Nebraska's Residential Energy Code

REScheck Walk-through

Nebraska Energy Code Training Program
Instructor: Matt Belcher
June 25, 2024. 11:00 AM – 1:00 PM CDT

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Housekeeping

Attendees are muted upon entry

Questions? Enter them in the chat box, or simply unmute yourself and ask

Webinar is being recorded – slides and recording will be sent to attendees

CEU's will be available upon request (ICC and AIA)

Email: jgossman@mwalliance.org with questions

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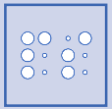
About the Nebraska Training Program

Goal: prepare the Nebraska workforce for changes in construction best practices

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 Matt/Verdatek Solutions

- 40+ Years in the Building Industry
- Served as a Top Building Codes official in the St. Louis area.
-Director of University of Missouri Columbia High Performance Buildings Research Center. Created and Instructed Curriculum for Students and Industry Professionals.
- Currently Assisting University of Missouri Science & Technology in Building and Energy Code Curriculum and Policy
-ICC Member serving on 2012, 2015, 2018 and 2024 Energy Code Development Committee. 2021& 27 Building Code-General Committee
- NAHB Approved Instructor for Advanced Building Science, Advanced Business Management

VERDATEK SOLUTIONS

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Learning Objectives

- Understand how to use *RESCHECK* for a simple UA Trade-off
- Learn how *RESCHECK* can be used as a Simulated Performance Alternative tool
- Understand prescriptive energy code requirements from 2018 IECC
- Identify standards for insulation requirements and fenestration performance

https://energycode.pnl.gov/REScheckWeb

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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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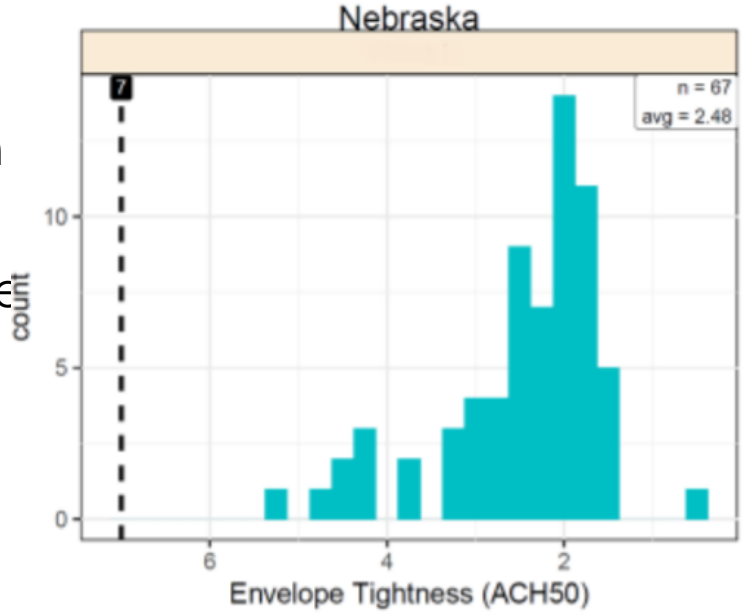
Nebraska Residential Field Study - Results

- 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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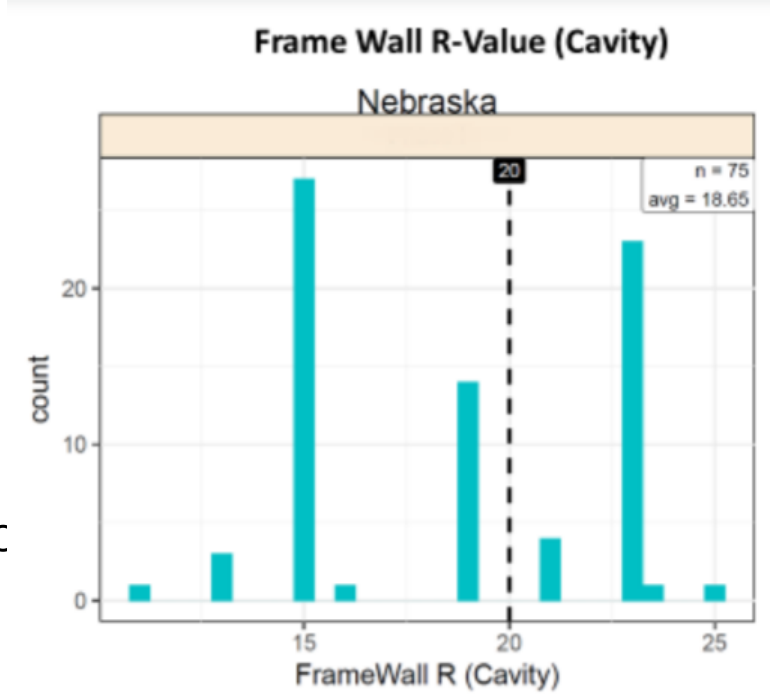
Nebraska Residential Field Study - Results

- 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 tc upgrade to meet 2018 IECC



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Design Approach for a High-Performance Home

The Key: It's not necessarily the stuff in the building — it's how it's all put together! (The house is a system)

- **Building Science as Guide**
  Understand physics of heat air and moisture flow
- **High Performance Enclosure**
  Sound structure, shell is tight, well-insulated and resilient
- **Air Distribution**
  Sealed & insulated ducts – located inside building envelope,
  intentional fresh air delivery
- **Reduced Equipment & Loads**
  Efficient Heating, Cooling, Hot Water, Lights, Appliances

