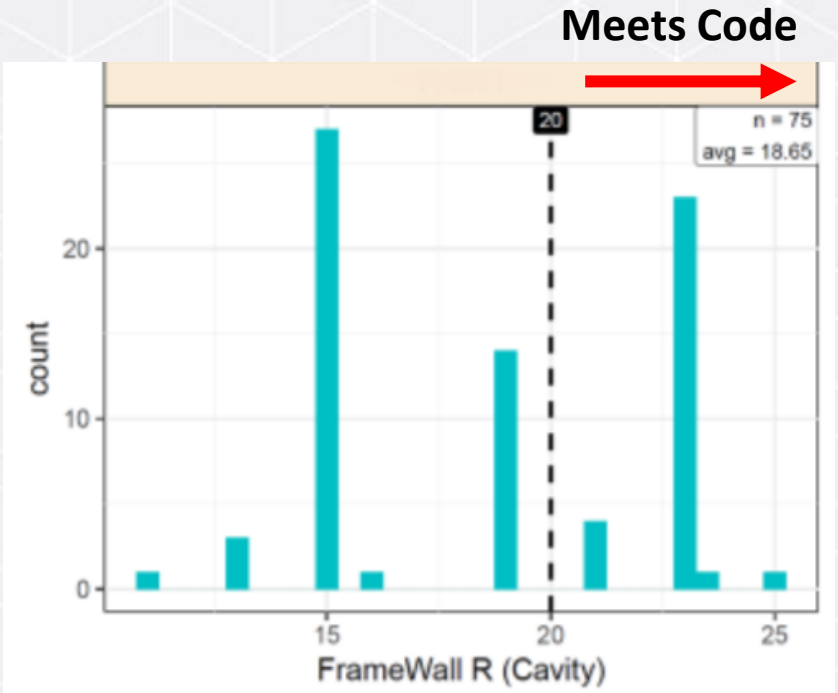
Residential Field Study - Results

- **Duct Leakage**:
  - Ducts with portions outside of conditioned space are OK
  - Ducts completely inside conditioned space are leaky
- **Ceiling Insulation**:
  - Amount: Good+ (Average: R-42.5)
  - Install: Not as good. Reduces compliance (R-factor)



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



BUILDING PERFORMANCE TESTING

Performance Testing

- Code required testing
  - Blower Door Test
  - Duct Pressure Test
  - Combustion Appliance Zone (CAZ) Testing
- Other diagnostics
  - Thermal Imaging
  - Energy analysis/modeling:
    - REM/Rate, EnergyGauge USA, TREAT

Image: greenbuildingadvisor.com

Blower Door Test

- Required in 2012/2015/2018 IECC
- 2018 IECC requires a leakage of 3ACH50 or better
- Verifies Air Leakage / Tightness of a Building; pressurize or depressurize building using blower door fan
- Only indicates how leaky the building is, not the leak location
- Best to perform at rough-in, before drywall is installed; easier to access / correct leaks at this time
- Must be performed at final inspection for code compliance

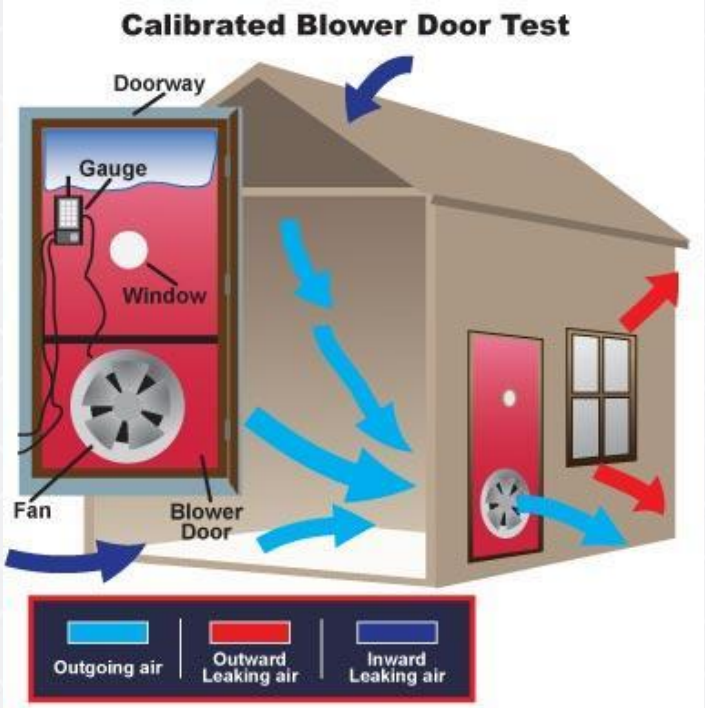


Image: bpihomeowner.org

Duct Tightness Testing

- Pressure tests duct system for air leaks
- Quantifies the air leakage rate
- Testing required if any part of the system is outside thermal envelope
- 2018 IECC max leakage is 4cfm/100sf
- But all ducts should be tested!
- If ducts leak, air won't get to where it's supposed to

Image: enwikipedia.org

Combustion Appliance Zone (CAZ) Testing

Image: buildinganalystgroup.com

- Assess backdraft potential in natural draft (atmospherically vented) appliances
- Improper venting can create dangerous, even deadly, carbon monoxide levels in a home
- Optional test that can be required by Code Official

Thermal Imaging

- Not required by code but can provide valuable information – particularly in existing buildings
- Thermal imaging allows you to literally see through walls!
- Excellent for identifying thermal bridging and faulty / missing insulation

Image: energy.gov

MECHANICAL SYSTEMS IN THE ENERGY CODE

Right-Sizing 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

Image: Drenergysavercentralva.com

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

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

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.

