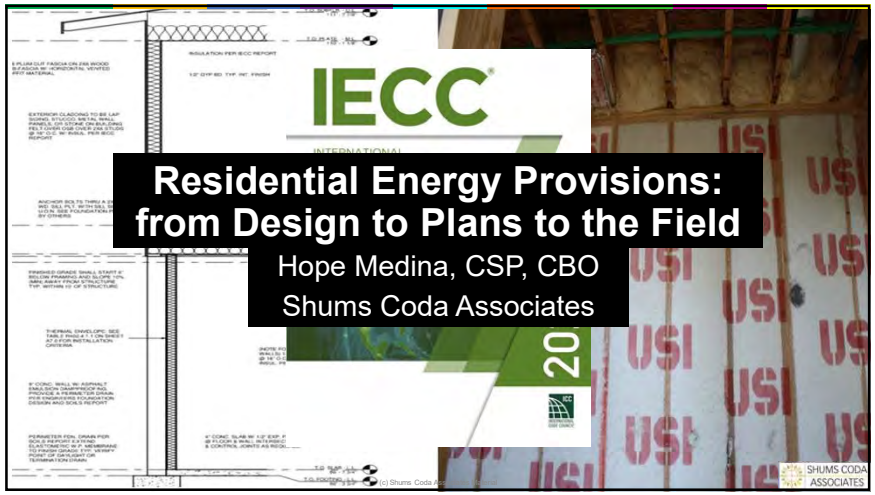
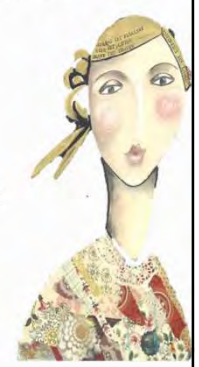


1

Hope Medina, CSP & CBO- Instructor

- ❖ Hold multiple International Code Council(ICC) certifications
- ❖Active participant in the code development process
- ❖ Active participant in the standard development process
- ❖Member of ICC Sustainability Membership Council
- ❖Present at many conference, summits, and other events
- ❖Speaker and guests on various podcasts and radio broadcast



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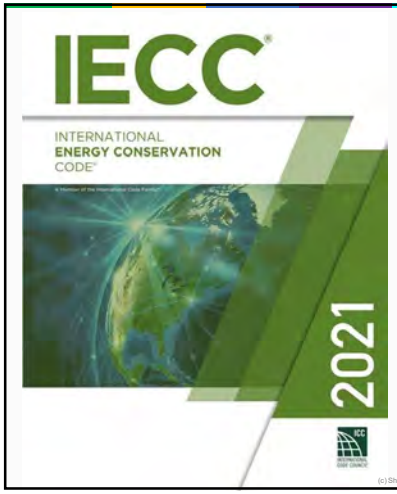

- Chapter 1 – Scope and Administration
- Chapter 2 – Definitions
- Chapter 3 – General Requirements
- Chapter 4 – Residential Efficiency
- Chapter 5 – Existing Buildings
- Chapter 6 – Reference Standards

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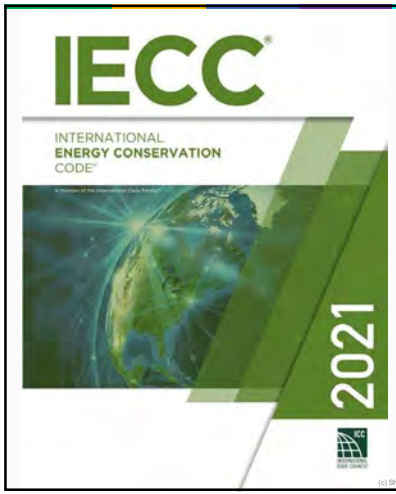

- Chapter 1 – Scope and Administration
- Chapter 2 – Definitions
- Chapter 3 – General Requirements
- Chapter 4 – Residential Efficiency
  - R401 – General
  - R402 – Building Thermal Envelope
  - R403 – Systems
  - R404 – Electrical Power and Lighting Systems
  - R405 – Total Building Performance
  - R406 – Energy Rating Index Compliance Alternative
  - R407 – Tropical Climate Region Compliance Path
  - R408 – Additional Efficiency Package Options
- Chapter 5 – Existing Buildings
- Chapter 6 – Reference Standards

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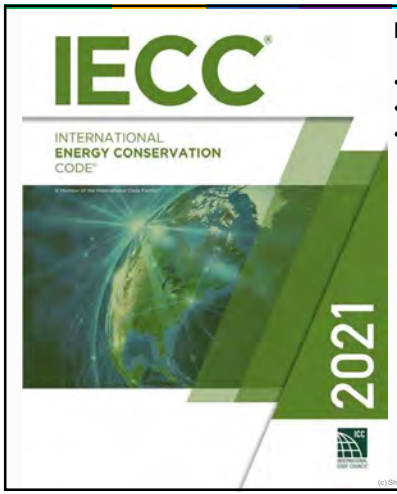

LET'S LOOK AT THE APPENDICE CHAPTERS

- **RA Board of Appeals**
- **RB Solar Ready Provisions**
- **RC Zero Energy Residential Building Provisions**

ONLY APPLICABLE IF ADOPTED

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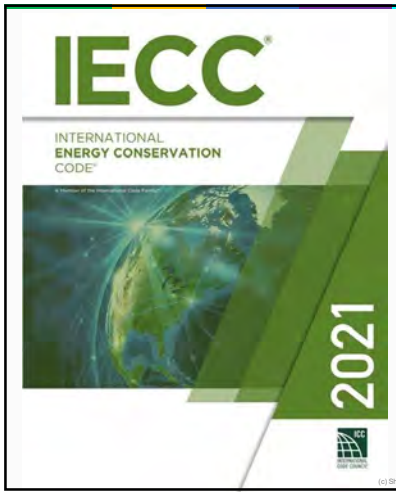
6



LET'S LOOK AT THE ADMIN CHAPTER

MORE SPECIFICALLY R103

R103.2 Information on construction documents.
Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the *building*, systems and equipment as herein governed. Details shall include the following as applicable:

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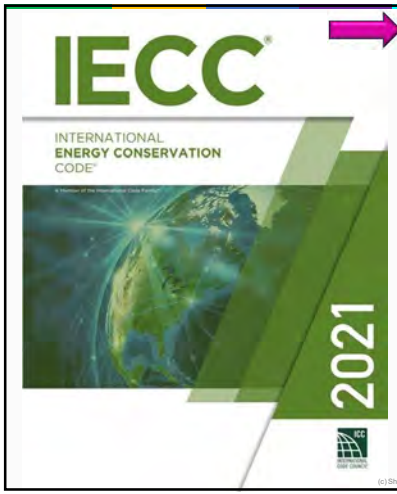

1. Energy Compliance Path
2. Insulation materials and their R-values.
3. Fenestration U-factors and solar heat gain coefficients (SHGC).
4. Area-weighted U-factor and solar heat gain coefficients (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.

R103.2.1 – Define the Thermal Envelope

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R401.2 Application.
Residential buildings shall comply with Section R401.2.5 and either Sections R401.2.1, R401.2.2, R401.2.3 or R401.2.4.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

9

R401.2.1 Prescriptive Compliance Option.
The Prescriptive Compliance Option requires compliance with Sections R401 through R404.

R401.2.2 Total Building Performance Option.
The Total Building Performance Option requires compliance with Section R405.

R401.2.3 Energy Rating Index Option.
The Energy Rating Index (ERI) Option requires compliance with Section R406.

R401.2.4 Tropical Climate Region Option.
The Tropical Climate Region Option requires compliance with Section R407.