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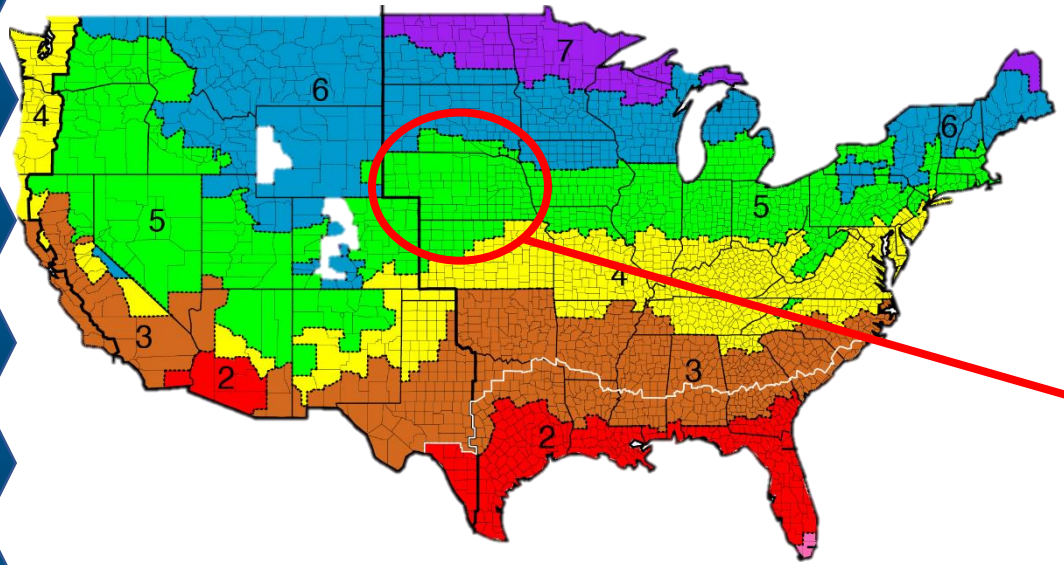
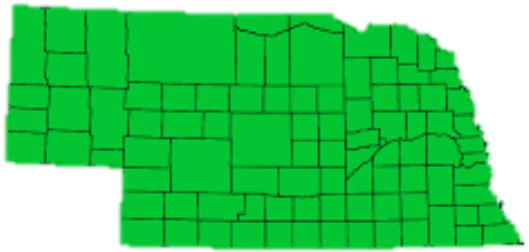
Climate Zones

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





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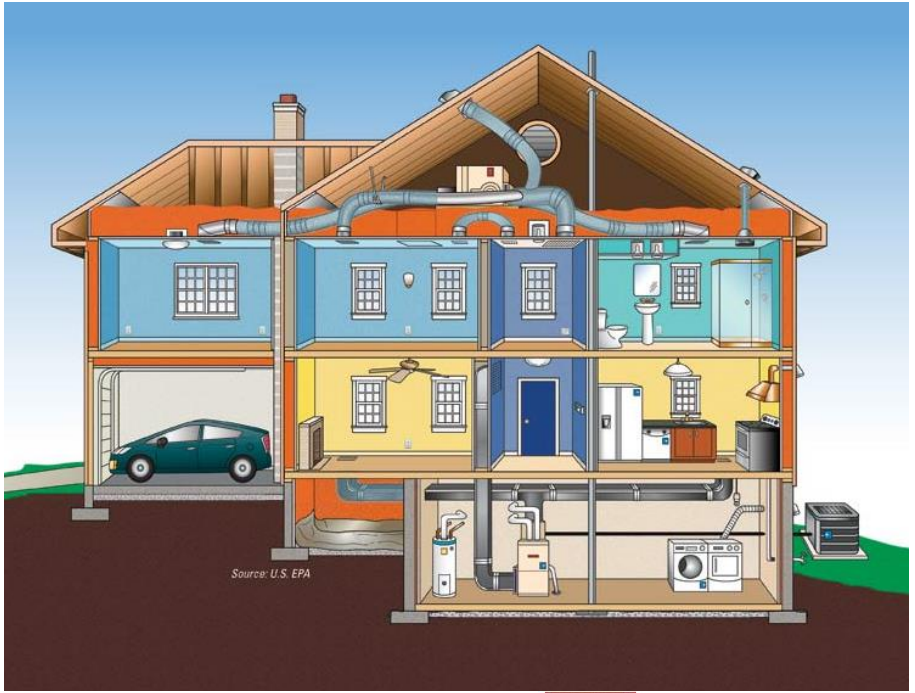
Part I

Building Science

A house is a system made up of interrelated parts:

- The building thermal envelope
- Systems
  - Heat and air conditioning
  - Ventilation
  - Water heating and distribution
- Lighting & appliances