Image: airworxacr.com

Balanced Ventilation

- Blows air into and out of the house
- Systems like ERVs are 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

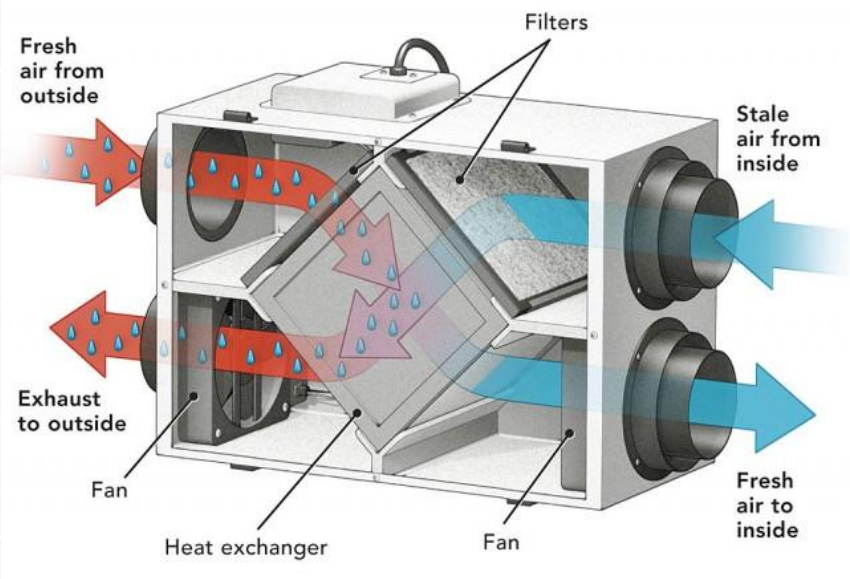


Image: epsalesinc.com

Ventilation and I.A.Q

- Building Envelope
- Air Sealing Package
- HVAC Design, Equipment & Installation
- ERV/HRV
- Water Heating Design

- Add them all up and they **= Comfort**

Image: homeconstructionimprovement.com

BUILDING THERMAL ENVELOPE AND THE 2018 IECC

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

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!

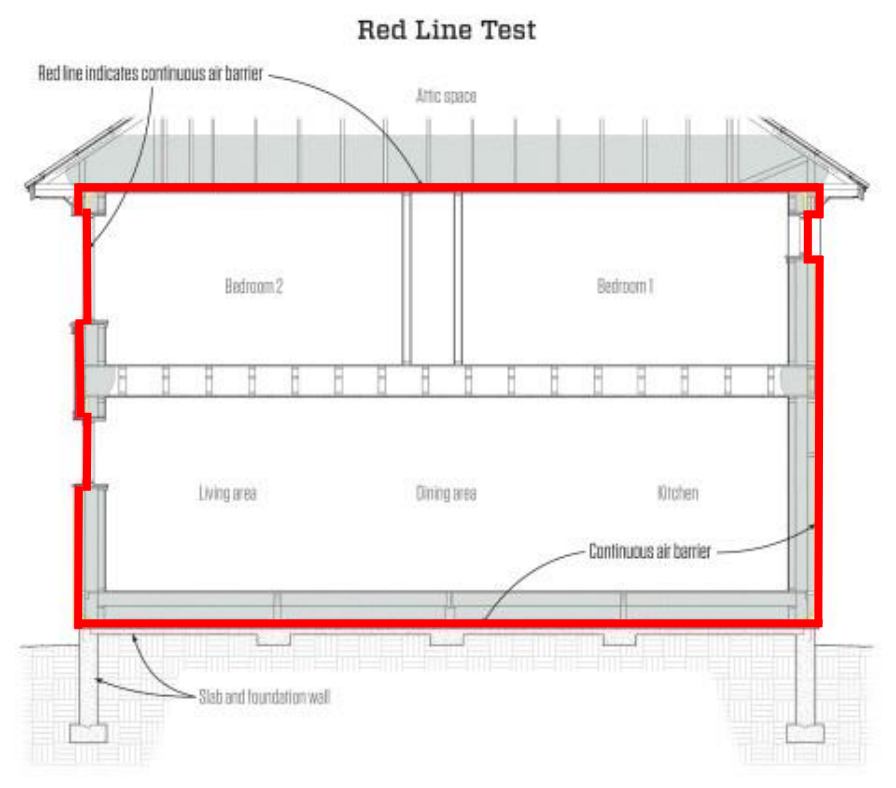


Image: jlconline.com

Air Barrier

- Primary air barrier:
  - Exterior sheathing
  - House wrap
  - Seam sealing
  - Interior drywall
- Penetrations in the primary air barrier create air leaks.
- *2018 IECC requires blower door test*
  - ***Maximum leakage: 3 ACH50***
  - ***Average Air Leakage Rate in NE: 2.8 ACH50***

Image: huberwood.com

Air Barrier - Strategies

- Drywall glued to the studs and plates
- Lapped and taped joints
- Close alignment with insulation
- Sealed air permeable insulation
- Taped or caulked sheathing seams
- Caulked or foam-sealed outlets, penetrations, sill plates, windows and doors