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Energy Compliance Paths 2021

- PRESCRIPTIVE
  - Insulation and Fenestration Criteria
  - R-Value Alternative
  - Total UA Alternative
- TOTAL BUILDING PERFORMANCE
- ENERGY RATING INDEX (ERI)
  - No On-site Renewable Energy
  - On-site Renewable Energy

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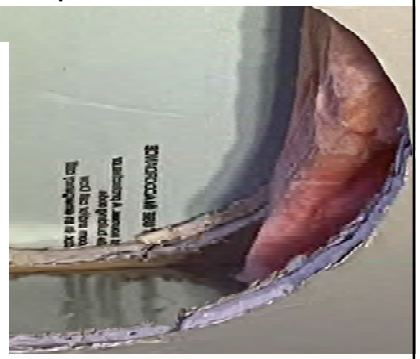
2021 Insulation and Fenestration Criteria Option The Concepts

- This option uses the entire assembly to demonstrate compliance
- 2021 Table R402.1.2 provides the assembly components that must meet the values listed
- Table R402.1.4 is still required for slab edge insulation and the fenestration SHGC requirements
- This approach is not often used



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2021 Insulation and Fenestration Criteria Option
The Concepts

Assembly approach- adding each component to the equation

Remember the lower the U-factor the better

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TABLE R402.1.2
MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
1	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.25	0.026	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	0.25	0.026	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30	0.55	0.40	0.024	0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.40	0.024	0.045	0.082	0.033	0.050	0.055
6	0.30	0.55	NR	0.024	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	NR	0.024	0.045	0.057	0.028	0.050	0.055

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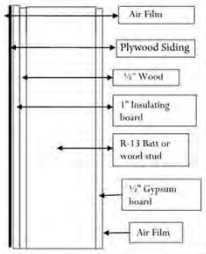
Example



	R-value at Insulation	R-value at Stud
Air Film	00.17	00.17
Plywood Siding	00.59	00.59
½" Wood	00.81	00.81
1" Insulating board	03.57	03.57
R-13 Batt or wood stud	13.00	04.55
½" Gypsum board	00.45	00.45
Air Film	00.68	00.68
Totals	19.27	10.82

Assume a framing factor of 20% (The area of the wall that is wood)

Average R= (0.80 x 19.27) + (0.20 x 10.82) = 15.41 + 2.16 = 17.57

U-value = 1/17.57 = 0.057

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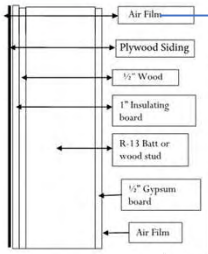
Example



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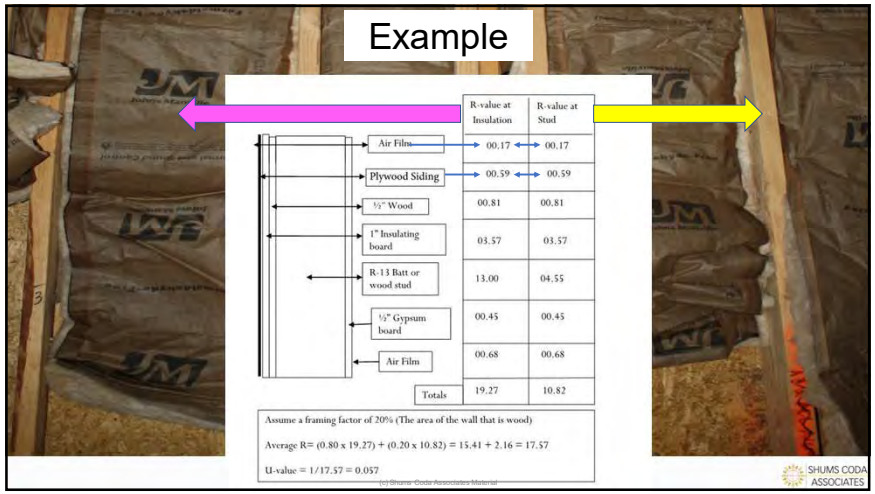
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Air Film 00.17 00.17
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(c) Shums Coda Associates Material
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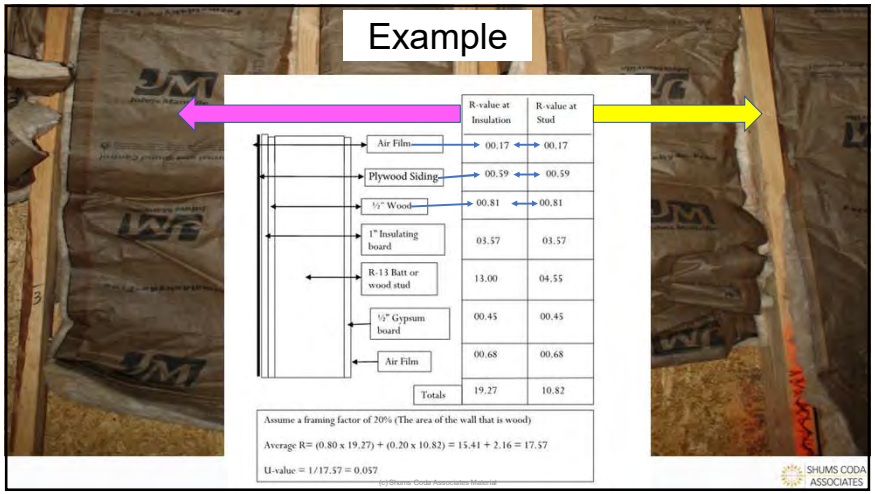
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(c) Shums Coda Associates Material
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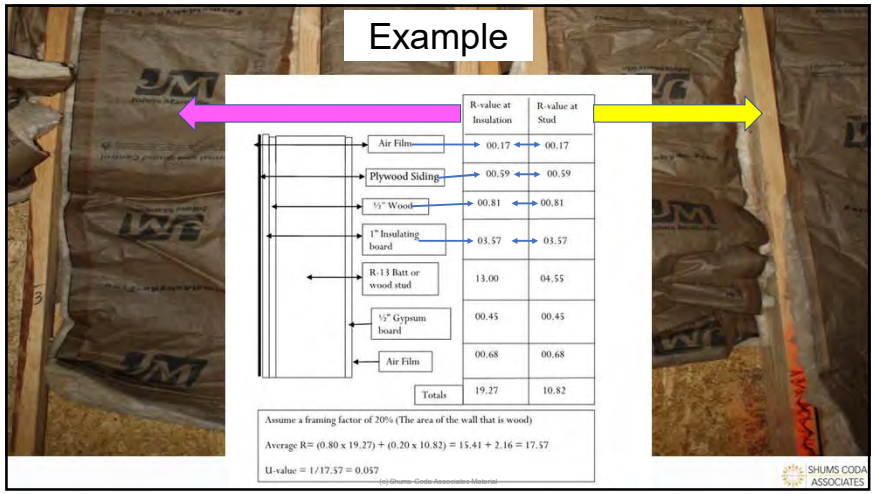
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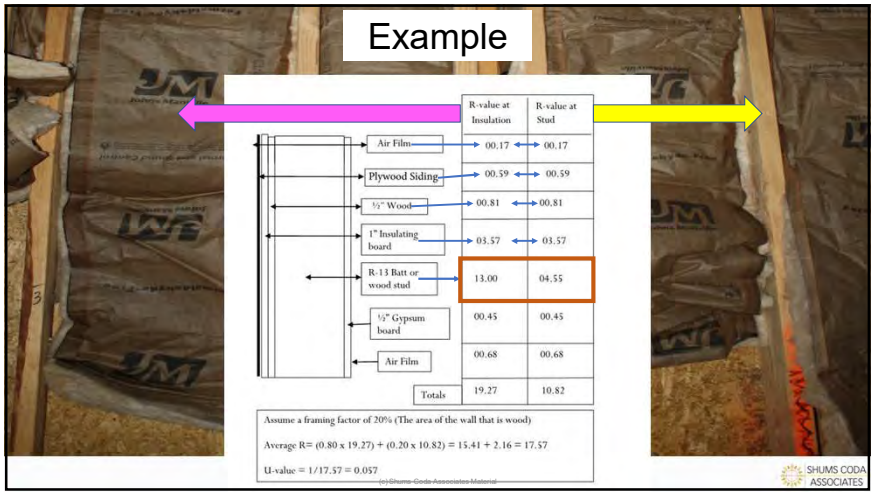
19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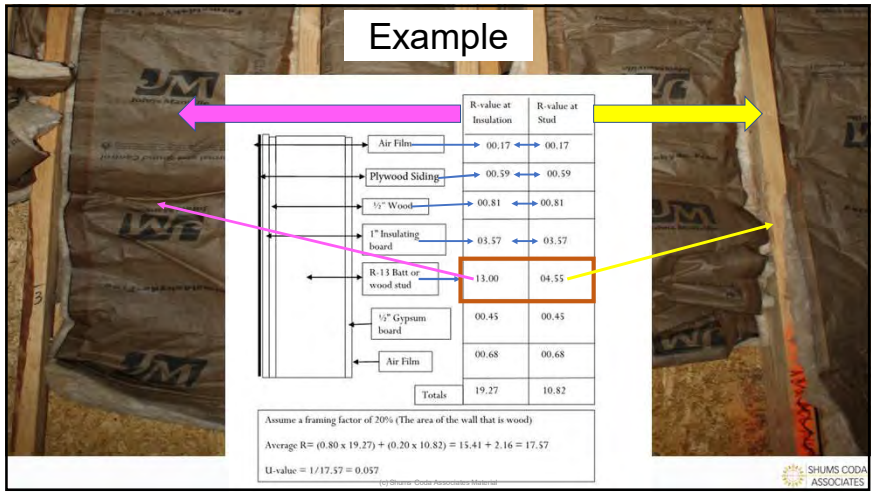
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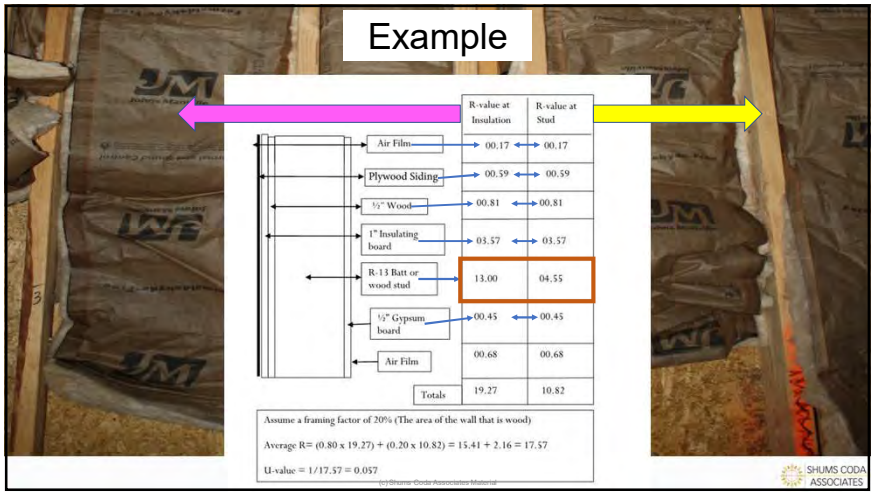
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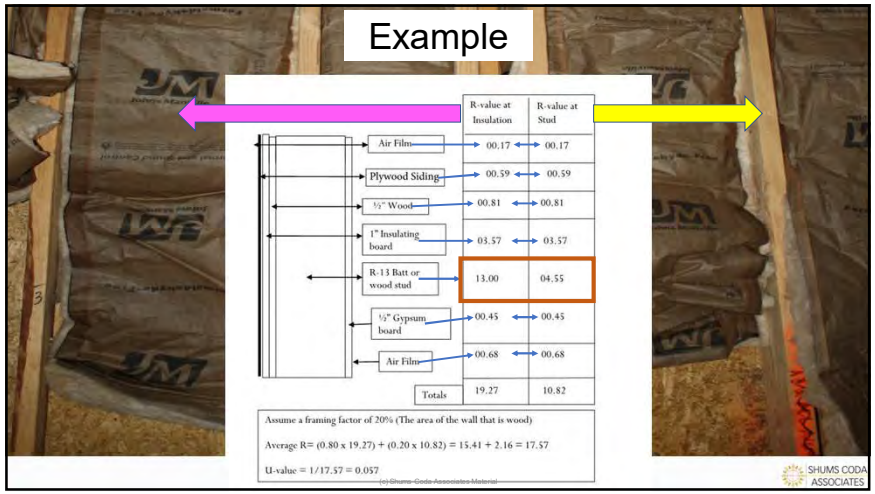
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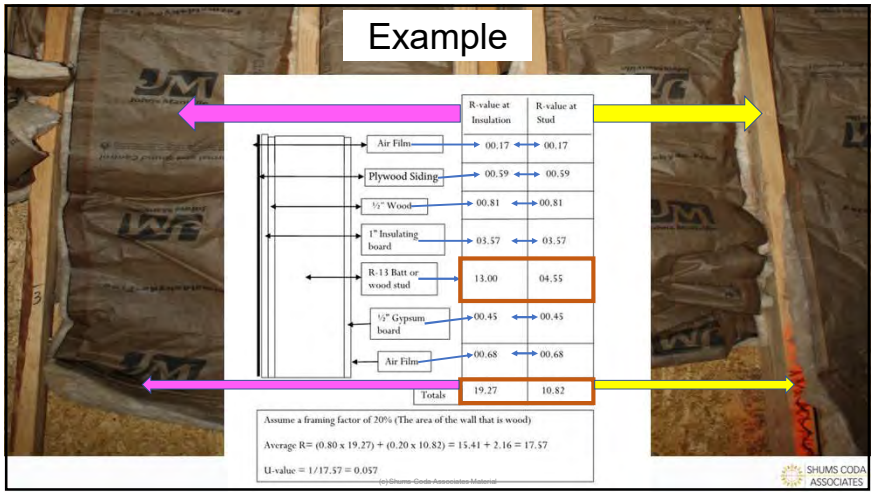
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U-value = 1/17.57 = 0.057
(c) Shums Coda Associates Material
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Example