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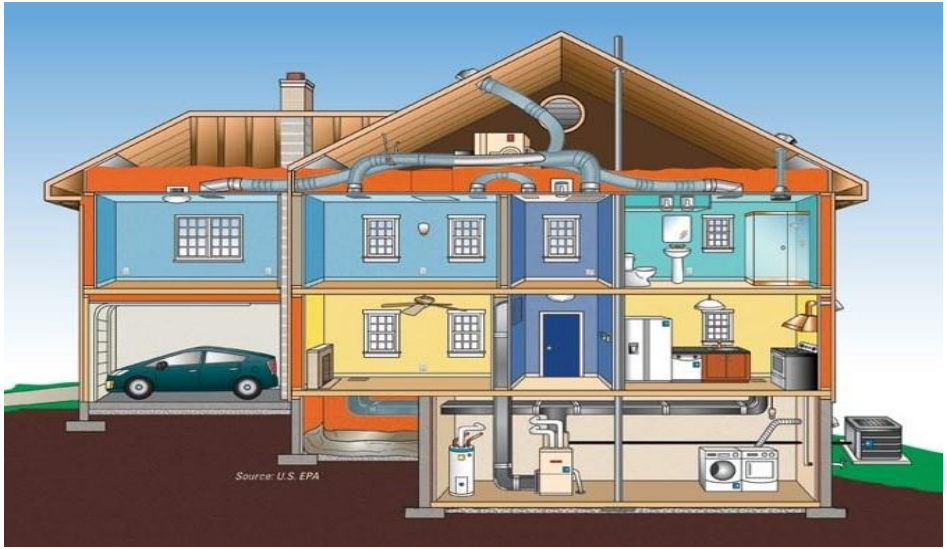
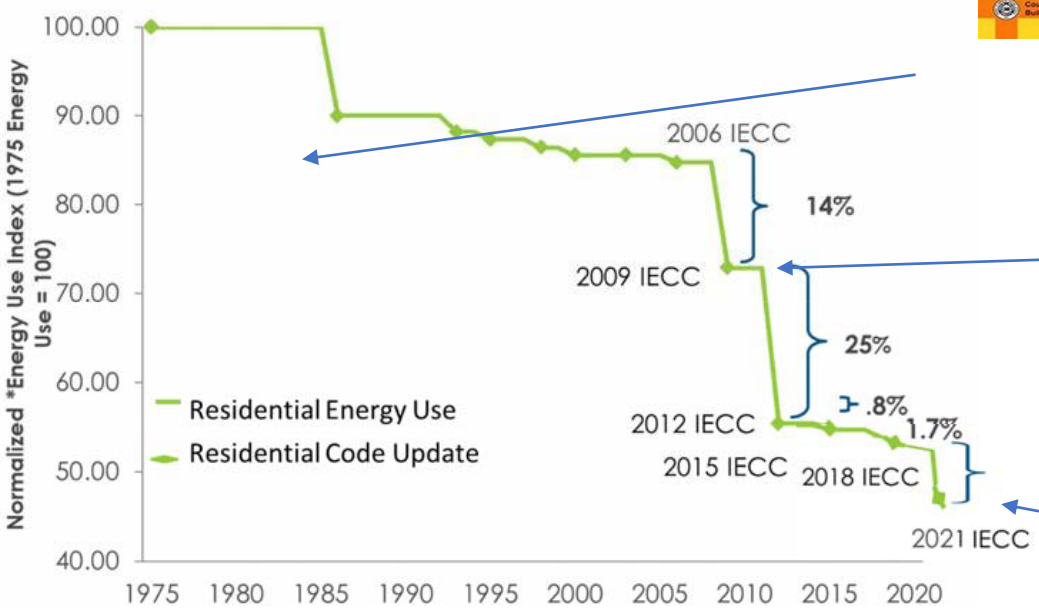
Building Thermal Envelope

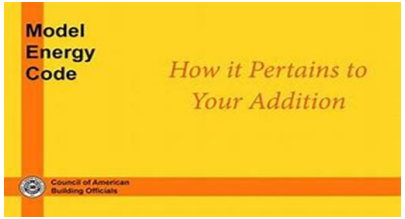
IECC Definition

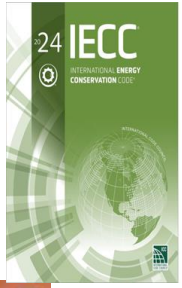
The basement walls, exterior walls, floor, roof and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.



Energy Code Background







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The Energy Code is Everywhere

- Unlike most other codes, the energy code directly impacts the work of many disparate building trades and systems, including:
  - Framing/Envelope
  - Plumbing
  - HVAC
  - Electric
  - Moisture management
  - Concrete
  - Caulking

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Part 2

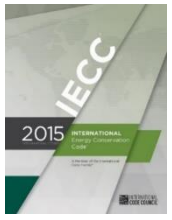
Energy Code: Residential Building

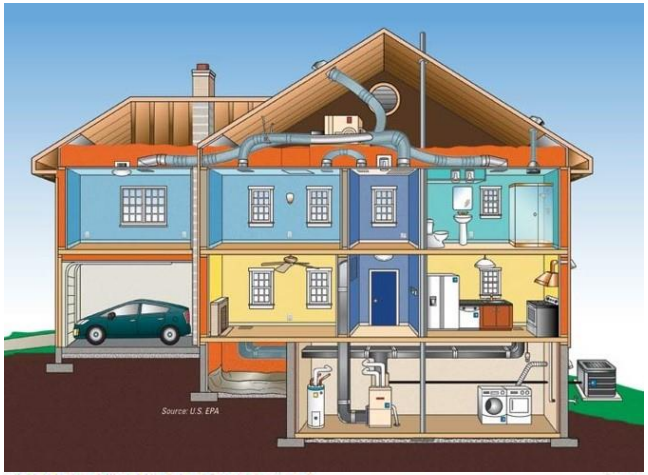
Applies to:

- New construction
- 1 and 2 family (R3)
- Multi-family, 3 stories and less (R2 and R4) – IECC 2009
- Additions, Alterations, Repairs

Exempt Buildings

- No conditioning
- Historical





CONDITIONED SPACE. For energy purposes, space within a building that is provided with heating and/or cooling *equipment* or systems capable of maintaining, through design or heat loss/gain, 50°F (10°C) during the heating season and 85°F (29°C) during the cooling season, or communicates directly with a *conditioned space*. For mechanical purposes, an area, room or space being heated or cooled by any *equipment* or *appliance*.