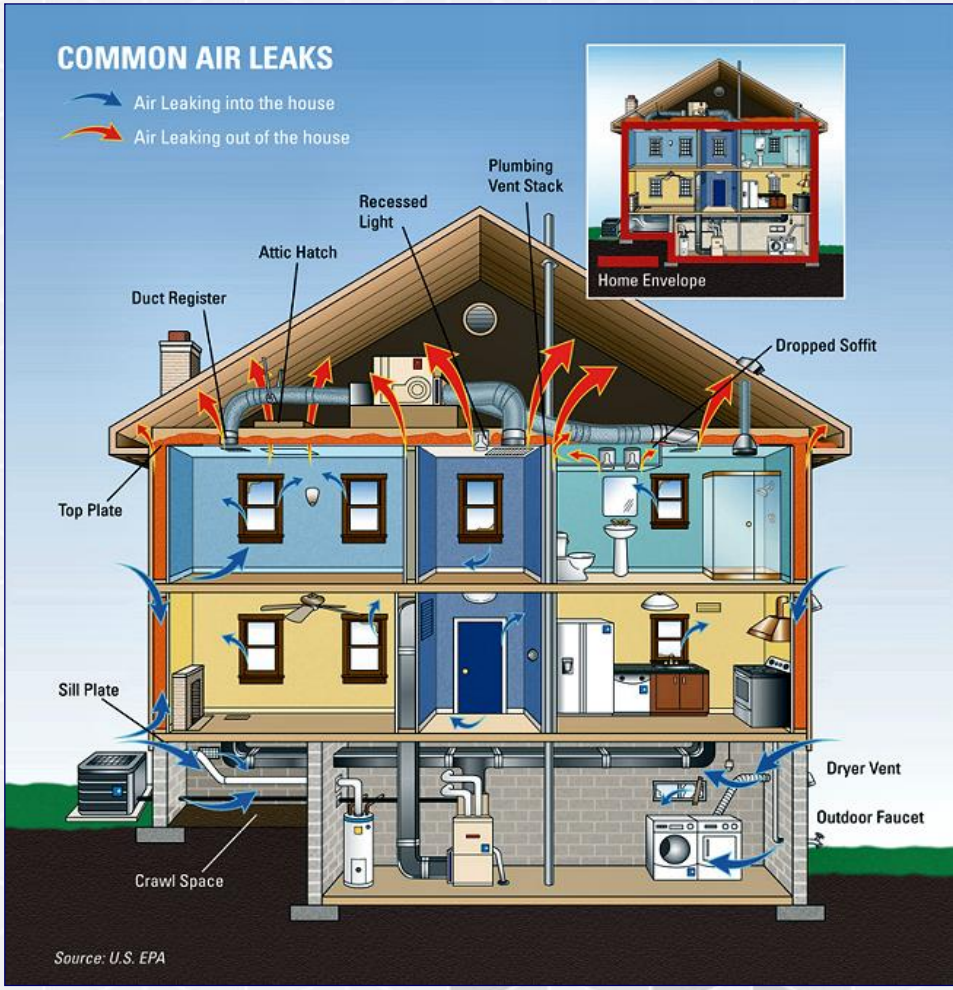


Image: epa.gov

Air Barrier – Strategies (cont.)

- Sealed joist bays
- Sealed HVAC supply and return outlets
- Sealed soffits and chases
- Sealing around the backside of tubs, knee walls and garages
- Sealed off garages
- Sealed recessed lighting cans

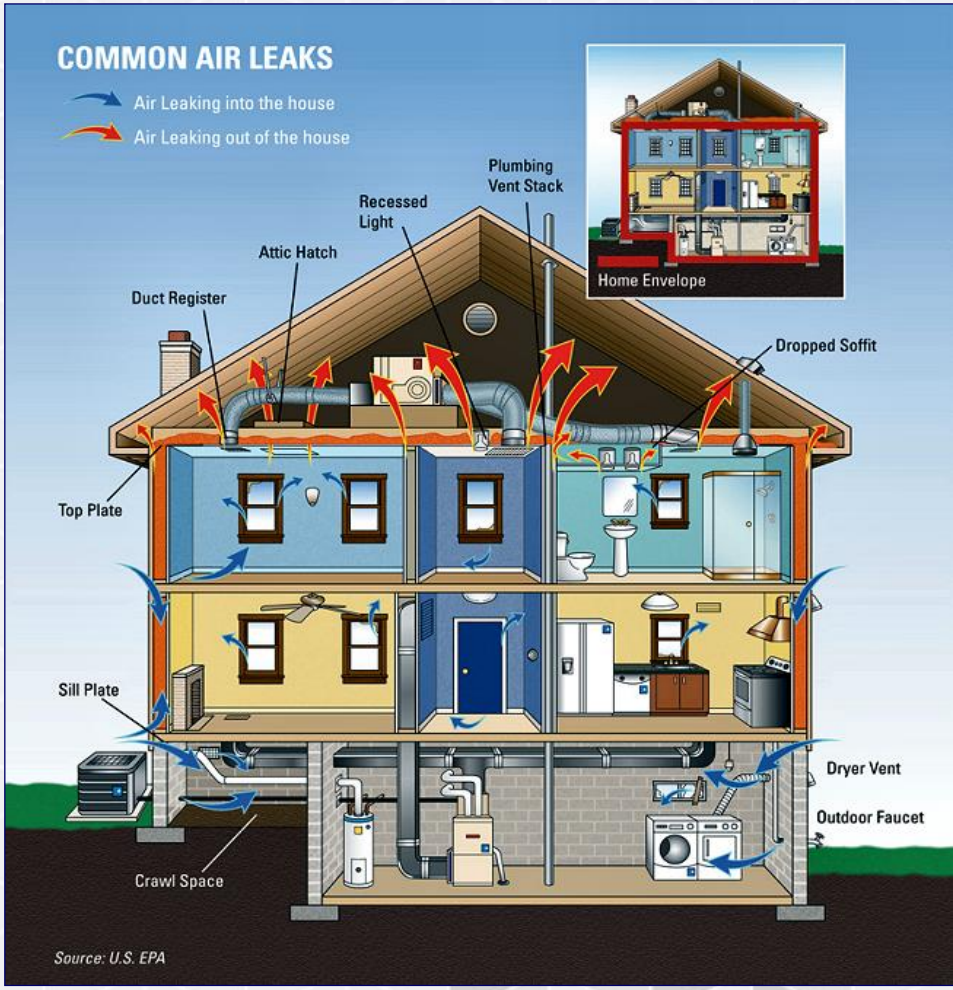


Image: epa.gov

Insulation

- Energy efficiency is maximized in homes that address these insulation issues strategically:
  - Placement
  - Type
  - Installation

Image: fmlink.com

Insulation - Placement

- Limiting airflow is a key factor for insulation effectiveness.
- Insulation should be in contact with the air barrier and entirely encapsulated.