Now we have to determine how much wood is in the wall. (Framing Factor)

	R-value at Insulation	R-value at Stud
Air Film	00.17	00.17
Plywood Siding	00.59	00.59
½" Wood	00.81	00.81
1" Insulating board	03.57	03.57
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Assume a framing factor of 20% (The area of the wall that is wood)

Average R= (0.80 x 19.27) + (0.20 x 10.82) = 15.41 + 2.16 = 17.57

U-value = 1/17.57 = 0.057

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Example

The Framing Factor is 20%
Which means that 20% of the wall is made up of where the wood is located and 80% of the wall is the cavity insulation

	R-value at Insulation	R-value at Stud
Air Film	00.17	00.17
R-13 Batt or wood stud	13.00	04.55
½" Gypsum board	00.45	00.45
Air Film	00.68	00.68
Totals	19.27	10.82

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U-value = 1/17.57 = 0.057

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Example

The Framing Factor is 20%
Which means that 20% of the wall is made up of where the wood is located and 80% of the wall is the cavity insulation
(.80 x 19.27) + (.20 x 10.82) =

	R-value at Insulation	R-value at Stud
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Air Film	00.68	00.68
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Average R= (0.80 x 19.27) + (0.20 x 10.82) = 15.41 + 2.16 = 17.57

U-value = 1/17.57 = 0.057

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Example

The Framing Factor is 20%
Which means that 20% of the wall is made up of where the wood is located and 80% of the wall is the cavity insulation
(.80 x 19.27) + (.20 x 10.82) =
15.41 + 2.16 = 17.57(R-Value)

	R-value at Insulation	R-value at Stud
Air Film	00.17	00.17
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Air Film	00.68	00.68
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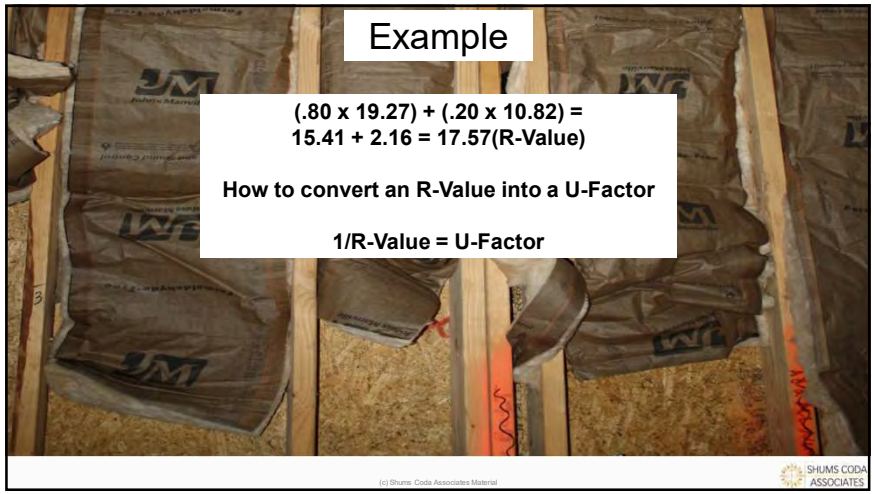

Example

(.80 x 19.27) + (.20 x 10.82) =
15.41 + 2.16 = 17.57(R-Value)

How to convert an R-Value into a U-Factor

1/R-Value = U-Factor

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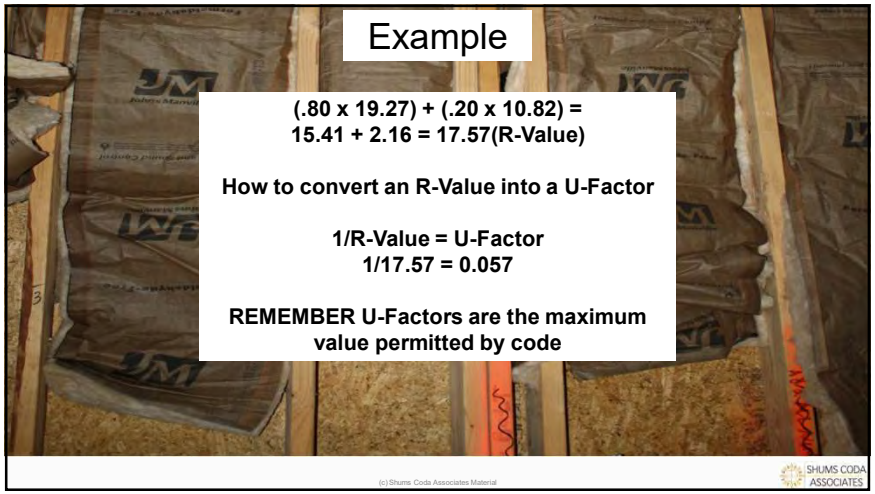