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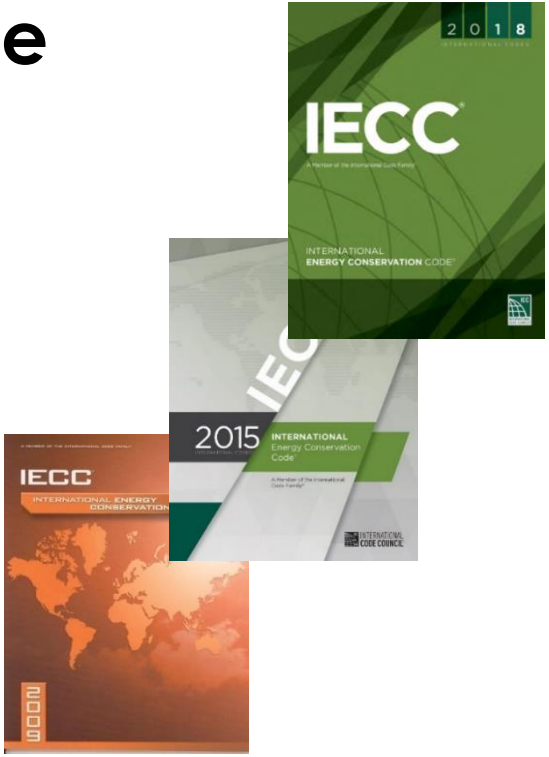
Scope of Residential Energy Code

Focus is on building envelope

- Ceilings, walls, windows, floors, foundations
- Sets insulation levels, window U-factors and SHGC
- Infiltration control
  - Caulk and seal to prevent air leaks
  - Verify envelope tightness with blower door test (or visual inspection for 2009 code)

Ducts

- No building cavities as ducts (post-2009)
- Seal properly and insulate even if all ductwork is in conditioned space
- Verify tight with duct pressurization test



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Scope of Residential Energy Code

- **Lighting equipment**
  - High-efficacy bulbs required (50%, 75%, 90%)
- **HVAC equipment efficiencies covered by different DOE standard**
- **No appliance requirements**

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IECC and IMC

- Whole-house mechanical ventilation required by energy code
- Ventilation rate and equipment requirements in the International Mechanical Code (IMC)

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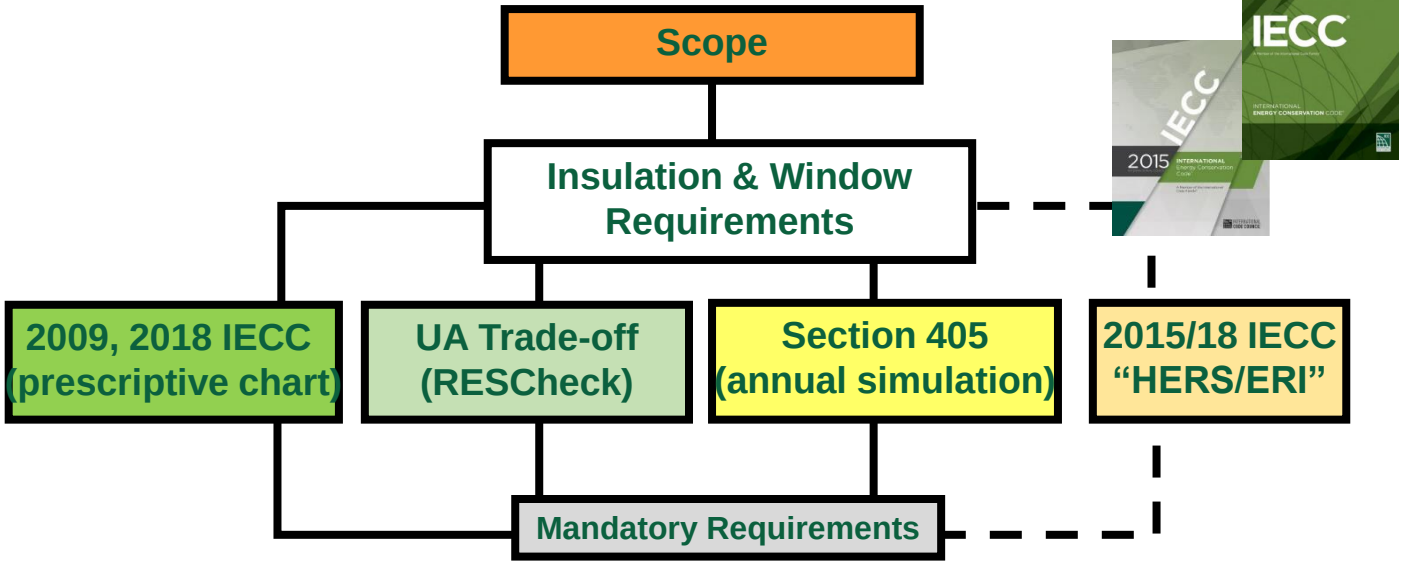
Compliance Paths



- The new Energy Rating Index (ERI) path gives the most design flexibility (e.g., credit for mechanical equipment efficiency).
- It also credits items not covered by the code (e.g., appliance efficiencies).