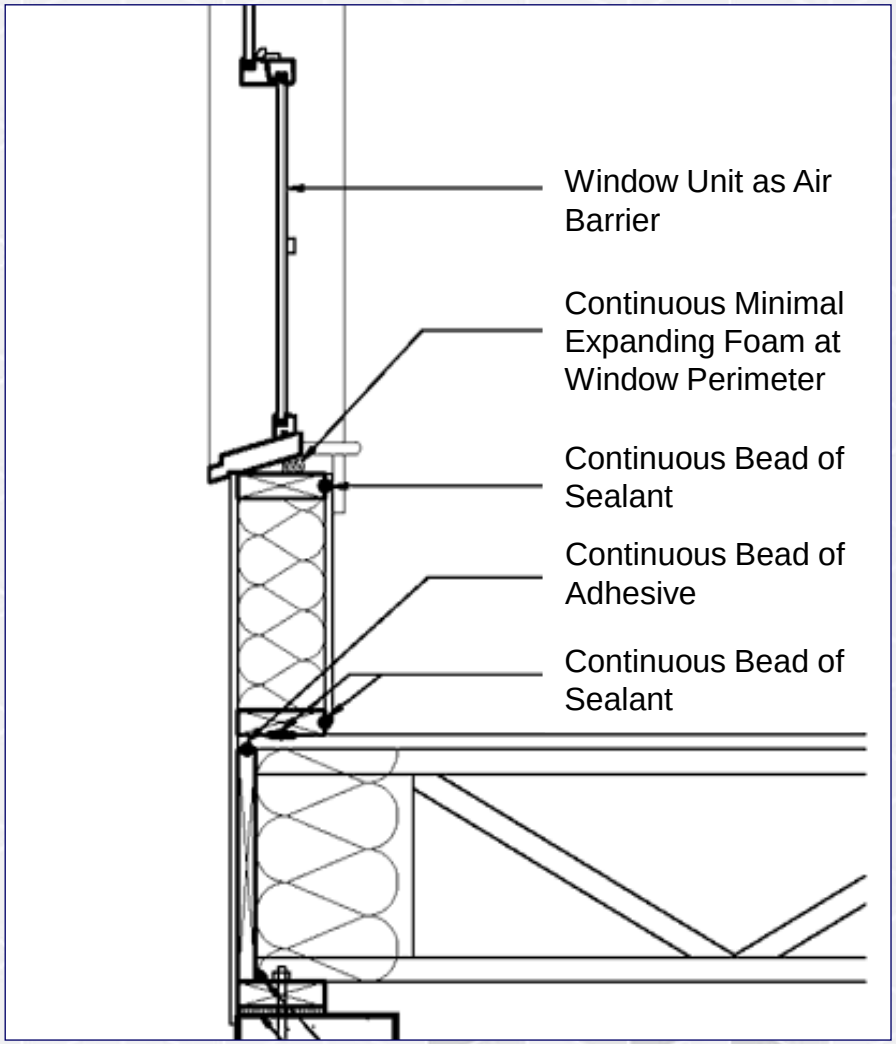


Image: basc.pnnl.gov

Insulation - Type

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

Materials:

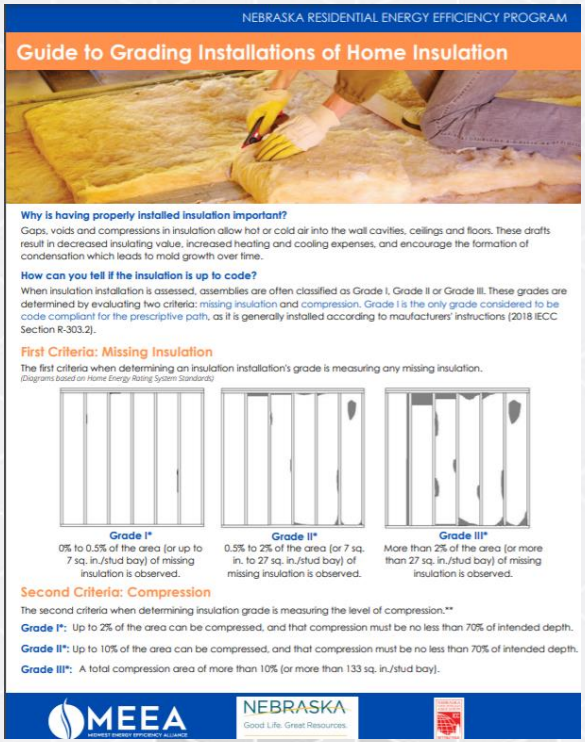
- Fiberglass
- Cellulose
- Low-density or open-cell foam
- High-density or closed-cell foam
- Foam sheathing

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

Insulation - Installation

- Inspection ratings:
  - Grade 1: Installed correctly (code required)
  - Grade 2: You tried, but not quite there
  - Grade 3: You've got to be kidding me!
- R-value:
  - Indicates a material's resistance to heat flow
- U-factor:
  - Indicates rate of heat loss by the product or assembly



NEBRASKA RESIDENTIAL ENERGY EFFICIENCY PROGRAM

Guide to Grading Installations of Home Insulation

Why is having properly installed insulation important?

Gaps, voids and compressions in insulation allow hot or cold air into the wall cavities, ceilings and floors. These drafts result in decreased insulating value, increased heating and cooling expenses, and encourage the formation of condensation which leads to mold growth over time.

How can you tell if the insulation is up to code?

When insulation installation is assessed, assemblies are often classified as Grade I, Grade II or Grade III. These grades are determined by evaluating two criteria: missing insulation and compression. Grade I is the only grade considered to be code compliant for the prescriptive path, as it is generally installed according to maufacturers' instructions (2018 IECC Section R-303.2).

First Criteria: Missing Insulation

The first criteria when determining an insulation installation's grade is measuring any missing insulation.

(Diagrams based on Home Energy Rating System Standards)

Grade I*
0% to 0.5% of the area (or up to 7 sq. in./stud bay) of missing insulation is observed.

Grade II*
0.5% to 2% of the area (or 7 sq. in. to 27 sq. in./stud bay) of missing insulation is observed.

Grade III*
More than 2% of the area (or more than 27 sq. in./stud bay) of missing insulation is observed.

Second Criteria: Compression

The second criteria when determining insulation grade is measuring the level of compression.**

Grade I*: Up to 2% of the area can be compressed, and that compression must be no less than 70% of intended depth.

Grade II*: Up to 10% of the area can be compressed, and that compression must be no less than 70% of intended depth.

