Nebraska's Residential Energy Code

2018 IECC-R
RESCheck: Requirements and Trade offs

Nebraska Energy Code Training Program

Instructor: Matt Belcher

June 27, 2023, 1 PM – 3:00 PM CDT

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Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box or unmute
- Webinar is being recorded - slides and recording will be emailed to attendees and posted on website
- CEUs available from AIA and ICC
- Certificates will be emailed to attendees
- Email canderson@mwalliance.org with questions

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About MEEA

- MEEA is a nonprofit membership organization with 150+ 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 Matt Belcher

- 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 and 2021 Building Code-General Committee
- NAHB Approved Instructor for Advanced Building Science,
- Advanced Business Management

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 PNNL, 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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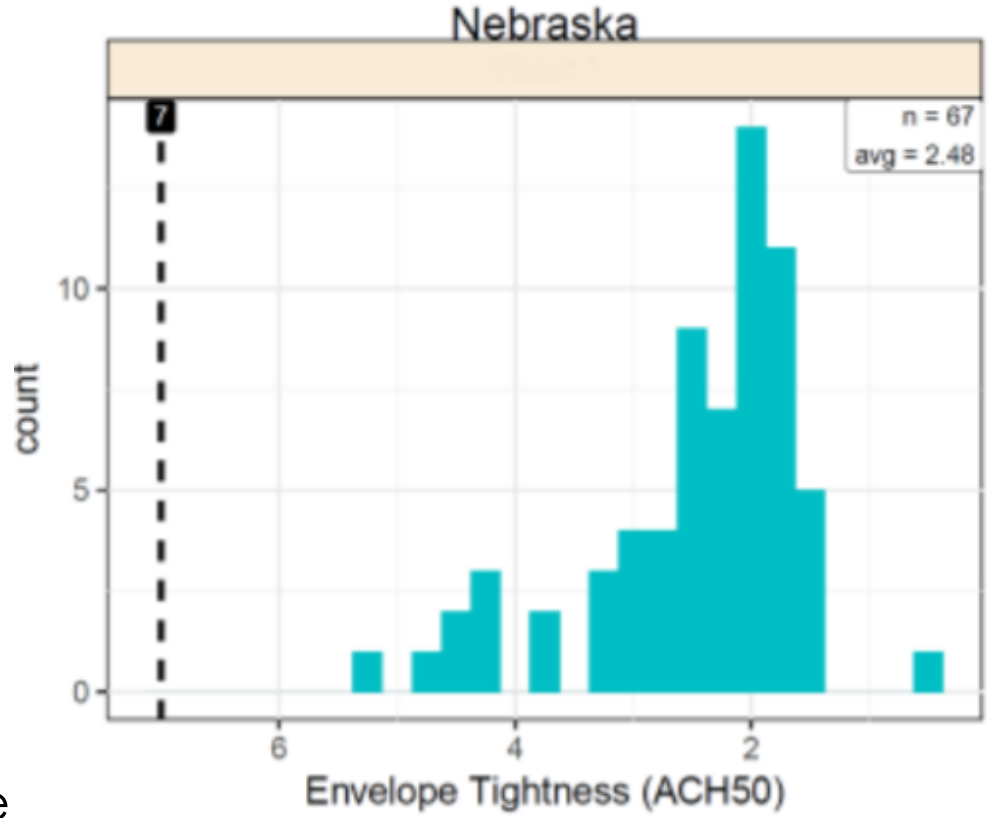
Field Study Results

- 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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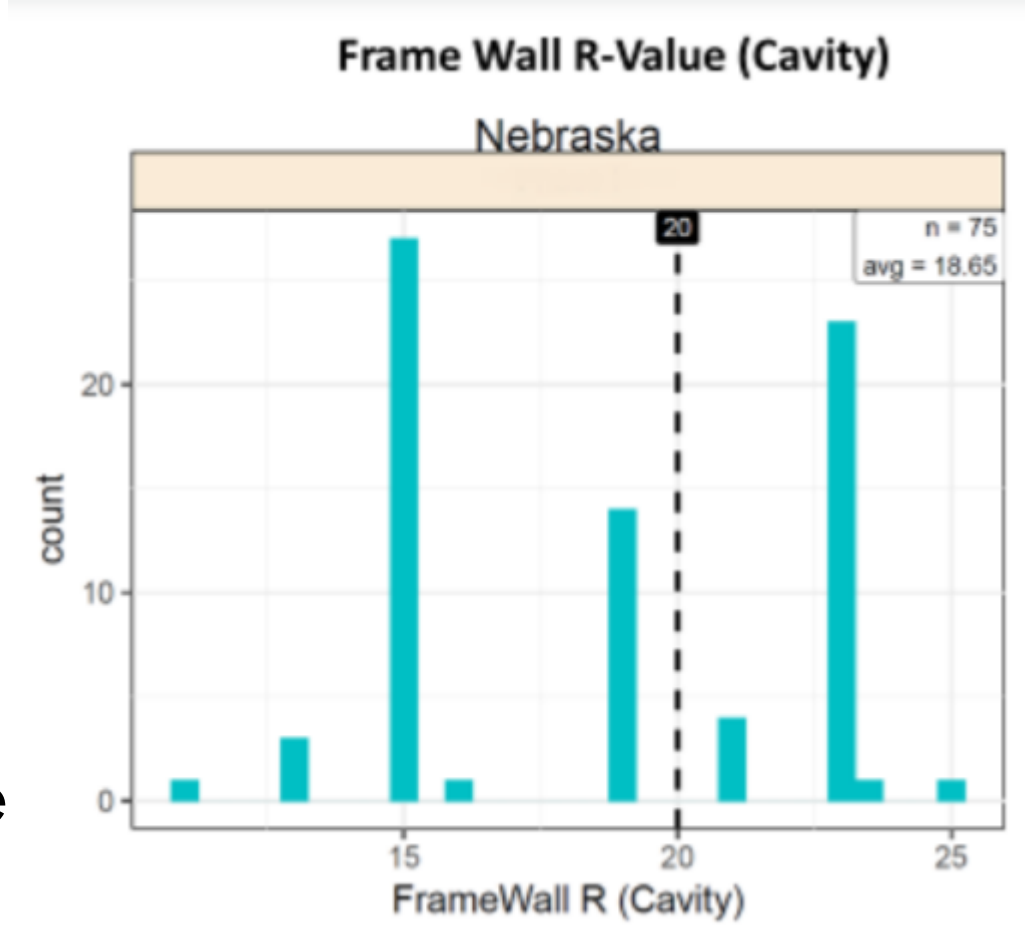
Field Study Results

- 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 nee to upgrade to meet 2018 IECC



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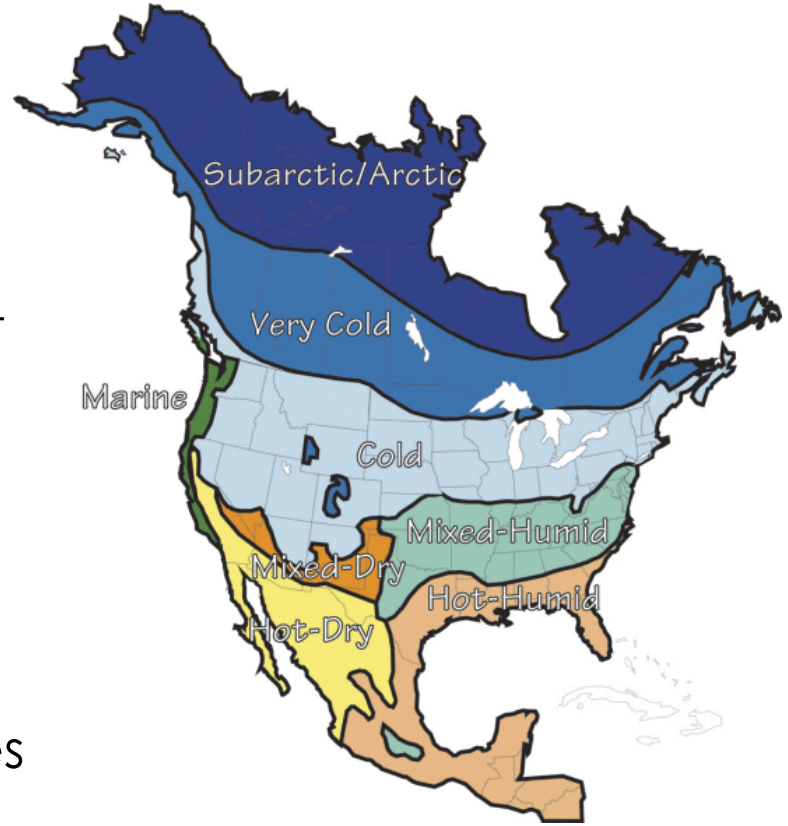
Design Approach for a High-Performance Home