Example

(.80 x 19.27) + (.20 x 10.82) =
15.41 + 2.16 = 17.57(R-Value)

How to convert an R-Value into a U-Factor

1/R-Value = U-Factor
1/17.57 = 0.057

REMEMBER U-Factors are the maximum value permitted by code

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U-FACTOR ALTERNATIVE

- No trade- off
- By the book
- Everything on the plans
- Documentation of assembly values

- Comply with R401- R404
- Thermal Envelope based off of Table R402.1.2 except for slab edge and SHGC requirements come from Table R402.1.3(2021) – R-Value Table

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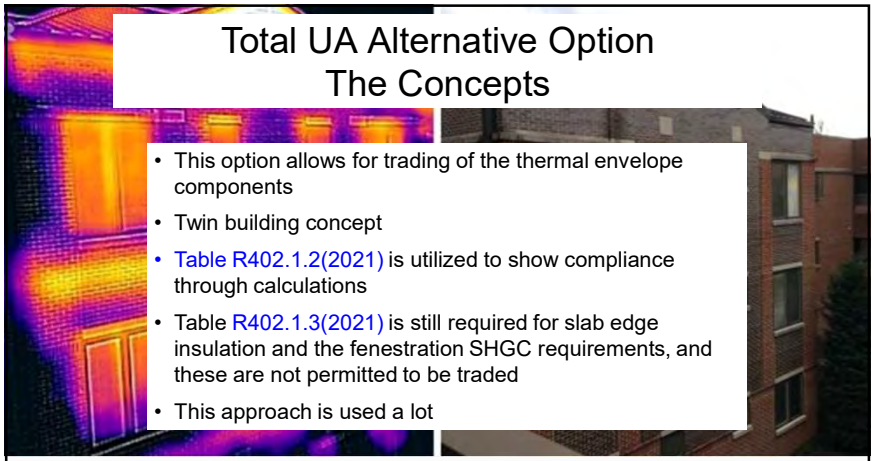

Total UA Alternative Option
The Concepts

- This option allows for trading of the thermal envelope components
- Twin building concept
- Table R402.1.2(2021) is utilized to show compliance through calculations
- Table R402.1.3(2021) is still required for slab edge insulation and the fenestration SHGC requirements, and these are not permitted to be traded
- This approach is used a lot

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Total UA Alternative Option (3)
The Concepts

TWIN BUILDING CONCEPT

- Prescriptive U-Factor values of the thermal envelope assemblies found in Table R402.1.2(2021)

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[c] WALL U-FACTOR	CRAWL SPACE WALL U-FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.035	0.084	0.165	0.064	0.360	0.477
3	0.32	0.55	0.030	0.060	0.098	0.047	0.091[f]	0.136
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7 and 8	0.30	0.55	0.026	0.045	0.057	0.028	0.050	0.050

(c) Shums Coda Associates Material

SHUMS CODA ASSOCIATES

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Total UA Alternative Option (3)
The Concepts

TWIN BUILDING CONCEPT

- Prescriptive U-Factor values of the thermal envelope assemblies found in Table R402.1.2
- Use the proposed values of the thermal envelope assemblies

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
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.035	0.084	0.165	0.064	0.360	0.477
3	0.32	0.55	0.030	0.060	0.098	0.047	0.091[f]	0.136
4 except Marine	0.32	0.55	0.030	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	0.050
6	0.30	0.55	0.026	0.045	0.060	0.033	0.050	0.050
7 and 8	0.30	0.55	0.026	0.045	0.057	0.028	0.050	0.050

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Total UA Alternative Option (3)
The Concepts

TWIN BUILDING CONCEPT

- Prescriptive U-Factor values of the thermal envelope assemblies found in Table R402.1.2
- Use the proposed values of the thermal envelope assemblies

REFERENCED DESIGN

PROPOSED DESIGN

If the of the Proposed Design U-Factor is equal to or less than the sum of the Referenced Design, it is considered to be compliant.

Reference Design U $\geq$ U Proposed Design

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Total UA Alternative Option (3)
The Concepts

TWIN BUILDING CONCEPT

- Prescriptive U-Factor values of the thermal envelope assemblies found in Table R402.1.2
- Use the proposed values of the thermal envelope assemblies

REFERENCED DESIGN

PROPOSED DESIGN

Reference Design U $\geq$ U Proposed Design

The fenestration SHGC must also be met

Slab edge insulation must also be met

These two items can not be traded

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Generated by RE*Scheck-Web* Software
Compliance Certificate

Project Example

Energy Code: **2015 IECC**
Location: **Amarillo, Texas**
Construction Type: **Single-family**
Project Type: **New Construction**
Conditioned Floor Area: **2,000 ft2**
Glazing Area **5%**
Climate Zone: **4 (4258 HDD)**
Permit Date:
Permit Number:

Construction Site: 1234 House, Arvada, co 80002 | Owner/Agent: | Designer/Contractor:

Compliance: Invalid SHGC(s)

Slab-on-grade tradeoffs are no longer considered in the UA or performance compliance path in REScheck. Each slab-on-grade assembly in the specified climate zone must meet the minimum energy code insulation R value and depth requirements.

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Prop. U-Factor	Req. U-Factor	Prop. UA	Req. UA
Ceiling: Flat Ceiling or Scissor Truss	1,000	60.0	0.0	0.024	0.026	24	26
Wall: Wood Frame, 16" o.c.	300	20.0	7.5	0.039	0.060	12	18
Floor: Slab-On-Grade (Unheated) Insulation depth: 4.0' Insulation position: Horizontal Insulation	10		10.0	0.684	0.767	0	0
Window: Wood Frame SHGC: 0.00	15			0.290	0.350	4	5

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Generated by RE*Scheck-Web* Software
Compliance Certificate

Project Example

Energy Code:
Location:
Construction Type:
Project Type:
Conditioned Floor Area:
Glazing Area
Climate Zone:
Permit Date:
Permit Number:

Construction Site: 1234 House, Arvada, co 80002 | Owner/Agent: | Designer/Contractor:

Compliance: Passes using UA trade-off

Compliance: **18.4% Better Than Code** Maximum UA: **49** Your UA: **40** Maximum SHGC: **0.40** Your SHGC: **0.40**

The % Better or Worse Than Code value reflects how close to compliance the house is based on code trade-off rules. It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

Slab-on-grade tradeoffs are no longer considered in the UA or performance compliance path in REScheck. Each slab-on-grade assembly in the specified climate zone must meet the minimum energy code insulation R value and depth requirements.

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Prop. U-Factor	Req. U-Factor	Prop. UA	Req. UA
Ceiling: Flat Ceiling or Scissor Truss	1,000	60.0	0.0	0.024	0.026	24	26
Wall: Wood Frame, 16" o.c.	300	20.0	7.5	0.039	0.060	12	18
Floor: Slab-On-Grade (Unheated) Insulation depth: 4.0' Insulation position: Horizontal Insulation	10		10.0	0.684	0.767	0	0
Window: Wood Frame SHGC: 0.40	15			0.290	0.350	4	5

Compliance Statement: The proposed building design described here is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the 2015 IECC requirements in REScheck Version : REScheck-Web and to comply with the mandatory requirements listed in the REScheck Inspection Checklist.