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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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Energy Rating Index (ERI) path

- The ERI may allow more options in materials choice, technologies and innovative strategies than the simulated performance path







- The Energy Rating Index (ERI) path gives the most design flexibility (e.g., credit for mechanical equipment efficiency)
- It also credits items not covered by the code (e.g., appliance efficiencies)

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Prescriptive R-values 2015 IECC vs. 2018 IECC

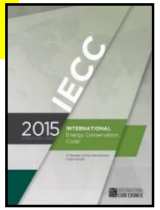
- One prescriptive "answer" for how to build per climate zone (CZ: 4 and 5)

TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5[h]	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19

3	0.32	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13+5[h]	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20+5[h] or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19

402.1.4 is similar table for U-factors



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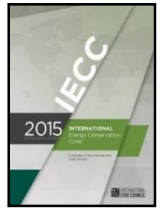
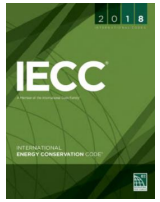
Prescriptive U-factors 2015 IECC vs. 2018 IECC





- One prescriptive “answer” for how to build per climate zone (CZ: 4 and 5)

TABLE R402.1.4
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
2015								
4 except Marine	0.35	0.55	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
2018								
4 except Marine	0.32	0.55	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.026	0.060	0.082	0.033	0.050	0.055

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Section 402.2: Insulation Requirements

Details for insulating various aspects of the building envelope:

- **Ceilings with Attic – 402.2.1**
- **Ceilings w/out Attic – 402.2.2**
- **Eave baffles – 402.2.3**
- **Access hatches and doors– 402.2.4**
- Mass Walls – 402.2.5
- Steel Framing – 402.2.6
- Partial Structural sheathed walls – 402.2.7
- **Floors – 402.2.8**
- **Basement Walls – 402.2.9**
- Slab-on-grade – 402.2.10
- **Crawlspace Walls – 402.2.11**
- Masonry Veneer – 402.2.12
- Sunrooms – 402.2.13

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Envelope Tradeoff Options

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Total UA Method

- 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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Continuous Insulated Envelope

- Total wall performance allows for window walls or other design trade offs..

REScheck Tradeoff Option

www.energycodes.gov

Software evaluates specific designs quickly

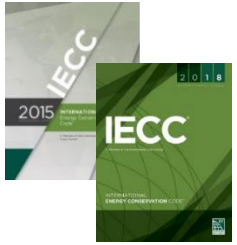
Demonstrates SHGC compliance

Allows trade-offs

- Building envelope components
- No trade-offs for better heating & cooling equipment efficiencies

Specify code edition

UA or Simulated Performance



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Conduction Heat Flow

Heat transfer through a solid object: the formula for calculating conduction heat transfer is $q = U \times A \times \Delta T$

q = heat flow (Btu/hr)

U = inverse of R-Value [U=1/R, R=1/U] (Btu/hr ft^2 °F)

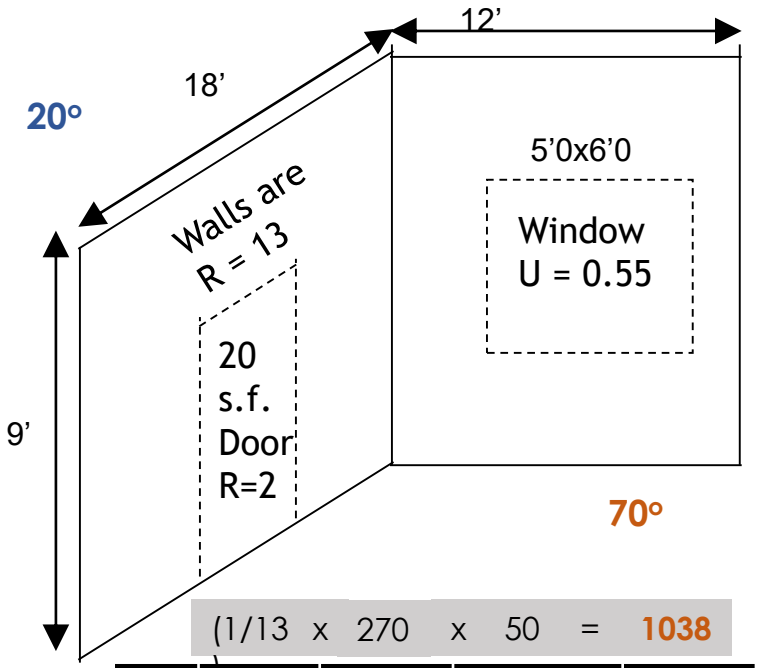
A = area (square feet)

ΔT = temperature difference across component (°F)