- **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



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

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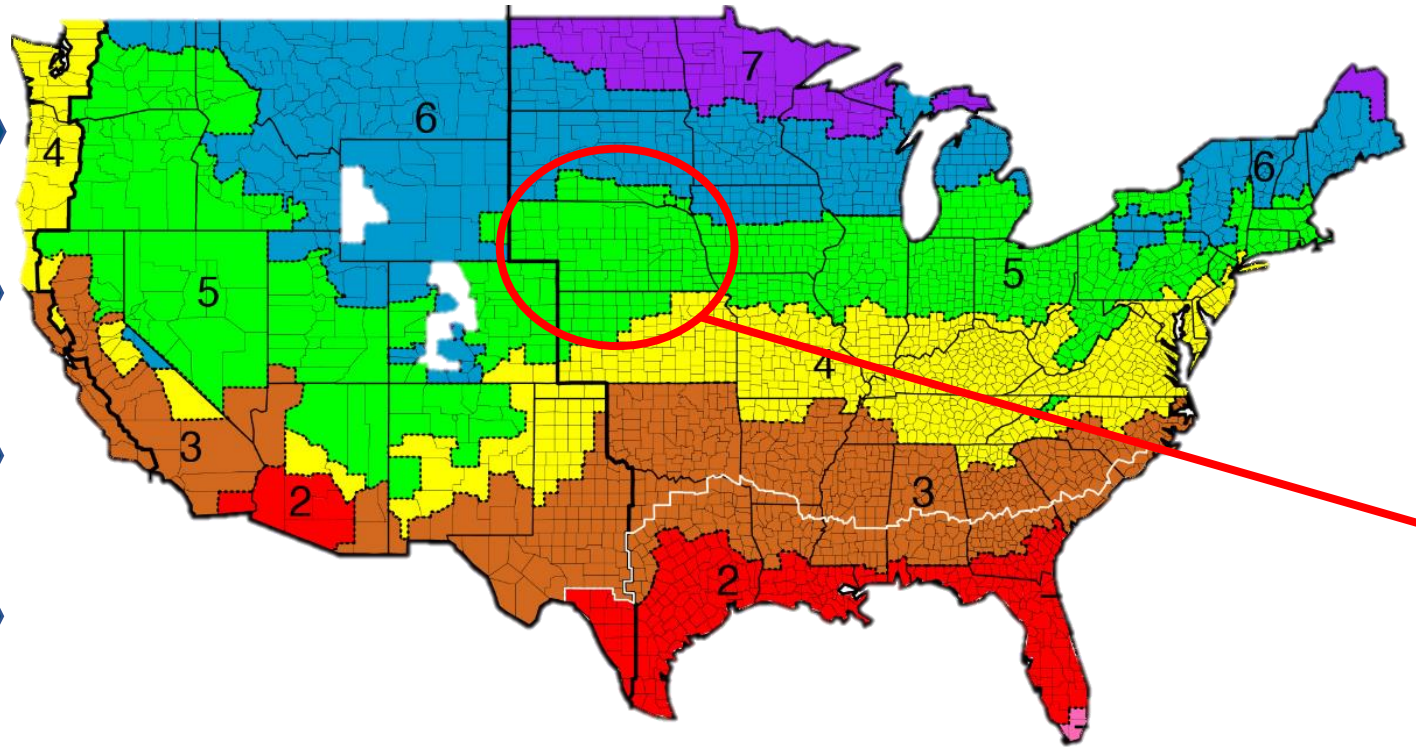
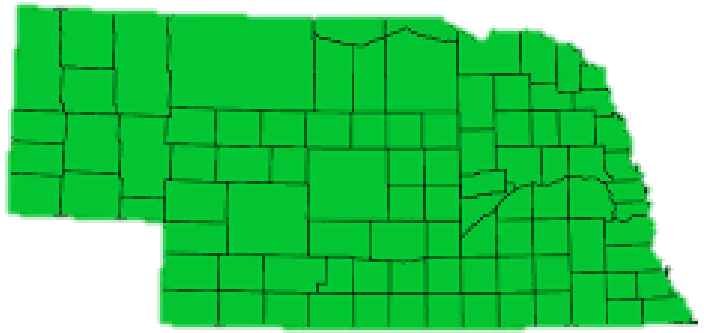
Climate Zones



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



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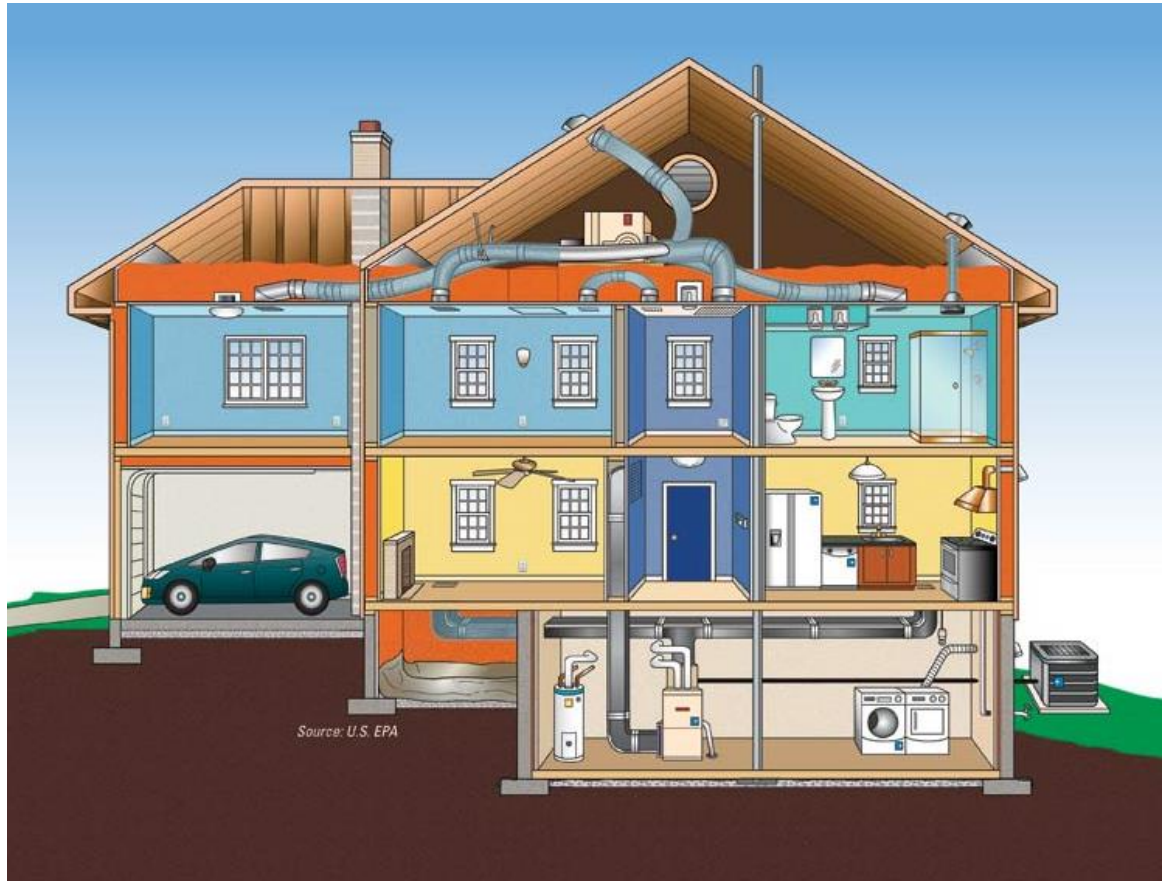
Part I

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 Science

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.