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Generated by RE*Scheck-Web* Software
Compliance Certificate

Project Two Story R 2 No Floor

Energy Code: **2018 IECC**
Location: **Parker, Colorado**

TOTAL UA ALTERNATIVE

- By the book- except for……
- Trade off allowed for the thermal envelope
- Comply with R401- R404
- Thermal Envelope requirements based on R402.1.5
- Everything on the plans and should match the REScheck Values and Manual J
- REScheck Compliance Certificate or other approved software generated report

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CONCEPTS

TOTAL BUILDING PERFORMANCE- Residential

- Method for whole building/house performance trade offs
- Twin building concept – Reference design and Proposed design
- Tables determine what can be traded in the design
- Annual Energy Cost determines compliance

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CONCEPTS

REFERENCE DESIGN HOUSE

PROPOSED HOUSE

- Geometric twin
- Values from Values from Table R405.4.2(1)
- Geometric twin
- Envelope U-factors based on builder's proposed design

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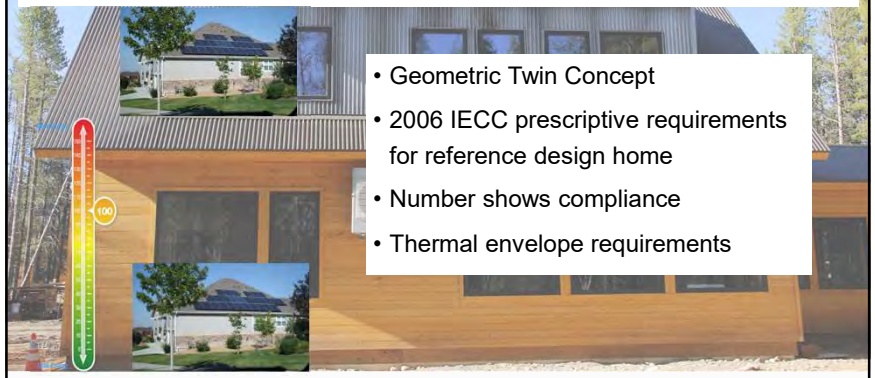
ENERGY RATING INDEX COMPLIANCE ALTERNATIVE – ERI R406 – OVERALL CONCEPT



- Geometric Twin Concept
- 2006 IECC prescriptive requirements for reference design home
- Number shows compliance
- Thermal envelope requirements

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ENERGY RATING INDEX CONCEPT -2021

- Comply with Table R406.2
- Thermal envelope equation
  - Onsite renewable included
  - Onsite renewable not included
- Comply with Table R406.5
- Two Complaince reports
  - Based on plans report at submittal
  - Actual report for issuance of CO
- Verified by approved third party
- Software tool requirements
- Renewable energy certificate (REC)

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1. Energy Compliance Path ✓
2. Insulation materials and their R-values.
3. Fenestration U-factors and solar heat gain coefficients (SHGC).
4. Area-weighted U-factor and solar heat gain coefficients (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.

R103.2.1 – Define the Thermal Envelope

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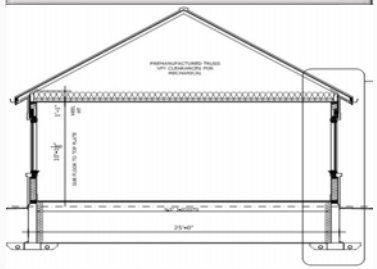
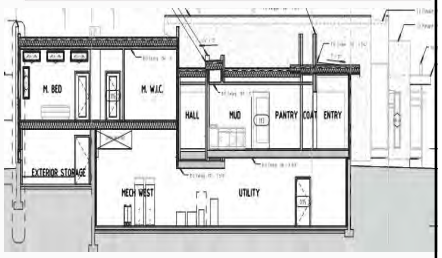
DEFINE THE THERMAL ENVELOPE

SIMPLE THERMAL ENVELOPE



MORE COMPLEX THERMAL ENVELOPE



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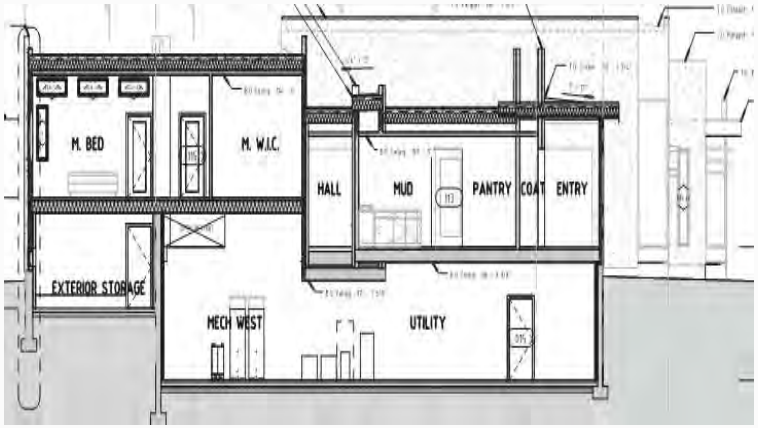

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ARE YOU IN OR OUT?

CRAWLSPACE

GARAGE

ATTIC

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ARE YOU IN OR OUT?

FUEL BURNING APPLIANCE ROOMS

R402.4.4

- Locate completely outside of thermal envelope or
- Insulate walls, ceiling, and floors to values in Table R402.1.2(2018) or R402.1.3(2021)
- Utilize sealing of the room
- Doors gasketed no louvers
- Duct work and water lines in room shall be insulated

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THERMAL vs. SOUND

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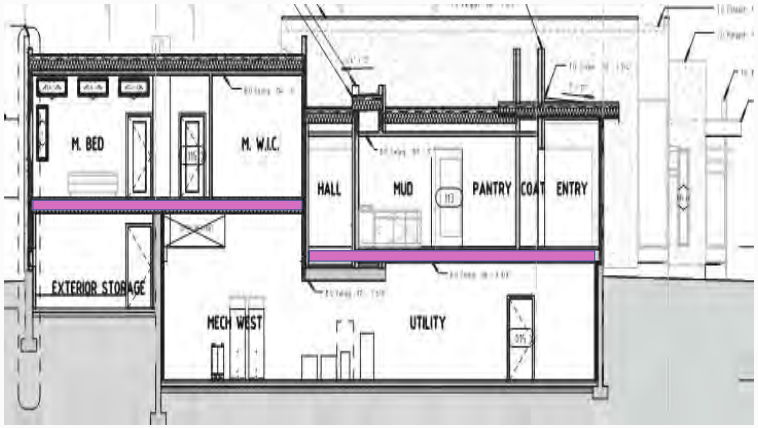

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49

1. Energy Compliance Path
2. Insulation materials and their R-values.
3. Fenestration U-factors and solar heat gain coefficients (SHGC).
4. Area-weighted U-factor and solar heat gain coefficients (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.

R103.2.1 – Define the Thermal Envelope ✓

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High Average of R-Values for Various Insulation Types

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Estimated R-values for Insulation Compressed into Framing Cavities

Nominal Lumber Size	Cavity Depth											
I Joist	14"	49										
I Joist	11 7/8"	44	38									
2x12	11 1/4"	42	37	30								
I Joist	9 1/2"		33	29								
2x10	9 1/4"		32	29	30	25						
2x8	7 1/4"			25	25	24						
2x6 *(metal)*	6"					21			19			
2x6	5 1/2"						21	20	18			
2x4 *(metal)*	4"						16	16	14			
2x4 *(metal)*	3 5/8"						15	15				
2x4	3 1/2"						15	14		15	13	11
2x3	2 1/2"									11	10	8.9
2x2 *(metal)*	1 5/8"											6.5
2x2	1 1/2"											6.1
Label R-Value		R-49	R-38	R-30		R-25	R-21	R-20	R-19	R-15	R-13	R-11
Label Thickness		14"	12"	10"	9 1/2"	8"	5 1/2"		6 1/4"	3 1/2"		

Insulation Institute
KNOWLEDGE. LEADERSHIP. CONFIDENCE.

Disclaimer: The data contained in this chart were obtained from the majority of NAIMA fiber glass member companies, and the data represent an aggregation of values and should not be associated with one specific company. These values are not constant and are subject to change. The compression data on R-value reductions included in this document is representative of fiber glass building insulation generally and specific company products may vary. NAIMA assumes no responsibility for your use of this information.

NAIMA
NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION

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INSTALLATION 303.2

Materials, systems and equipment shall be installed in accordance with the manufacturer's instructions and the IBC or IRC.

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Grading System

Meet ASTM-specified installation requirements in the applicable standards C1015, C1320 and ASTM C1848 – RESNET/ICC

Grade 1

It completely fills the cavity- side to side, and top to bottom. In the case of air-permeable insulation is encapsulated on six sides. It's cut around electrical junction boxes, split around wires and pipes, and generally not compressed.

No moderate or substantial defects

Grade 2

There's some imperfections in the installation but overall, it's still not too bad.

Grade 3

It has "substantial gaps and voids."