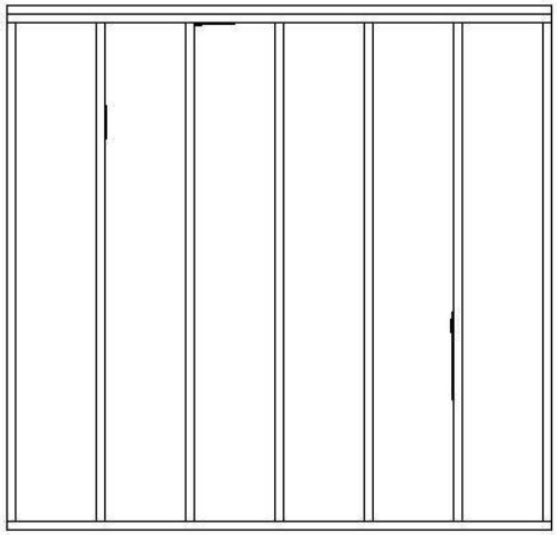
Grade III*: A total compression area of more than 10% (or more than 133 sq. in./stud bay).

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

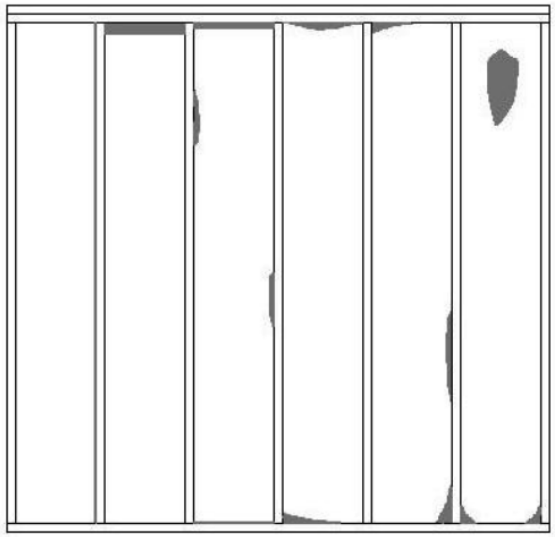
NEBRASKA Good Life. Great Resources.

Batt Insulation Grading

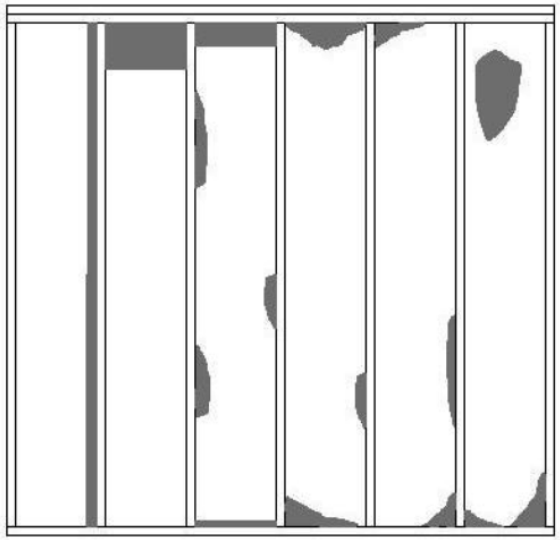
Code Compliant — **Not Acceptable**



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

Alternative Systems

- Alternative framing techniques can make holistic improvements to a building envelope assembly. For example:
  - Increase stud spacing to 24 inches on center and raise headers above the top plate or hung on single jacks with header hangers:
    - U-factor: 0.058 to 0.055
    - R-value: 17.24 to 18.18
  - Double stud wall assemblies and truss wall assemblies
  - SIPs, ICFs and precast concrete