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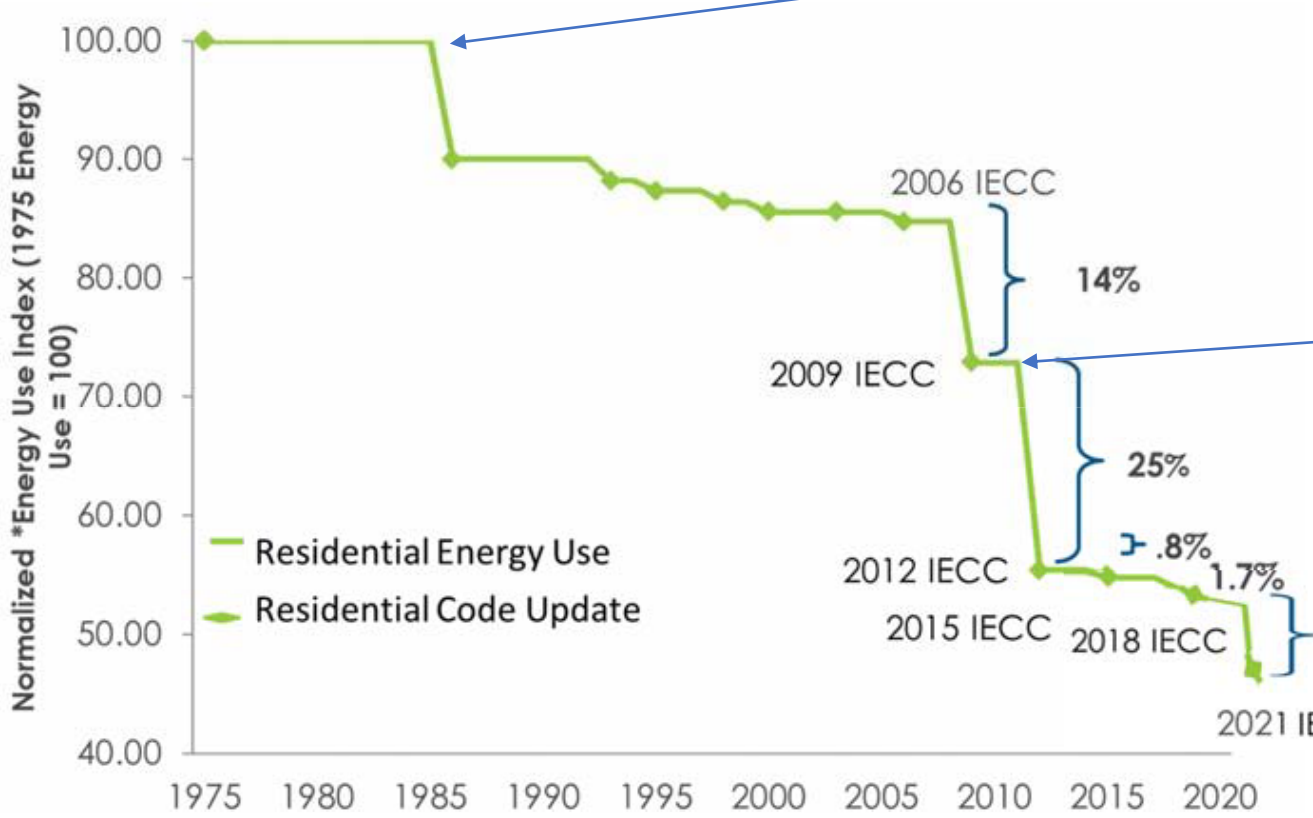
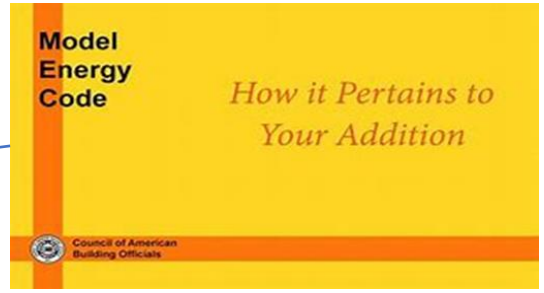
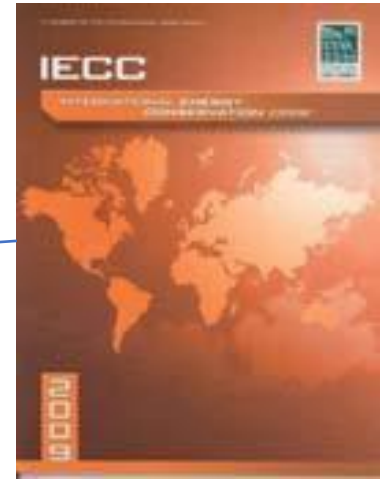
Residential Energy Code Background







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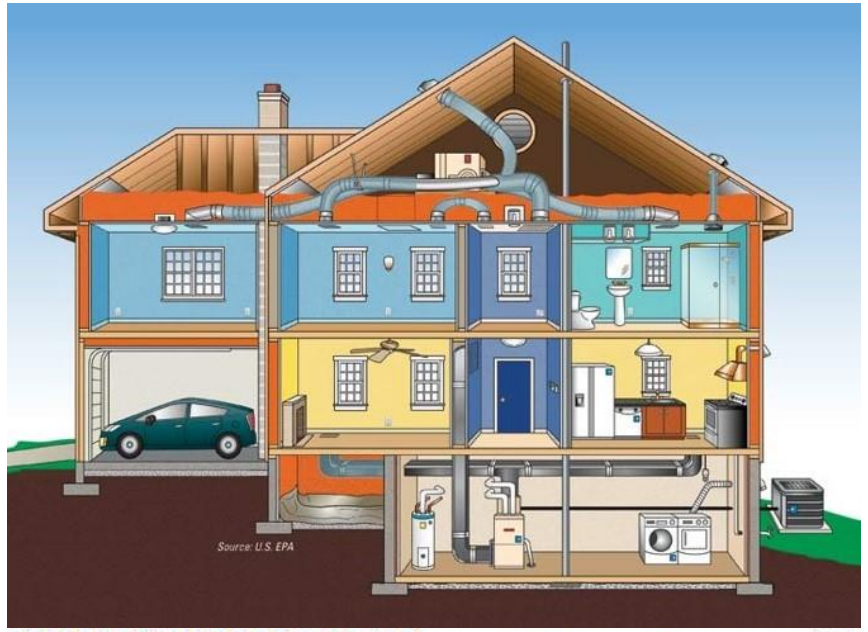
Part 2

Energy Code: Residential Buildings

Applies to:

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



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*.