$$q = U \times A \times \Delta T$$

Manual J: q = A x HTM

where HTM = UxΔT



(1/13 x 270 x 50 = **1038**

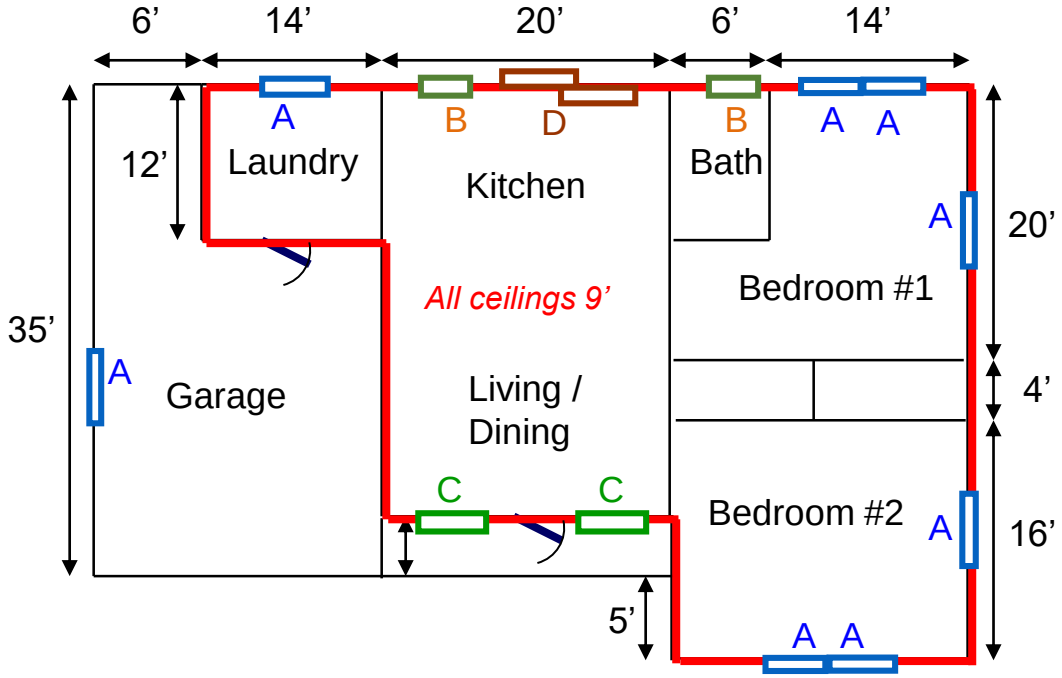
R	U	Area	Delta T	q
13	1/13	220	50	846
2	½	20	50	500
-	0.55	30	50	825

Questions so far?

Please feel free to unmute or put questions/comments in the chat!

RESCHECK - Simple House

https://energycode.pnl.gov/REScheckW



- Perimeter: 54x2 + 40x2 = *188* ft.
- Gross Wall: 188 x 9 = *1,692* sq. ft.
- Floor Area:
  12x14 +
  20x31 +
  20x40 =
  1,588 sq. ft.
- Ceiling Area: *1,588* sq. ft.
- Windows
  - A: 12 x 7 = 84 sq. ft.
  - B: 9 x 2 = 18 sq. ft.
  - C: 20 x 2 = 40 sq. ft.

  Windows: *142* sq. ft.
- Glass Doors: 20 x 2 = *40* sq. ft.
- Solid Doors: *40* sq. ft. (R-3)
- Volume: 1588x9 = 14,292 c.f.

A: 3’0 x 4’0 DP low-e (U.31, SHGC.24)

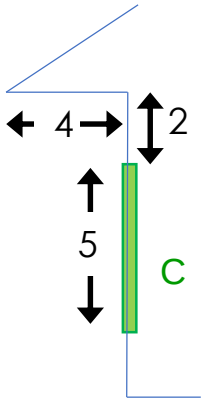
B: 3’0 x 3’0 DP low-e (U.33, SHGC.26)

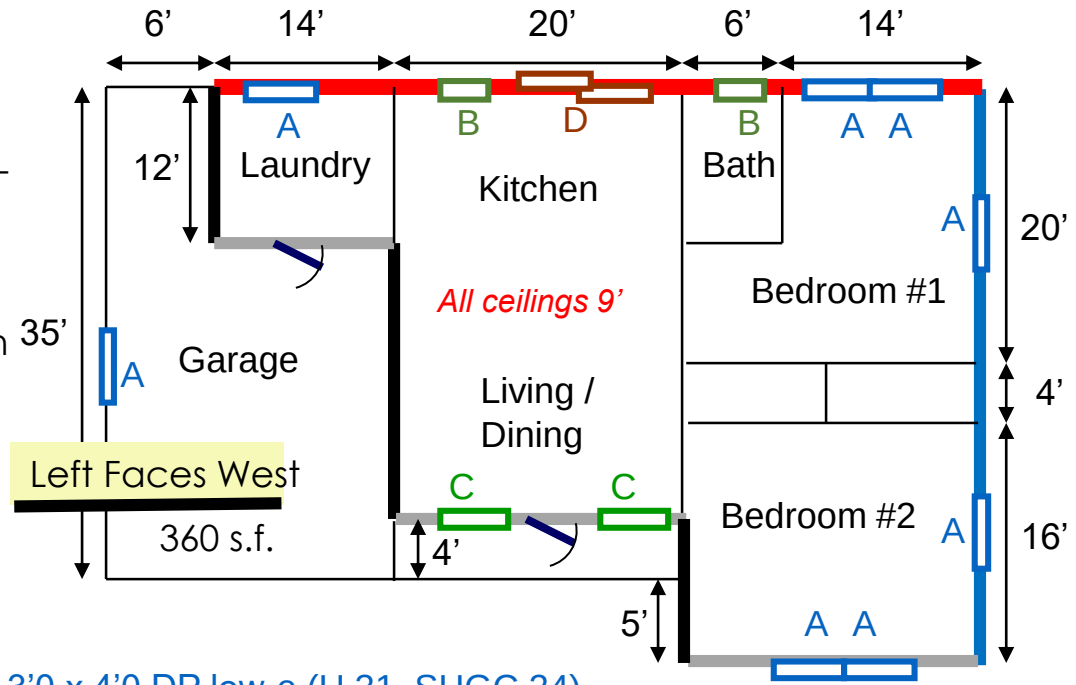
C: 4’0 x 5’0 DP low-e (U.32, SHGC.25)

D: 6’0 x 6’8 DP Sliding Glass Door with tint (U.47, SHGC.48)

Simple House (1588 s.f.)