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INSULATION MARKING 303.1.1

- An R-value identification mark shall be applied by the manufacturer to each piece of building thermal envelope insulation 12 inches (305 mm) or greater in width. R303.1.1
- Insulating materials shall be installed such that the manufacturer's R-value mark is readily observable upon inspection. R303.1.2

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INSULATION CERTIFICATE R303.1.1

- TYPE, MANUFACTURER, AND R-VALUE
- BLOWN INSULATION
  - INITIAL THICKNESS
  - SETTLED THICKNESS
  - SETTLED R-VALUE
  - INSTALLED DENSITY
  - COVERAGE AREA WITH THE NUMBER OF BAGS INSTALLED
- SPRAY FOAM
  - INSTALLED THICKNESS WITH R-VALUE
- INSULATED SIDING
  - R-VALUE ON PRODUCT PACKAGING
- INSTALLER MUST SIGN
- POST IN A CONSPICUOUS LOCATION

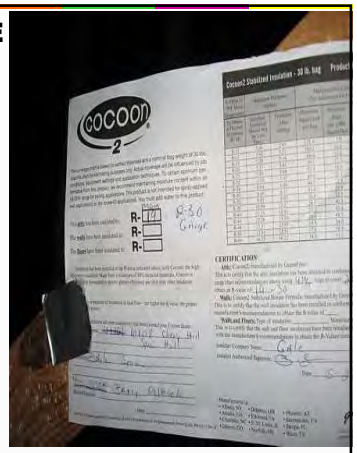

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TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c, g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c, g] WALL *R*-VALUE
0	NR	0.75	0.25	30	13 or 0& 10ci	3/4	13	0	0	0
1	NR	0.75	0.25	30	13 or 0& 10ci	3/4	13	0	0	0
2	0.40	0.65	0.25	49	13 or 0& 10ci	4/6	13	0	0	0
3	.30	0.55	0.25	49	20 or 13& 5ci[h] or 0& 15ci[h]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	.30	0.55	0.40	60	30 or 20&5ci[h] or 13& 10ci[h] or 0&20ci[h]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30[i]	0.55	0.40	60	30 or 20&5ci[h] or 13& 10ci[h] or 0&20ci[h]	13/17	30	15ci or 19 or 13& 5ci	10ci, 4 ft	15ci or 19 or 13& 5ci
6	0.30[i]	0.55	NR	60	30 or 20&5ci[h] or 13& 10ci[h] or 0&20ci[h]	15/20	30	15ci or 19 or 13& 5ci	10ci, 4 ft	15ci or 19 or 13& 5ci
7 and 8	0.30[i]	0.55	NR	60	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	19/21	38	15ci or 19 or 13& 5ci	10ci, 4 ft	15ci or 19 or 13& 5ci

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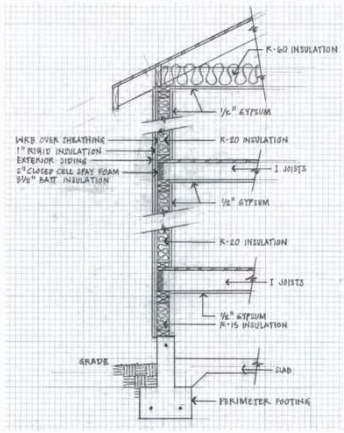
TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	CEILING *R*-VALUE
0	30
1	30
2	49
3	49
4 except Marine	60
5 and Marine 4	60
6	60
7 and 8	60



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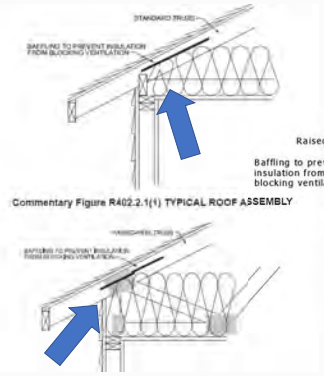
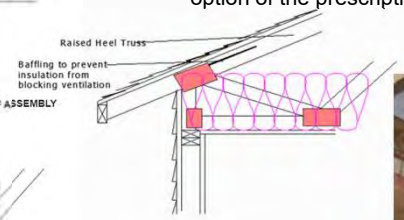
R402.2.1 CEILINGS WITH ATTICS.

- If Table R402.1.3 requires an R-60 you can use an R-49 if the R-49 Extends over the top plate –Example Above deck roof insulation design
- Only permitted for the R-value Alternative option of the prescriptive path





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R402.2.2 CEILINGS WITHOUT ATTICS.

- Space is restricted for full insulation
- R-30 permitted
- If extends over top plate to outer edge
- Not compressed
- Only allows for 500 SQFT or 20% of ceiling area
- Only permitted for the R-value Alternative option of the prescriptive path

Commentary Figure R402.2.2 CEILING WITHOUT ATTIC SPACE

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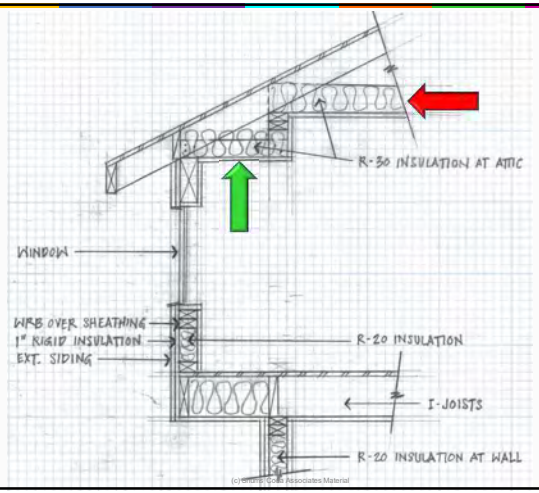

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OTHER ROOFS TYPES TO BE AWARE OF

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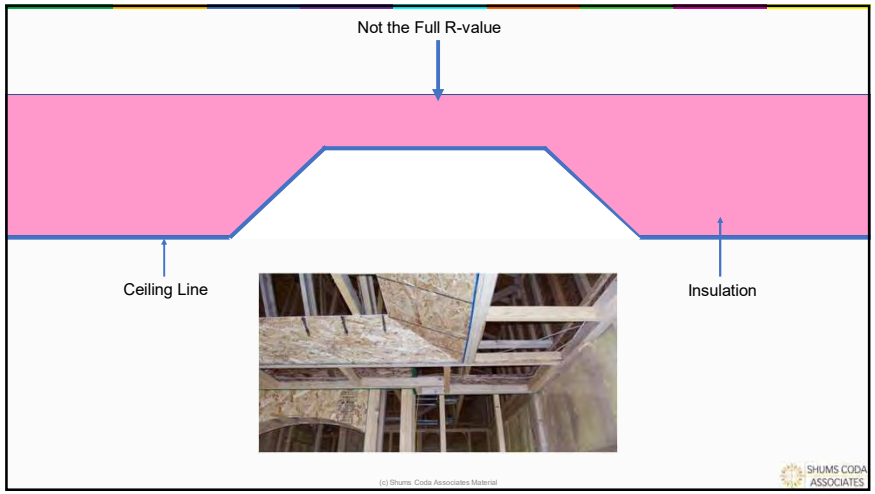

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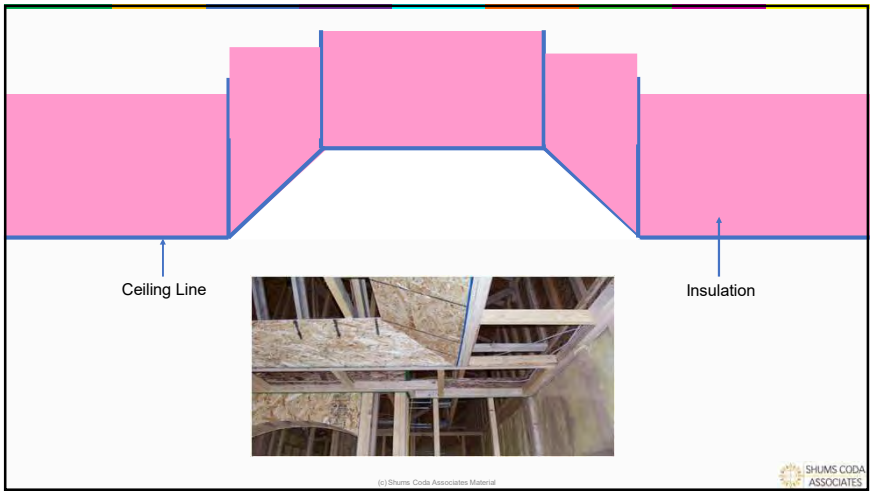

66

R402.2.3 EAVE BAFFLE.

For air-permeable insulation in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain a net free area opening equal to or greater than the size of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material. The baffle shall be installed to the outer edge of the exterior wall top plate so as to provide maximum space for attic insulation coverage over the top plate. Where soffit venting is not continuous, baffles shall be installed continuously to prevent ventilation air in the eave soffit from bypassing the baffle.