Exempt Buildings

- No conditioning
- Historical

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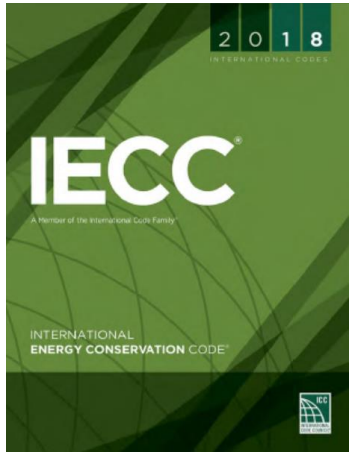
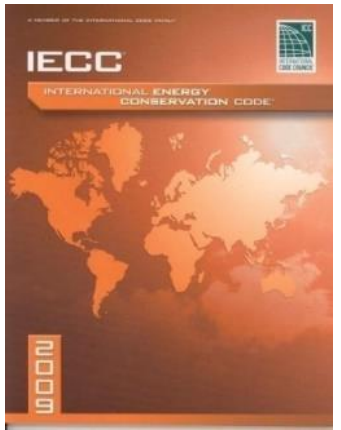
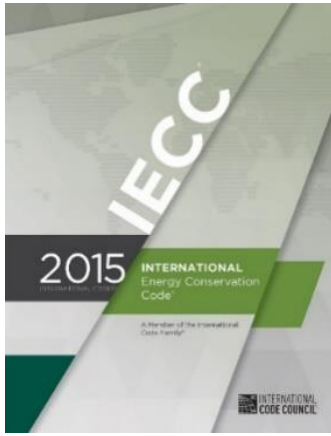
Scope of Residential Energy Code

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







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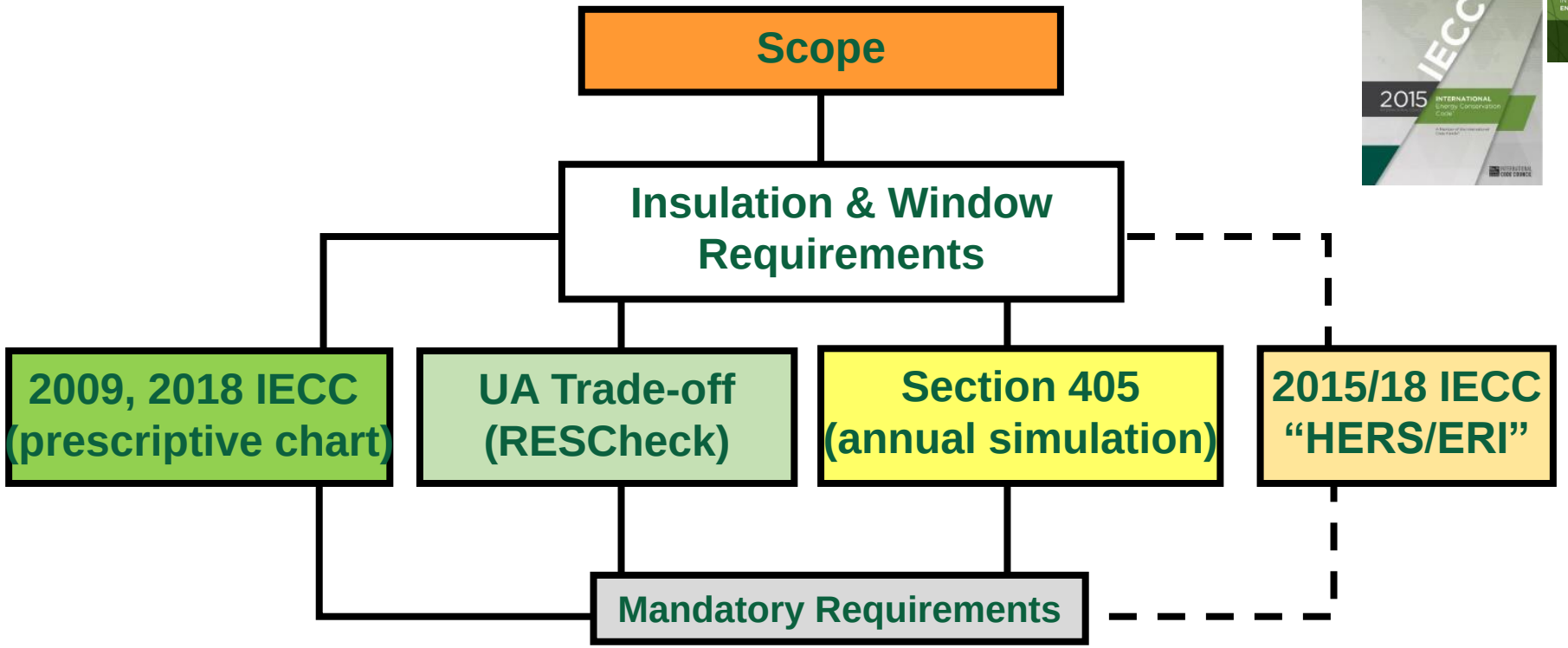
Energy Codes

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 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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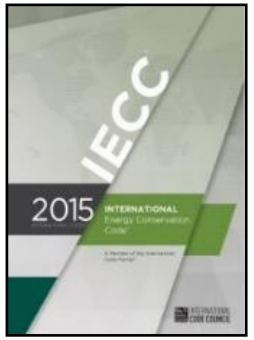
Prescriptive R-values 2015 IECC vs. 2018 IECC

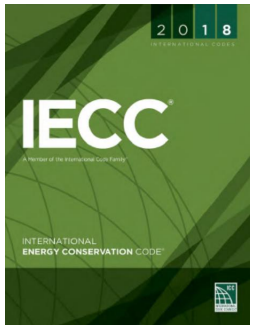
One prescriptive "answer" for how to build per climate zone (CZ: 4 and 5)

402.1.4 is similar table for U-factors

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
2015										
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
2018										
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





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

Section 402.2: Insulation Requirements

Details for insulating 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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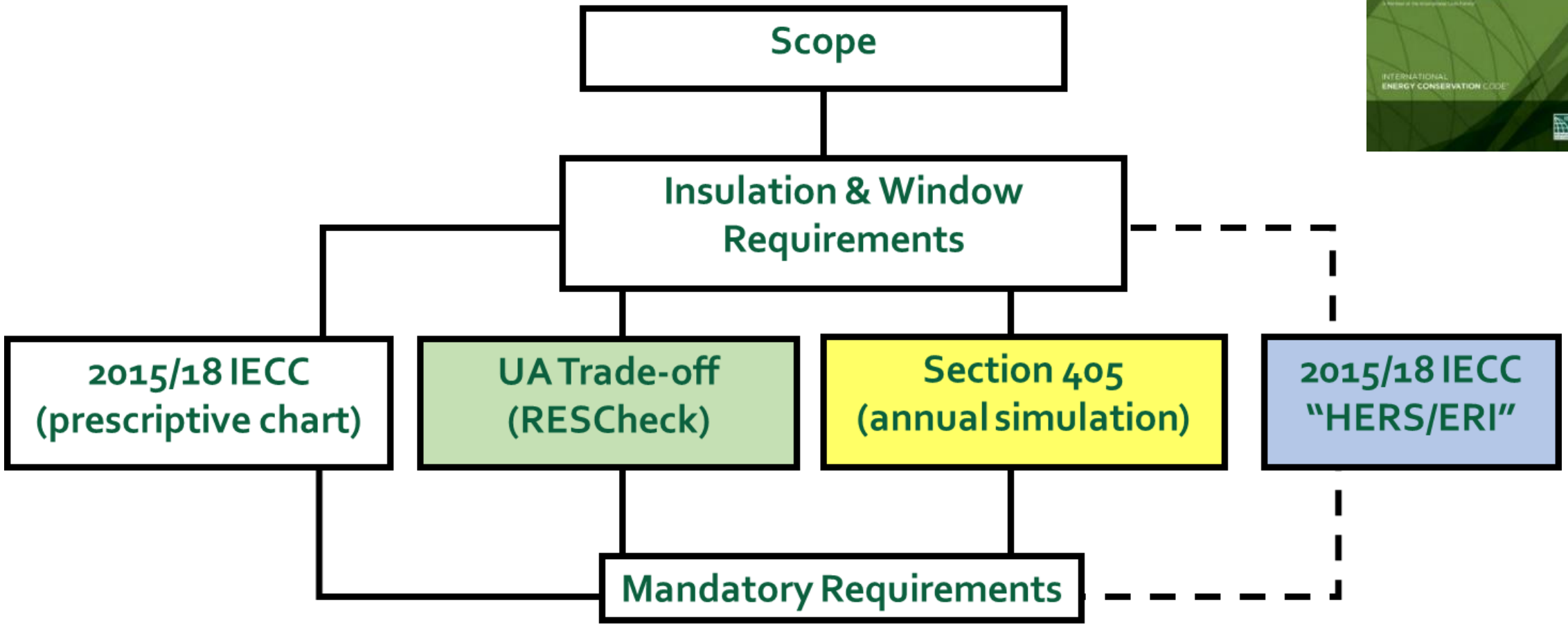
Envelope Tradeoff Options