Assume:
- Front faces south
- 1' overhang except 4' porch
- 2x4 frame walls, R-13+R-6
- R-49 flat ceiling (1588 s.f.)
- R-5 slab edge insulation





A: 3'0 x 4'0 DP low-e (U.31, SHGC.24)

B: 3'0 x 3'0 DP low-e (U.33, SHGC.26)

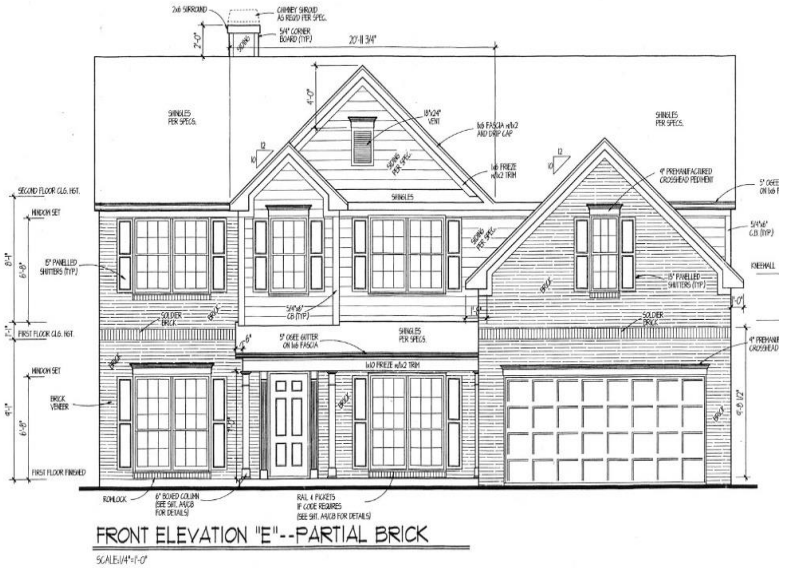
C: 4'0 x 5'0 DP low-e (U.32, SHGC.25)

D: 6'0 x 6'8 DP Sliding Glass Door with sun tint (U.47, SHGC.48)

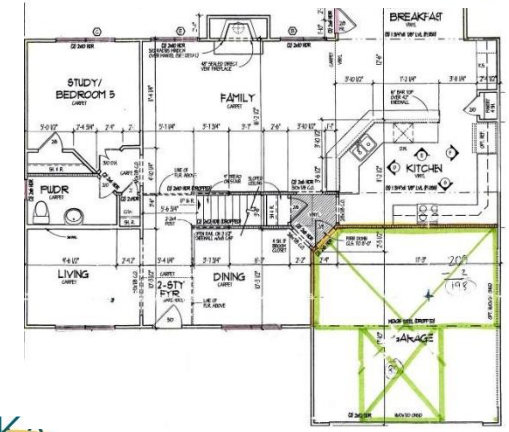
Front Faces South 486 s.f.

RESCHECK – ACME House

https://energycode.pnl.gov/REScheckWeb



Second:
1,473 s.f.



First:
1,343 s.f.

"Acme" base case, 2-story
2816 s.f home (Omaha)

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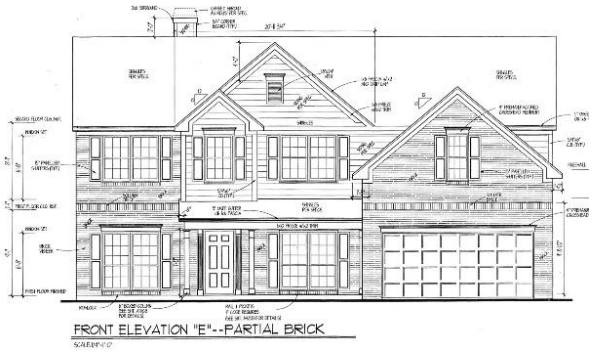
RESCHECK – ACME House Base Case Takeoffs

- Total cond. Floor area: 2816 s.f., Volume: 25,791 c.f.
- First floor area: 1343 s.f., slab on grade: **167' perimeter**, R-10. 2'
- Second level, floor over garage: **280 s.f.,** R-19
- Gross Exterior walls: **2578 s.f.**
  - Net Exterior walls: 2170 s.f., R-20
- Gross Wall Adjacent to Garage: **257 s.f.**
  - Net Wall Adjacent to Garage: 237 s.f., R-13
- Attic Kneewall: **420 s.f.**, R-13+R-5 continuous
- Windows (F,L,B,R): 157+22+177+12 = **368 s.f.**, U-0.30, SHGC-0.26
- Glass Door: **20 s.f.**, U-0.33, SHGC-0.30
- Front Door wood: **20 s.f.**, U-0.5
- Garage Door metal, foam core: **20 s.f.**, U-0.33
- Flat ceiling: **1220 s.f.**, R-49 Vaulted ceiling: **390 s.f.**, R-25



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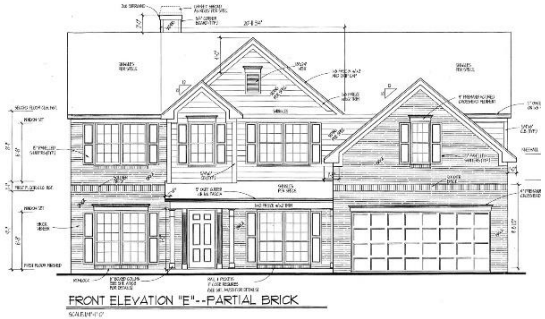
RESCHECK – ACME House Roofline Takeoffs

- Total cond. Floor area: 2816 s.f., Volume: 29,811 c.f.
- First floor area: 1343 s.f., slab on grade: **167' perimeter**, R-10, 2'
- Second level, floor over garage: **280 s.f.,** R-19
- Gross Exterior walls: **2578 s.f.**
  - Net Exterior walls: 2170 s.f., R-20
- Gross Wall Adjacent to Garage: **257 s.f.**
  - Net Wall Adjacent to Garage: 237 s.f., R-13
- Foamed Gable End walls: **744 s.f.**, R-20
- Windows (F,L,B,R): 157+22+177+12 = **368 s.f.**, U-0.30, SHGC-0.26
- Glass Door: **20 s.f.**, U-0.42, SHGC-0.30
- Front Door wood: **20 s.f.**, U-0.5
- Garage Door metal, foam core: **20 s.f.**, U-0.33
- Foamed Roofline (vaulted ceiling): **1986 s.f.**, R-20



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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.