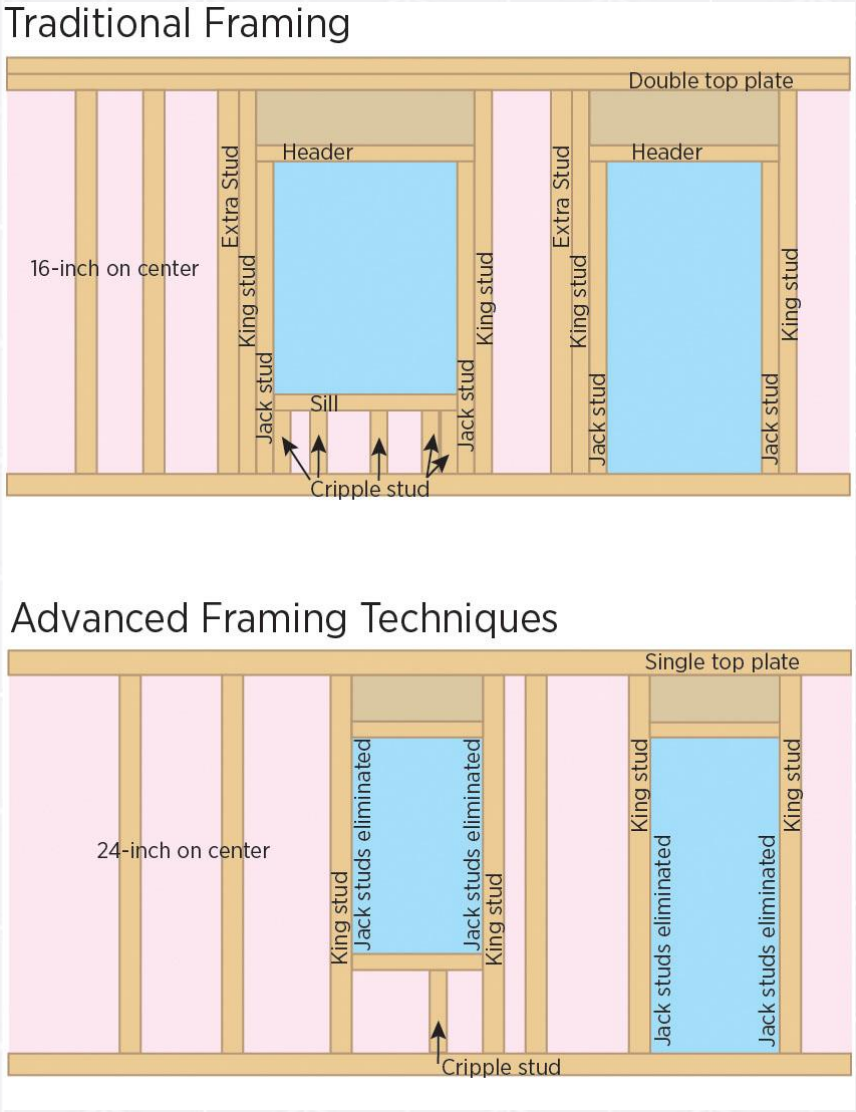


Image: Pacific Northwest National Laboratory

Thermal Envelope

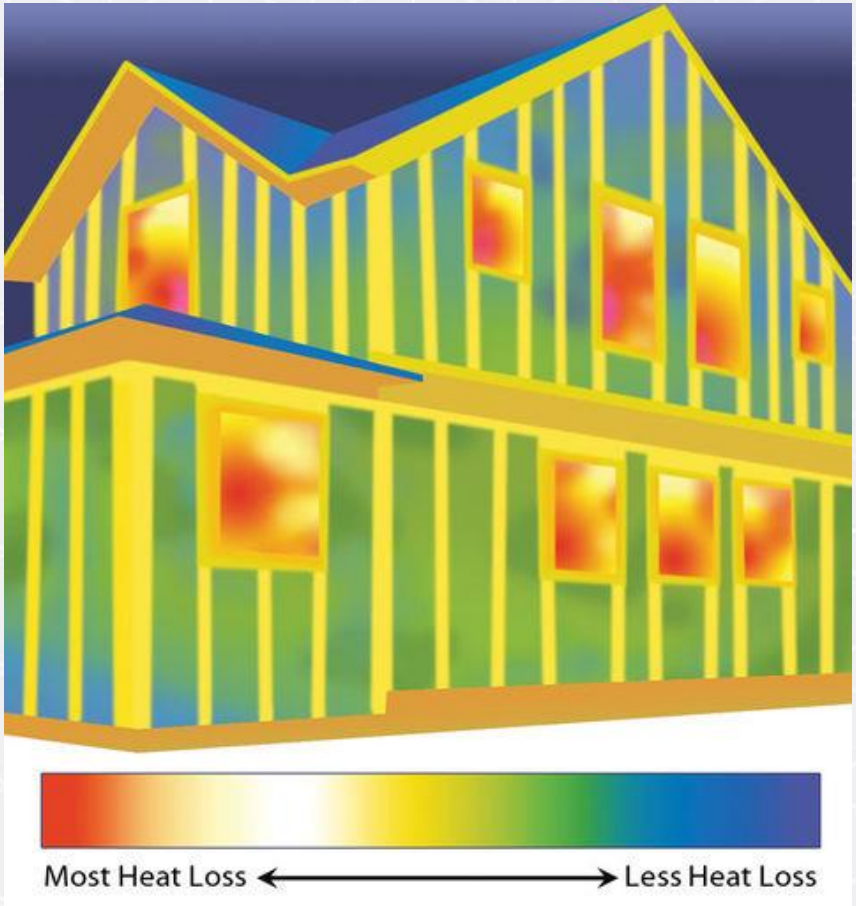


Image: buildinggreen.com

Reducing Thermal Bridging

Anybody see a problem here?

Thermal Envelope - Moisture Control

- Best practices that accommodate building science principles will:
  - Air seal
  - Add thermal performance
  - Manage the moisture that moves through the assembly.
- It can become a fairly complicated issue:
  - Moisture can move in both directions in almost all climate zones.
  - Different materials have differing permeability.
  - Vapor at dew point will convert to bulk moisture

Windows, Skylights and Doors

- An average home may **lose 30%** of its heat or air conditioning energy through its windows.
- They lose heat in four ways:
  - Conduction
  - Radiation
  - Convection
  - Air leakage