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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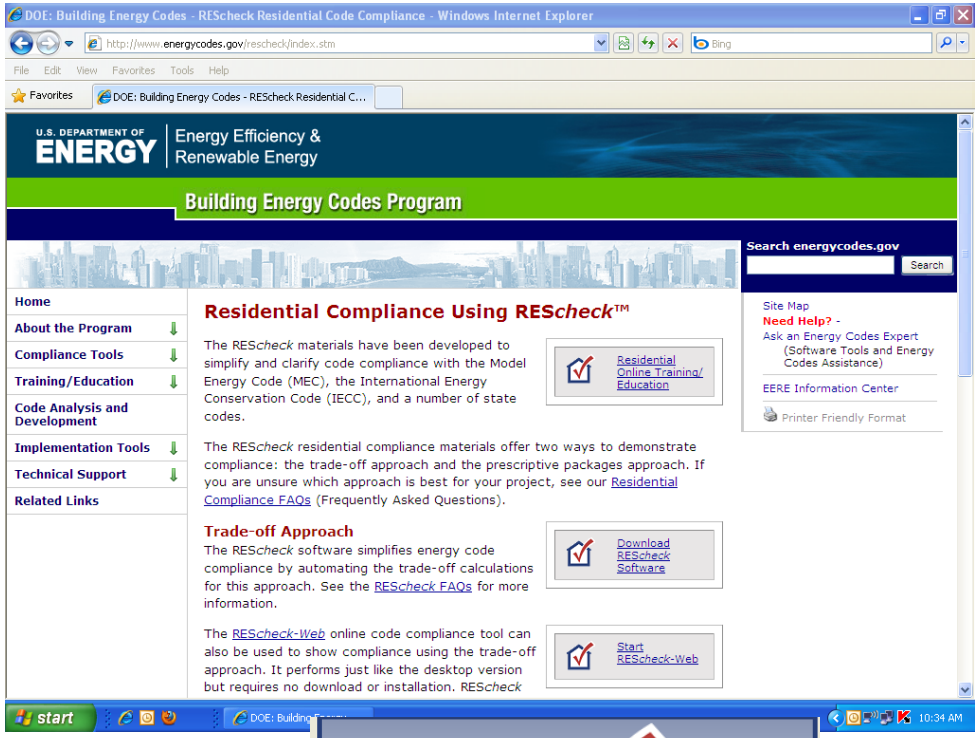
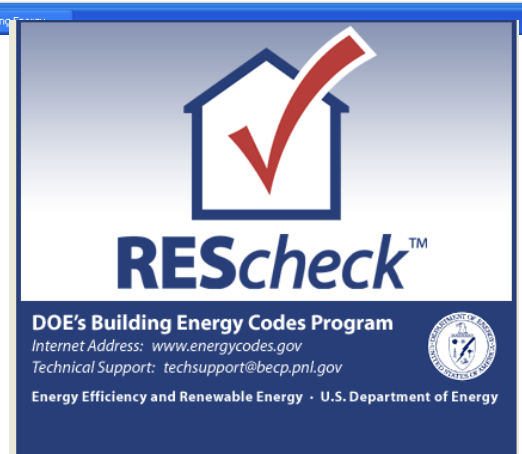
Continuous Insulated Envelope

- 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)

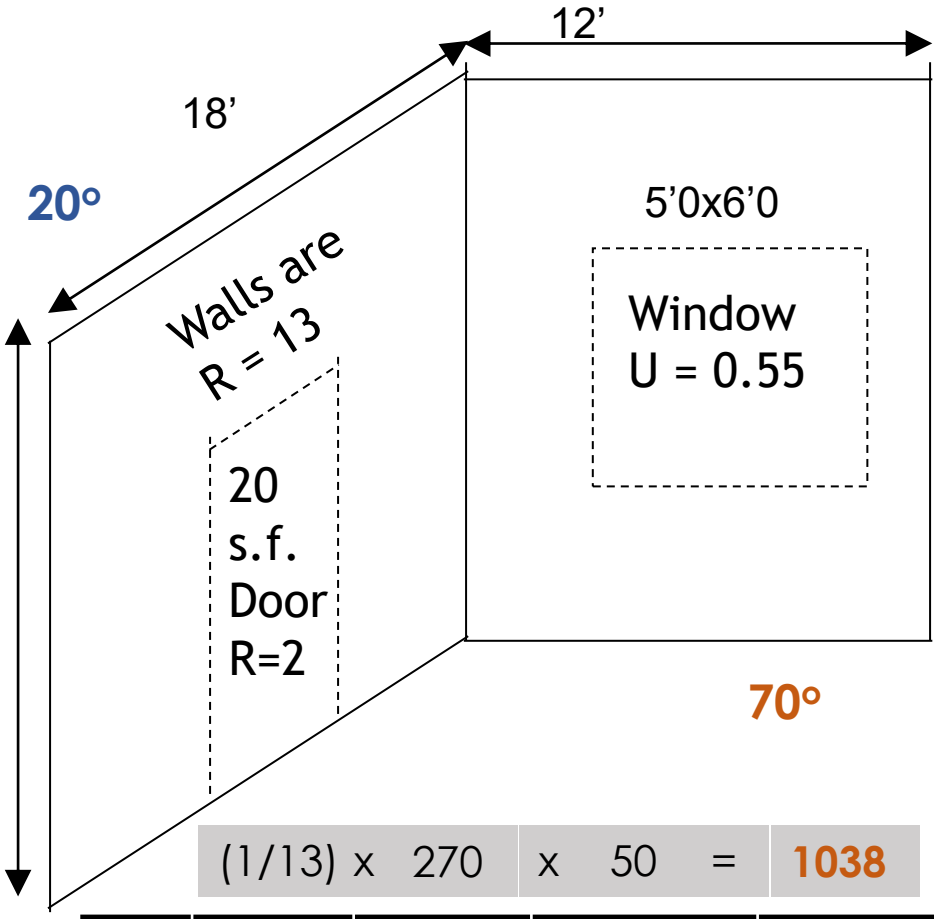
A = area (square feet)

ΔT = temperature difference across component (°F)

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

Manual J: $q = A \times HTM$

*where HTM = U x **ΔT***



(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?

Type in chat or unmute!