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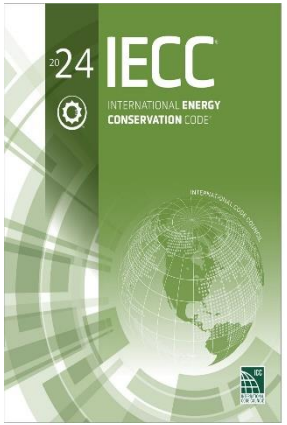
2024 National Energy Standard

- In Process since November ’21 ***Final Approval 3/24!***
- Use ‘21 Energy Code as Basis and Improvements from there.
- Many more stakeholders than IECC Development
- Glide slope to Net Zero by 2030
- Expanded Appendices
- Carbon Impact/Credits



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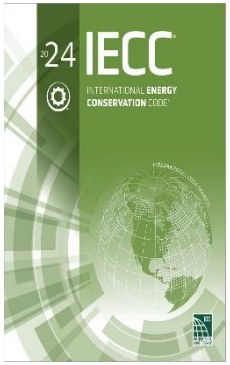
2024 National Energy Standard

- *More* focus on Electrification
- Tables for Envelope and Fenestrations (402/403)updated
- More reliance of high performance
- More focus on testing/verification
- More intent to move appendices items forward in 2027 & 2030 versions



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2024 IECC: The Result

- Wall insulation and ceiling insulation issues from 2021 IECC – this was the biggest issue with the 2021 IECC
- Expanded the performance path to include equipment trade-offs, duct location trade-offs, and very reasonable envelope backstops
- Includes a much-slimmed down version of the electrification readiness measures in an appendix that would have been if it wasn't for the omnibus

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2024 IECC: The Result

- Added a wide range of reasonable options for compliance with R408
- Fixed the ERI path
- Recognizes federal preemption challenges with both electrification and higher levels of stringency

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Key Takeaways

https://energycode.pnl.gov/REScheckWeb

- 2018 IECC has new requirements for:
  - Air sealing
  - Duct sealing
  - U-Factor
  - R-Values
  - Performance Testing
  - Good Alternative Methods!

- Controlling moisture is *critical*
  - Proper air sealing is key
  - Right-sizing HVAC is required
  - Mechanical ventilation must be installed and takes on new importance

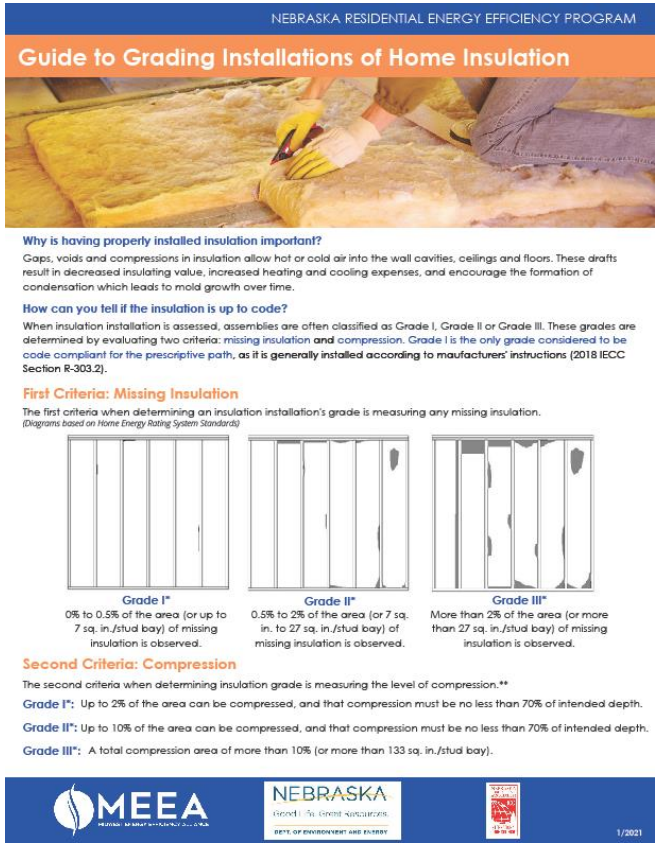
ResCheck is a Great Tool to capture Each Homes Performance Metrics!

Helpful Handouts

Series of Informational Topics

Made to share with Trades/Subs, etc.

Posted under "resources" on our main website:



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 manufacturers' 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).

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https://www.mwalliance.org/nebraska-energy-codes-training-program

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Continuing Education Credits

Participants of this session are eligible for continuing education credits from the **International Code Council** and **AIA**

John will send out certificates of completion of this training (within 2 weeks of today's date), along with the slides in PDF format, if you wish to have your hours for CEUs logged, please respond to that email.

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Upcoming Events:

Coming in July

7/17: ComCheck Walkthrough

Let us know if you would like to schedule an in-person Codes update training session this Summer as well!

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Thank you!

- Questions?

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

- John Gossman, Midwest Energy Efficiency Alliance jgossman@mwalliance.org

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