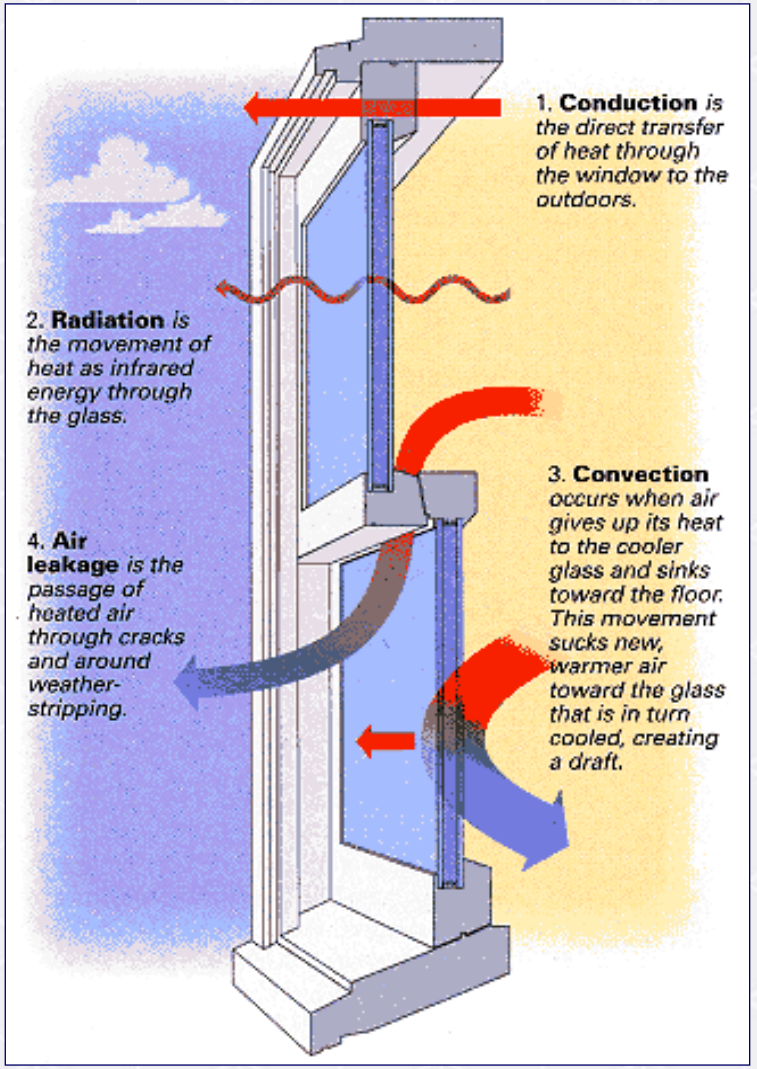


Image: NAHB

Frame and Glazing Options

- Window frame materials have varying conductivity properties:
  - Wood, vinyl, aluminum and fiberglass
  - Thermal breaks
- Glazing options:
  - Insulated glass
  - Low-E glass
  - Low-conductance gas fillings
  - Triple glazing
  - Tints

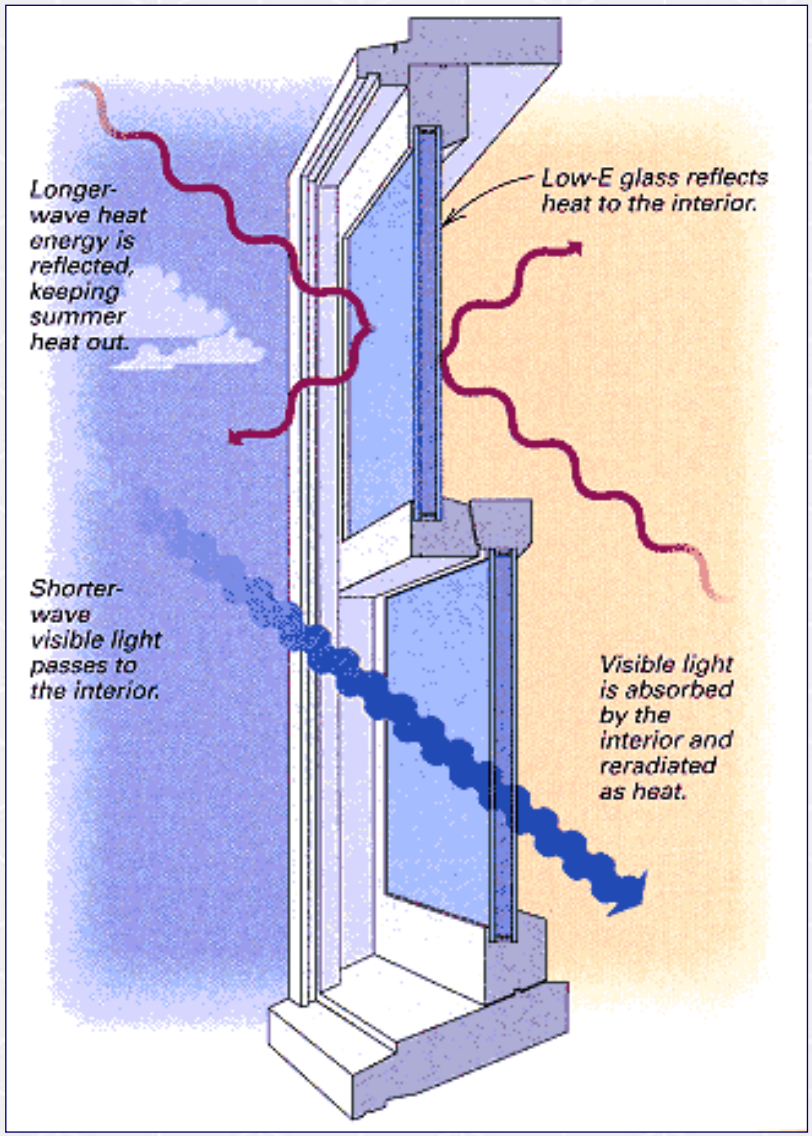


Image: NAHB

Fenestration Ratings

- The National Fenestration Rating Council rating system is helpful for comparing different manufacturers' windows.
- 2018 IECC, Climate Zone 5 (Nebraska) requires windows with:
  - U-factor ≤ 0.30
  - Air leakage ≤ 0.3 cfm/f2
  - No requirement for SHGC

Image: nfrc.org

Skylights and Doors

- Skylights:
  - Rated the same as windows.
  - Strategies that are useful for windows may not work for skylights.
  - Low solar heat gain coefficient (SHGC) and U-factor skylights are the prudent design choice
    - *2018 IECC skylight U-Factor ≤ 0.55 in Climate Zone 5*
- Doors:
  - The opaque part of door is assigned a U-factor
    - *2018 IECC door U-factor is ≤ 0.3 in Climate Zone 5*
  - The entire door is assigned an air leakage number
    - *2018 IECC air leakage ≤ 0.5 cfm/ft^2 in Climate Zone 5*

KEY TAKEAWAYS AND REVIEW

Key Takeaways

- The residential energy code is not that complicated
- It all starts with air sealing
  - If the outside and inside mix you can't control anything
- Simple to implement once you understand the building science behind it.
- The code helps you build a better, more comfortable, healthier, longer lasting home

Image :channelfutures.com

Review Questions – Session 4

Why Was the Energy Code Originally Created?

A. Primarily as a response to the “Energy Crises” of the late 1970’s
B. To help market insulation products
C. The Mechanical Code was already published.
D. Window performance was starting to improve.

Review Questions – Session 4

What are the important components of the building envelope? (select all that apply)

A. Air barrier
B. Ducts
C. Thermal Barrier (Insulation)
D. Moisture Barrier (Moisture control)
E. Lighting
F. HVAC system
G. Windows, Doors and Skylights

Review Questions – Session 4

What are two practices that are critical to achieving energy conservation?

A. Using heat and cold to your benefit.
B. Reducing demand by increasing thermal performance, reducing use by using higher efficient HVAC components
C. Reducing humidity and cold weather
D. Using HVAC systems properly. Reducing need for insulation.