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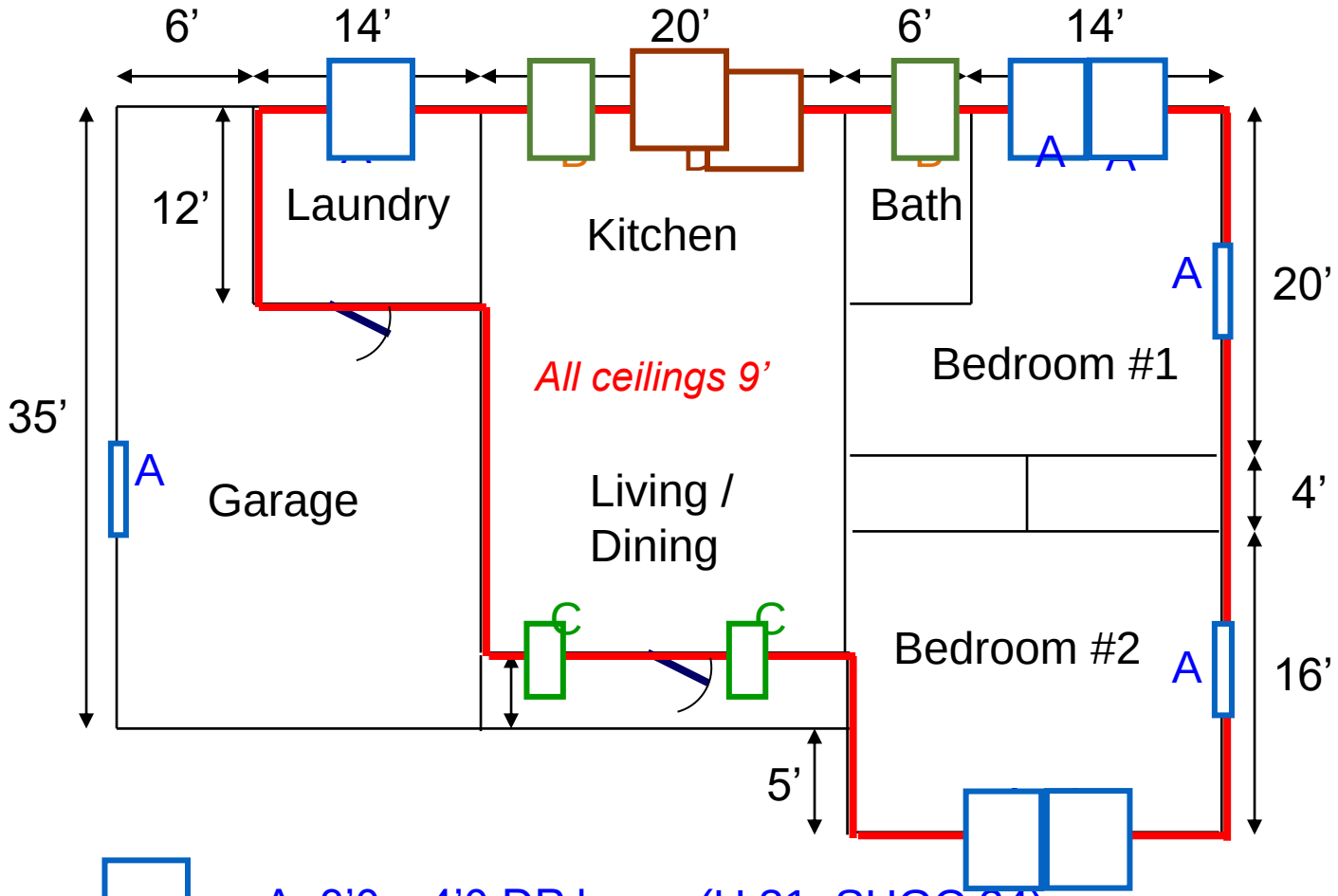
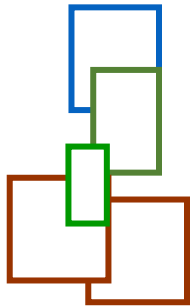
https://energycode.pnl.gov/REScheckWeb





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)

- 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.

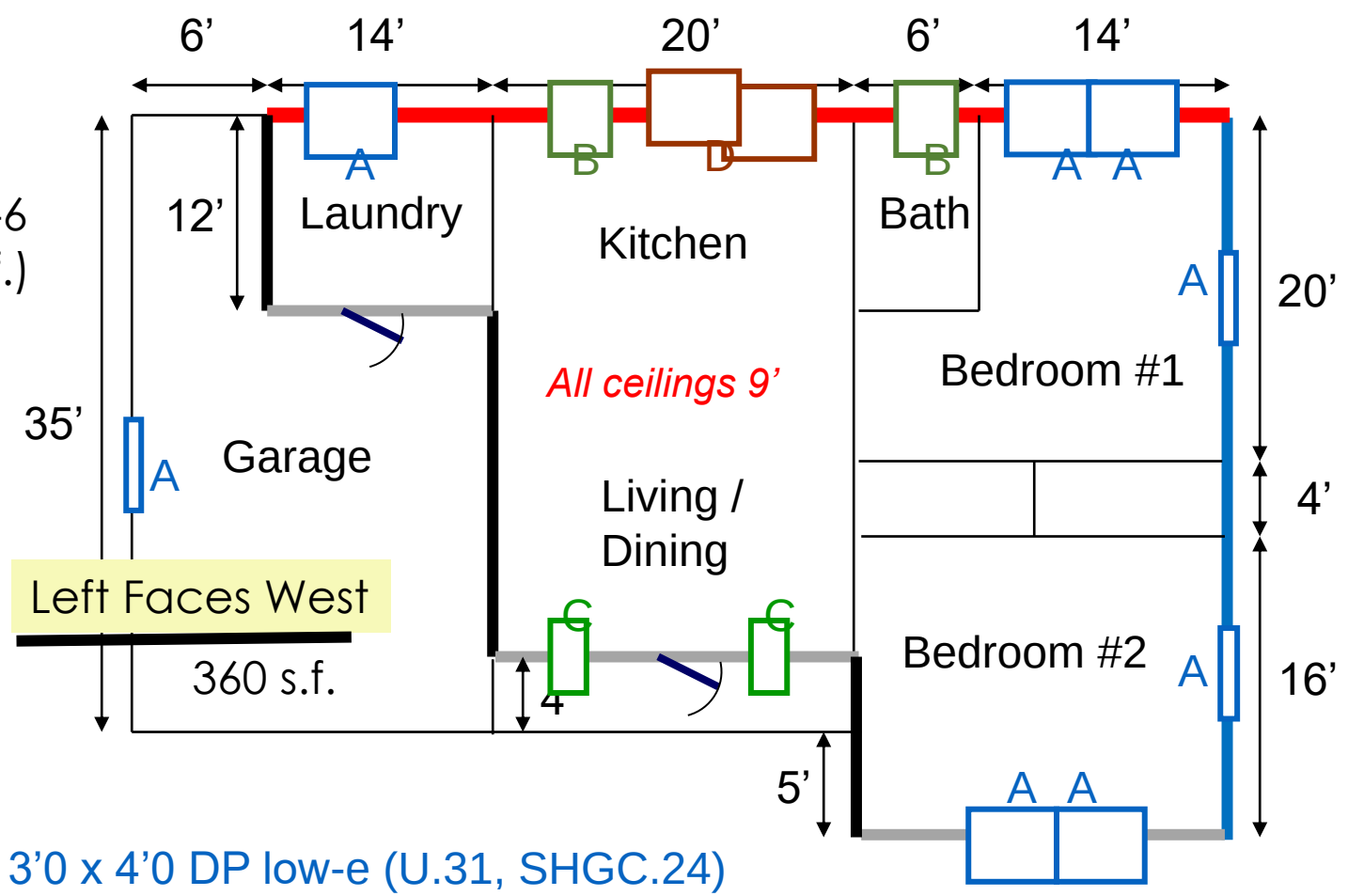
Simple House (1588 s.f.)

Back Faces North

486 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



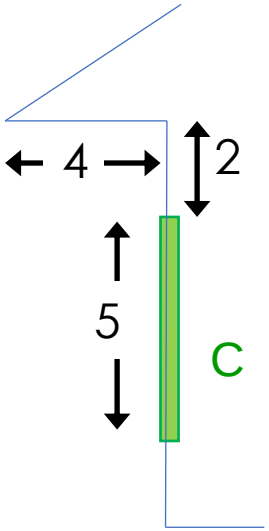
North

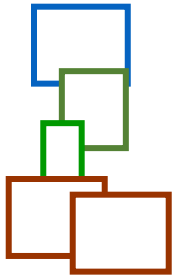
Right Faces East

360 s.f.

Left Faces West

360 s.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 sun tint (U.47, SHGC.48)

Front Faces South

486 s.f.

Questions so far?

Type in chat or unmute!