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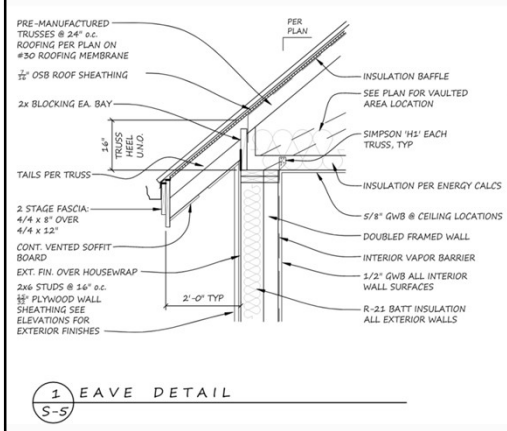
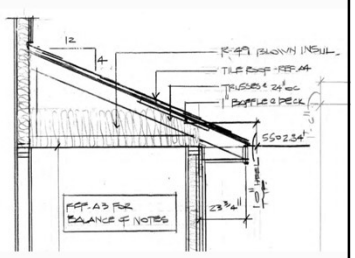
R402.2.3 EAVE BAFFLE





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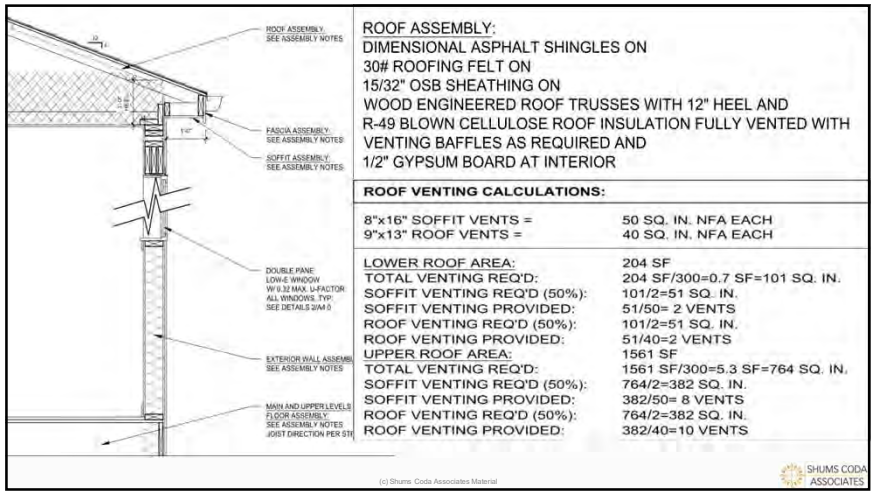
ROOF ASSEMBLY: SEE ASSEMBLY NOTES
FASCIA ASSEMBLY: SEE ASSEMBLY NOTES
SOFFIT ASSEMBLY: SEE ASSEMBLY NOTES
DOUBLE PANE LOW-E WINDOW W/ 0.32 MAX. U-FACTOR ALL WINDOWS. TYP. SEE DETAILS 2/A4.0
EXTERIOR WALL ASSEMBLY SEE ASSEMBLY NOTES
MAIN AND UPPER LEVELS FLOOR ASSEMBLY: SEE ASSEMBLY NOTES JOIST DIRECTION PER STR
ROOF ASSEMBLY:
DIMENSIONAL ASPHALT SHINGLES ON
30# ROOFING FELT ON
15/32" OSB SHEATHING ON
WOOD ENGINEERED ROOF TRUSSES WITH 12" HEEL AND
R-49 BLOWN CELLULOSE ROOF INSULATION FULLY VENTED WITH
VENTING BAFFLES AS REQUIRED AND
1/2" GYPSUM BOARD AT INTERIOR
ROOF VENTING CALCULATIONS:
8"x16" SOFFIT VENTS = 50 SQ. IN. NFA EACH
9"x13" ROOF VENTS = 40 SQ. IN. NFA EACH
LOWER ROOF AREA: 204 SF
TOTAL VENTING REQ'D: 204 SF/300=0.7 SF=101 SQ. IN.
SOFFIT VENTING REQ'D (50%): 101/2=51 SQ. IN.
SOFFIT VENTING PROVIDED: 51/50= 2 VENTS
ROOF VENTING REQ'D (50%): 101/2=51 SQ. IN.
ROOF VENTING PROVIDED: 51/40=2 VENTS
UPPER ROOF AREA: 1561 SF
TOTAL VENTING REQ'D: 1561 SF/300=5.3 SF=764 SQ. IN.
SOFFIT VENTING REQ'D (50%): 764/2=382 SQ. IN.
SOFFIT VENTING PROVIDED: 382/50= 8 VENTS
ROOF VENTING REQ'D (50%): 764/2=382 SQ. IN.
ROOF VENTING PROVIDED: 382/40=10 VENTS
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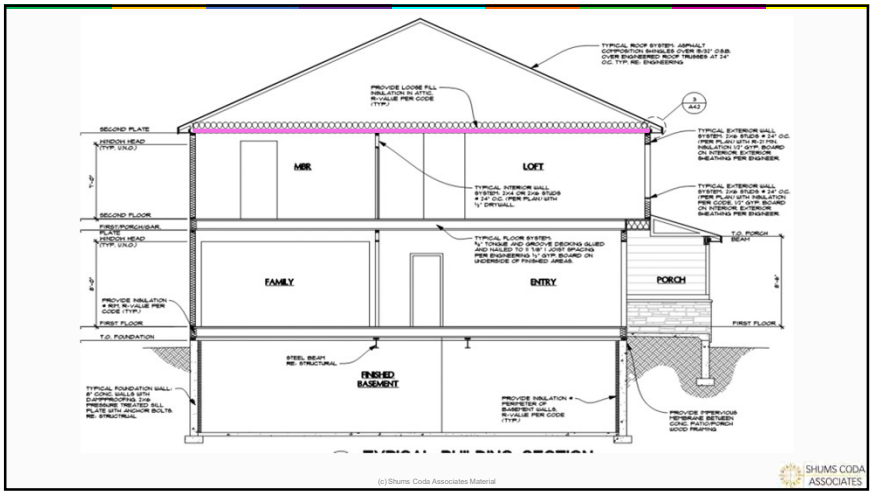
MBR
LOFT
FAMILY
ENTRY
PORCH
FINISHED BASEMENT
SECOND PLATE
SECOND FLOOR
FIRST FLOOR
T.O. FOUNDATION
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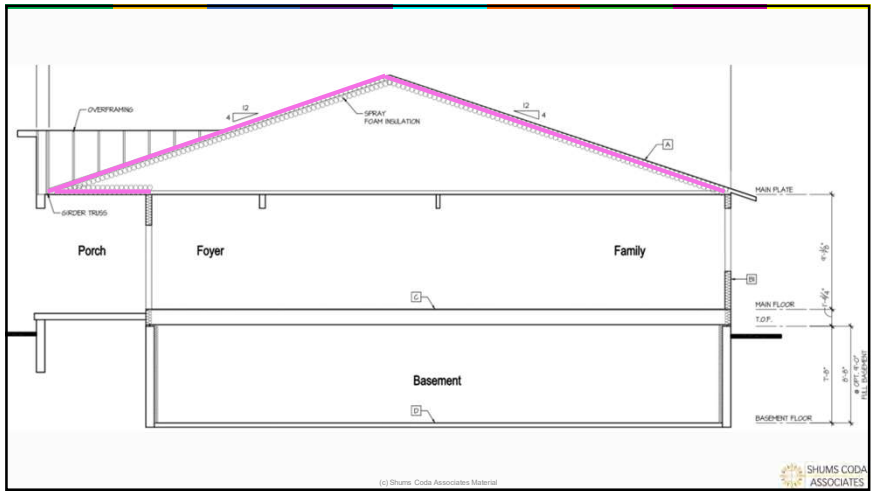

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ATTIC INSULATION MARKING R303.1.1.1

- THICKNESS OF INSULATION ON MARKERS EVERY 300 SQ FT.
- MARKERS HAVE 1 INCH MINIMUM IN HEIGHT
- SHALL FACE ATTIC ACCESS OPENING
- FOAM THICKNESS LISTED ON CERTIFICATE

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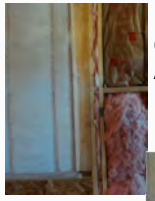
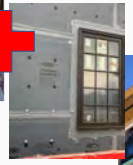
TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

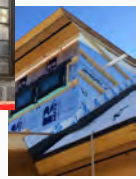
CLIMATE ZONE	WOOD FRAME WALL *R*-VALUE[g]
0	13 or 0& 10ci
1	13 or 0& 10ci
2	13 or 0& 10ci
3	20 or 13& 5ci[h] or 0& 15ci[h]
4 except Marine	30 or 20&5ci[h] or 13& 10ci[h] or 0&20ci[h]
5 and Marine 4	30 or 20&5ci[h] or 13& 10ci[h] or 0&20ci[h]
6	30 or 20&5ci[h] or 13& 10ci[h] or 0&20ci[h]
7 and 8	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]