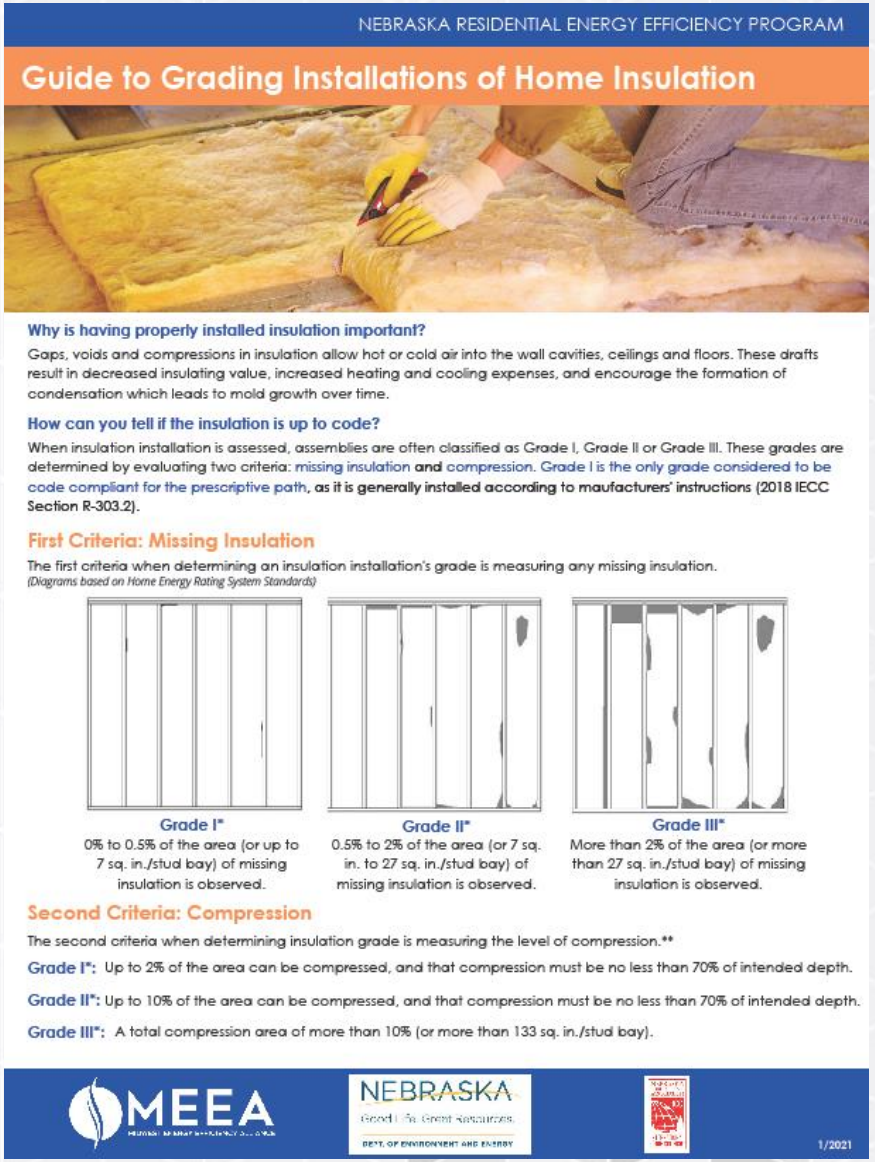
Review Questions – Session 4

What are one of the standard benchmarks for measuring the energy e-structures are tested against them?

A. HERS Rating/Blower Door Test
B. Using the Richter scale.
C. Adding all the R Values to come up with the U Factor
D. Using your cell phone to operate your HVAC system

Resources

- Developed Handouts on specific topics
  - Insulation installation
  - HVAC Right Sizing
  - **Others coming soon**
- **Let us know what topics would be helpful!**
- Made to share with Trades/Subs, etc.
- Visit: https://www.mwalliance.org/metropolitan-community-college-energy-code-course



NEBRASKA RESIDENTIAL ENERGY EFFICIENCY PROGRAM

Guide to Grading Installations of Home Insulation

Why is having properly installed insulation important?

Gaps, voids and compressions in insulation allow hot or cold air into the wall cavities, ceilings and floors. These drafts result in decreased insulating value, increased heating and cooling expenses, and encourage the formation of condensation which leads to mold growth over time.

How can you tell if the insulation is up to code?

When insulation installation is assessed, assemblies are often classified as Grade I, Grade II or Grade III. These grades are determined by evaluating two criteria: missing insulation **and** compression. Grade I is the only grade considered to be code compliant for the prescriptive path, **as it is generally installed according to maufacturers' instructions** (2018 IECC Section R-303.2).

First Criteria: Missing Insulation

The first criteria when determining an insulation installation's grade is measuring any missing insulation.
(Diagrams based on Home Energy Rating System Standards)

Grade I*
0% to 0.5% of the area (or up to 7 sq. in./stud bay) of missing insulation is observed.

Grade II*
0.5% to 2% of the area (or 7 sq. in. to 27 sq. in./stud bay) of missing insulation is observed.

Grade III*
More than 2% of the area (or more than 27 sq. in./stud bay) of missing insulation is observed.

Second Criteria: Compression

The second criteria when determining insulation grade is measuring the level of compression.**

Grade I*: Up to 2% of the area can be compressed, and that compression must be no less than 70% of intended depth.

Grade II*: Up to 10% of the area can be compressed, and that compression must be no less than 70% of intended depth.

Grade III*: A total compression area of more than 10% (or more than 133 sq. in./stud bay).

MEEA NEBRASKA 1/2021

Continuing Education Credits

- Participants of this session are eligible for continuing education credits from the International Code Council

- Course ID: **27249**
- CEUs: **0.20**

- If you would like a certificate of completion for this session, email Nicole at nwestfall@mwalliance.org

Next Week

- February 23, 2021, 6:30-8:30pm
- Topic: Mechanical Systems
- Contact Matt with Questions: matt@verda-solutions.com

SEE YOU NEXT WEEK!