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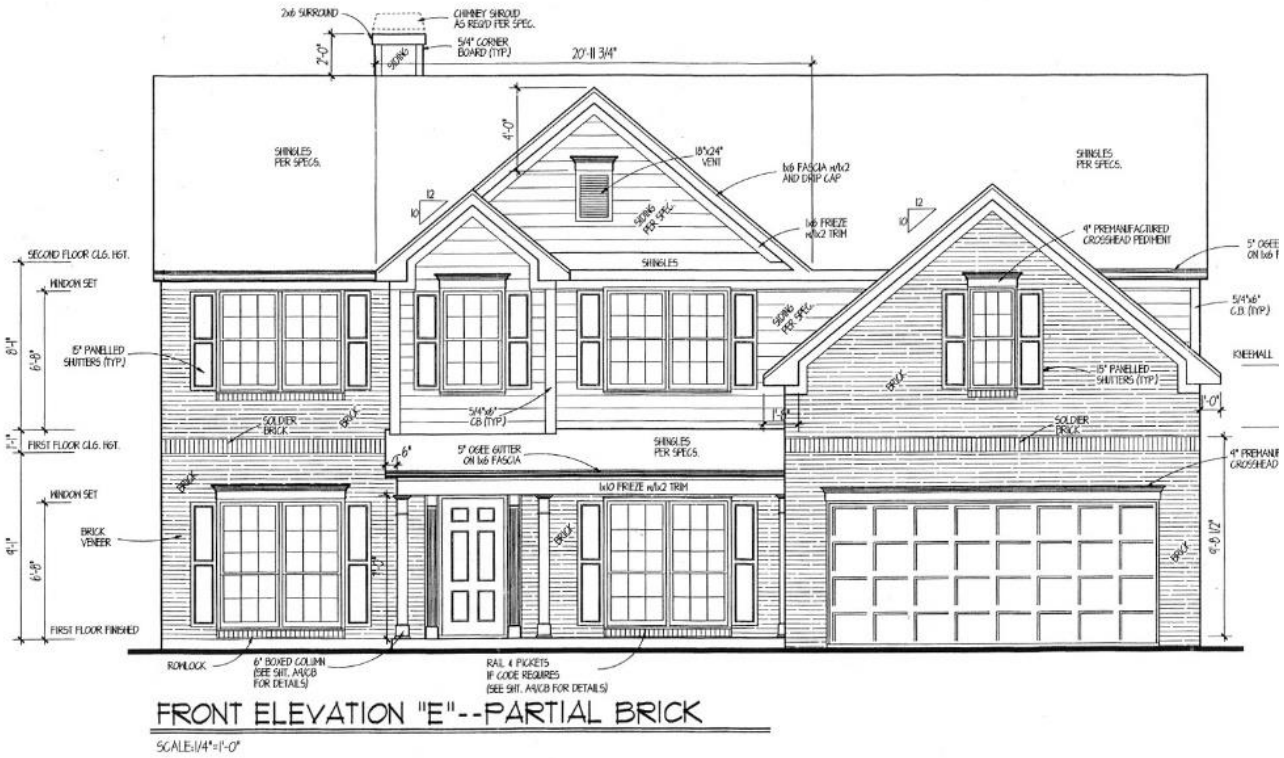
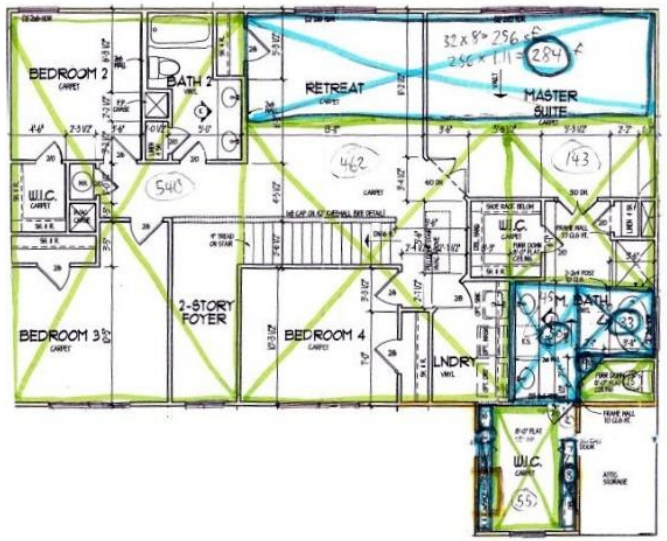
RESCHECK – ACME House

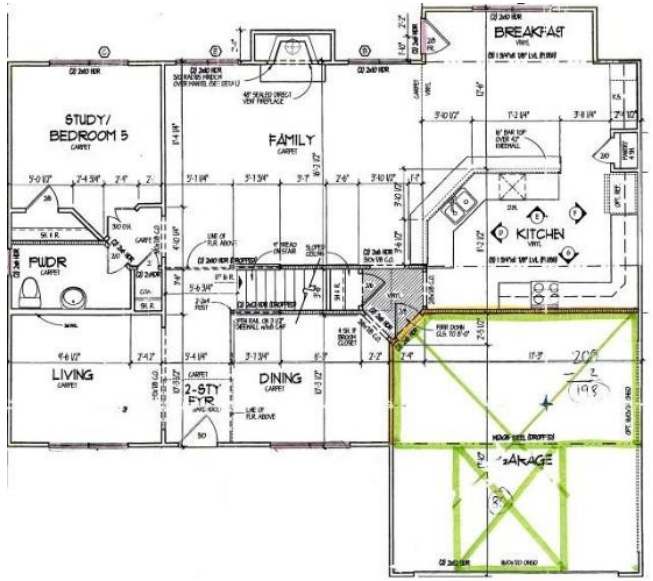
https://energycode.pnl.gov/REScheckWeb



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



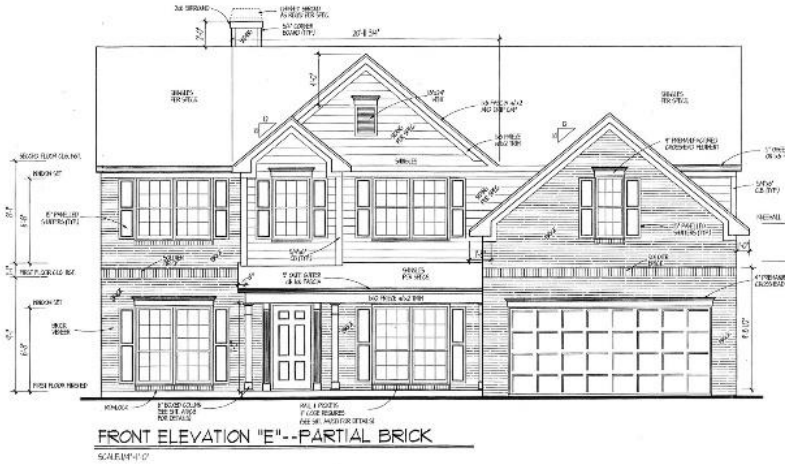
Second:
1,473 s.f.



First:
1,343 s.f.

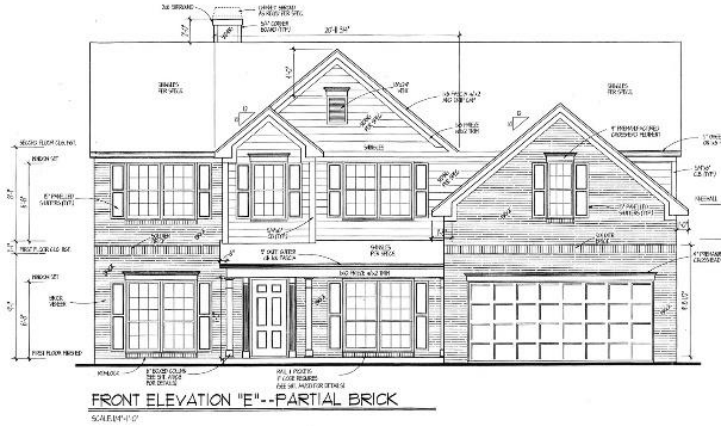
RESCHECK – ACME House Base Case Takeoffs

- 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



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



Sizing the System

"Heating and cooling equipment shall be sized in accordance with Section M1401.3"

"Heating and cooling equipment shall be sized in accordance with **ACCA Manual S** based on building loads calculated in accordance with **ACCA Manual J** or other approved heating and cooling calculation methodologies."
- 2015 IECC R403.7

- **Building orientation**
- **Glazing, walls, foundation & roof**
- **Design conditions**
- **Infiltration**
- **Internal loads**
- **Ventilation load**

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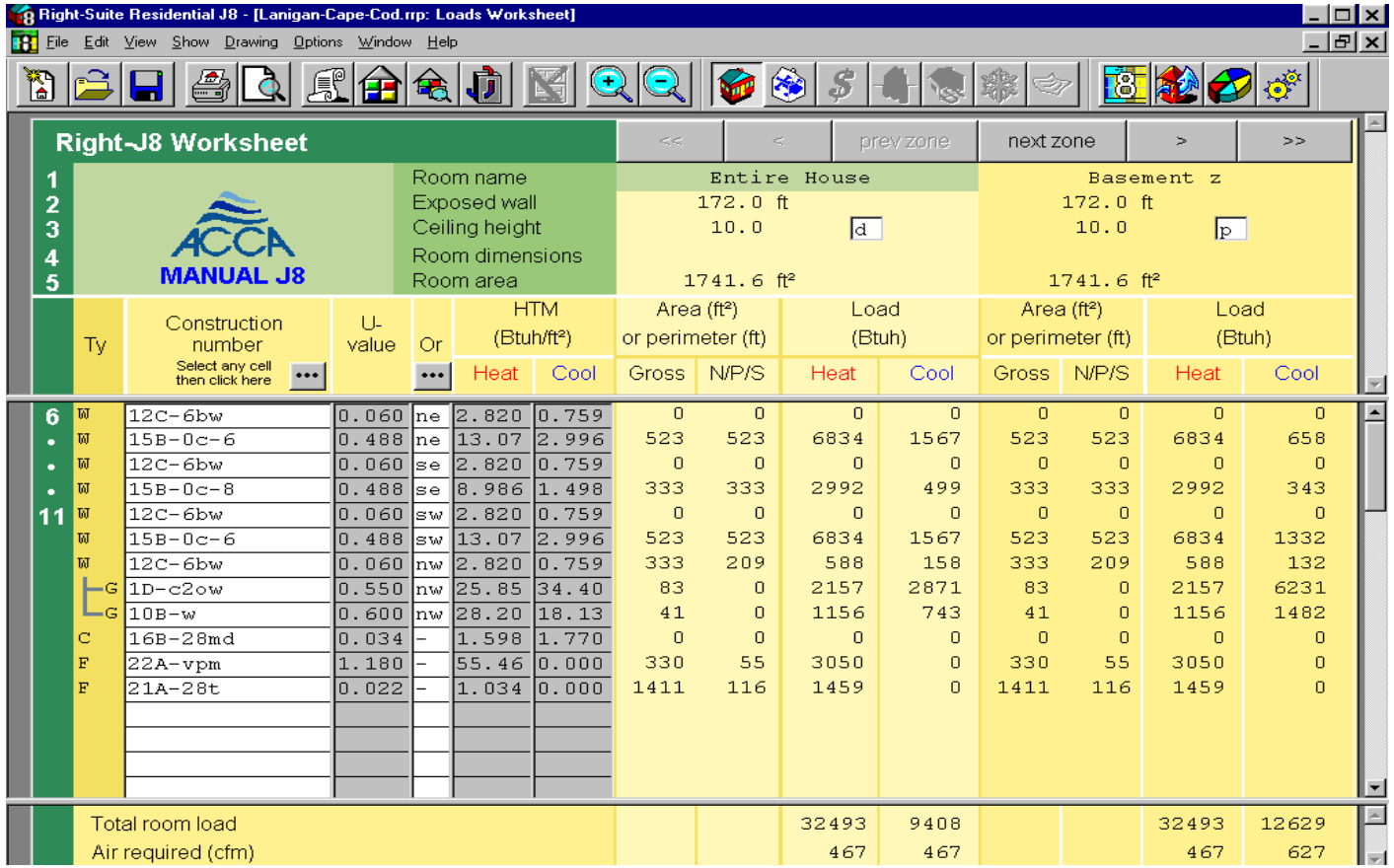
Manual J Software



Why is proper equipment sizing important?

- Equipment first-cost
- Longer/more efficient run times
- Limits equipment cycling
- Better dehumidification

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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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Key Takeaways

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!

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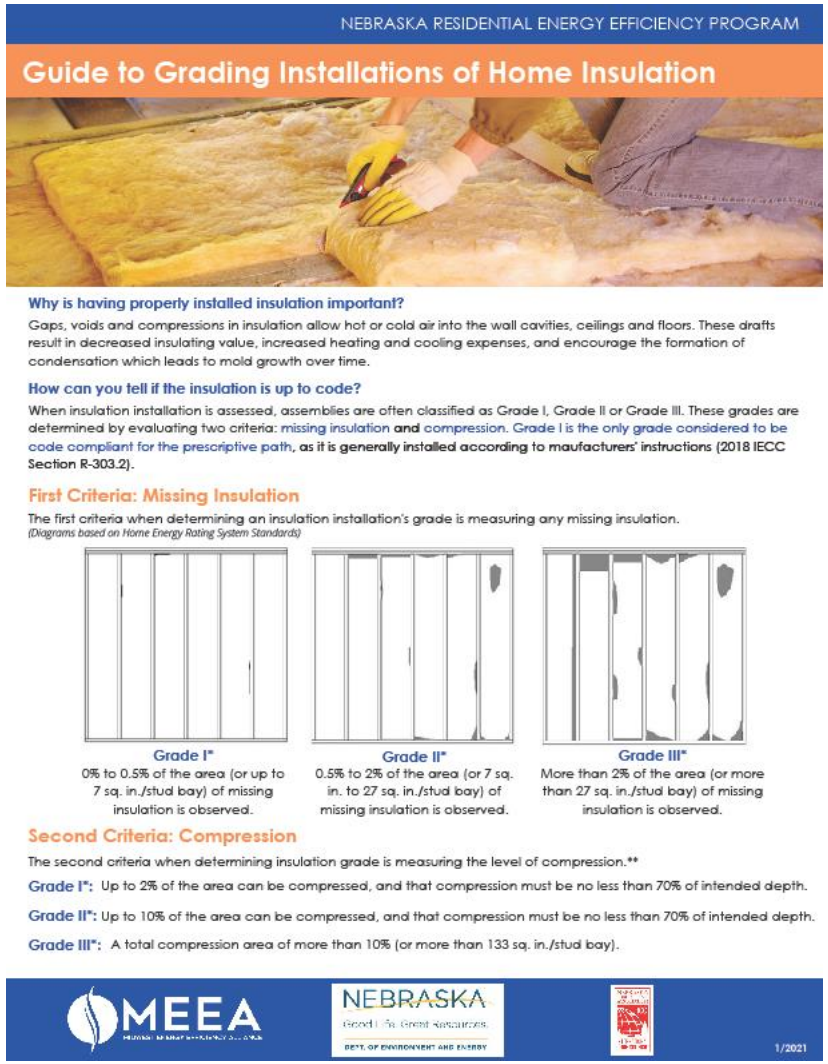
Helpful Handouts

- Series of Informational Topics
- Made to share with Trades/Subs, etc.
- Posted under "resources" on our main website:

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



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).

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Upcoming Events

- COMCheck Walk-through
  - Virtual on **Wednesday, July 19**
  - 10am-12pm
  - Free, CEUs provided

Nebraska Energy Codes Collaborative Meeting

- In-person in Lincoln, NE on **Tuesday, August 15**
- 9:30am-12pm, lunch provided

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Thank you!

Questions?

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

Corie Anderson, Midwest Energy Efficiency Alliance
canderson@mwalliance.org

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