CAVITY ONLY
All climate zones

CAVITY + CONTINUOUS





CONTINUOUS ONLY
All climate zones

(c) Shums Coda Associates Material

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Wall Insulation

- What is the insulation being used for
- Material will matter
- Size of stud
- How was it installed

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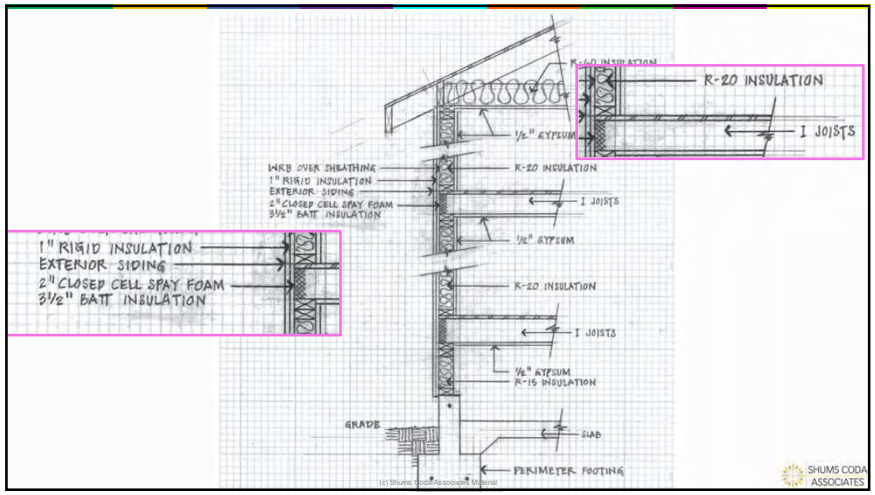

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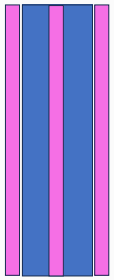
TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	MASS WALL *R*-VALUE [h]
0	3/4
1	3/4
2	4/6
3	8/13
4 except Marine	8/13
5 and Marine 4	13/17
6	15/20
7 and 8	19/21

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

INTERIOR

Use the 2nd number in column



EXTERIOR

Use the 1st number in column

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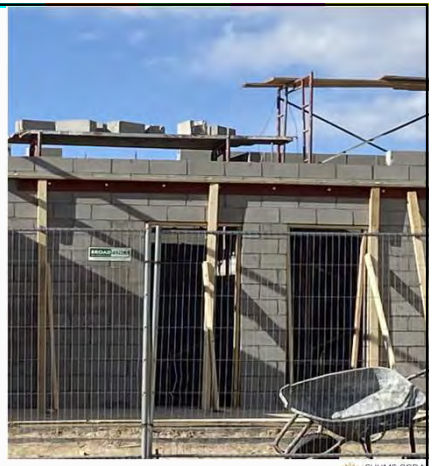
R402.2.5 Mass walls.
Mass walls where used as a component of the building thermal envelope shall be one of the following:

1.Above-ground walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer, adobe, compressed earth block, rammed earth, solid timber, mass timber or solid logs.

2.Any wall having a heat capacity greater than or equal to 6 Btu/ft2 × °F (123 kJ/m2 × K).



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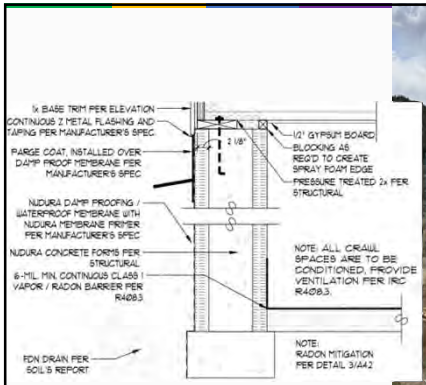

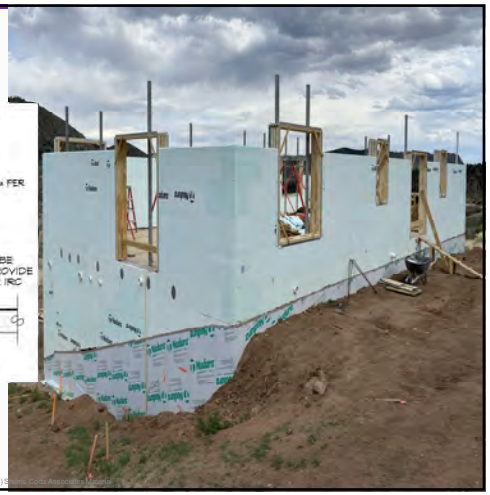

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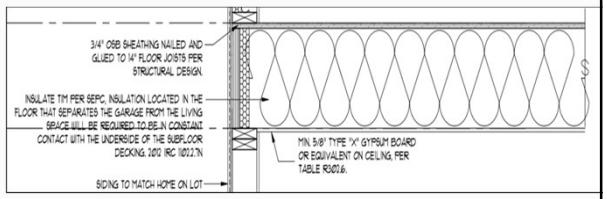
TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FLOOR *R*-VALUE
0	13
1	13
2	13
3	19
4 except Marine	19
5 and Marine 4	30
6	30
7 and 8	38

R402.2.7 FLOORS.

Floor cavity insulation shall comply with one of the following:

1. Installation shall be installed to maintain permanent contact with the underside of the subfloor decking in accordance with manufacturer instructions to maintain required R-value or readily fill the available cavity space.



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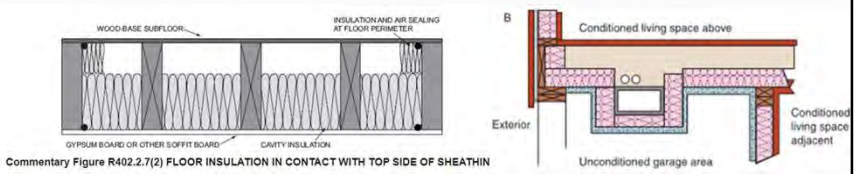
R402.2.7 FLOORS.

Floor cavity insulation shall comply with one of the following:

2. Floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.



Commentary Figure R402.2.7(2) FLOOR INSULATION IN CONTACT WITH TOP SIDE OF SHEATHIN

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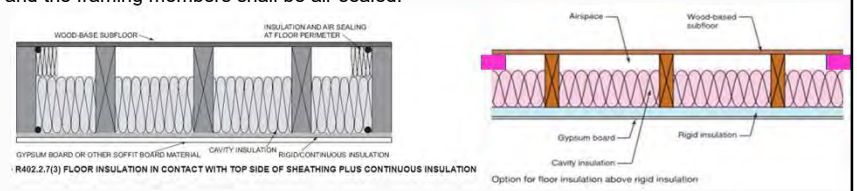
R402.2.7 FLOORS.

Floor cavity insulation shall comply with one of the following: (THREE OPTIONS)

3. A combination of cavity and continuous insulation shall be installed so that the cavity insulation is in contact with the top side of the continuous insulation that is installed on the underside of the floor framing separating the cavity and the unconditioned space below. The combined R-value of the cavity and continuous insulation shall equal the required R-value for floors. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.



R402.2.7(3) FLOOR INSULATION IN CONTACT WITH TOP SIDE OF SHEATHING PLUS CONTINUOUS INSULATION

Option for floor insulation above rigid insulation

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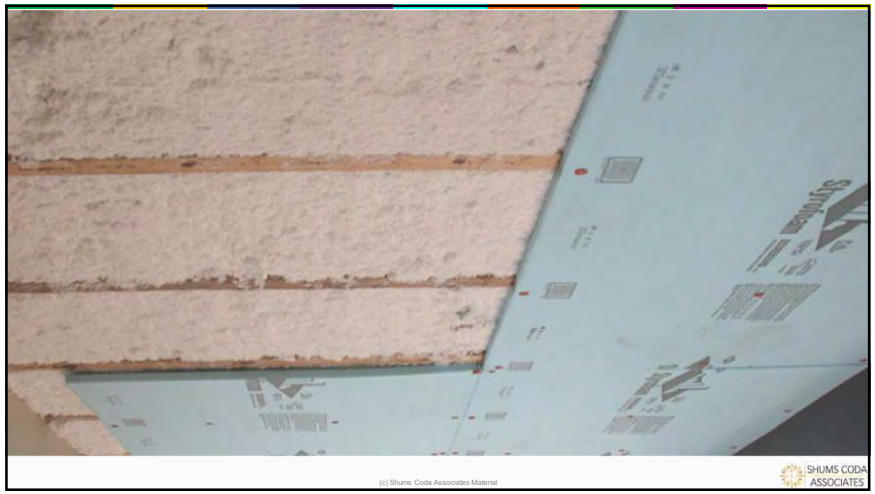

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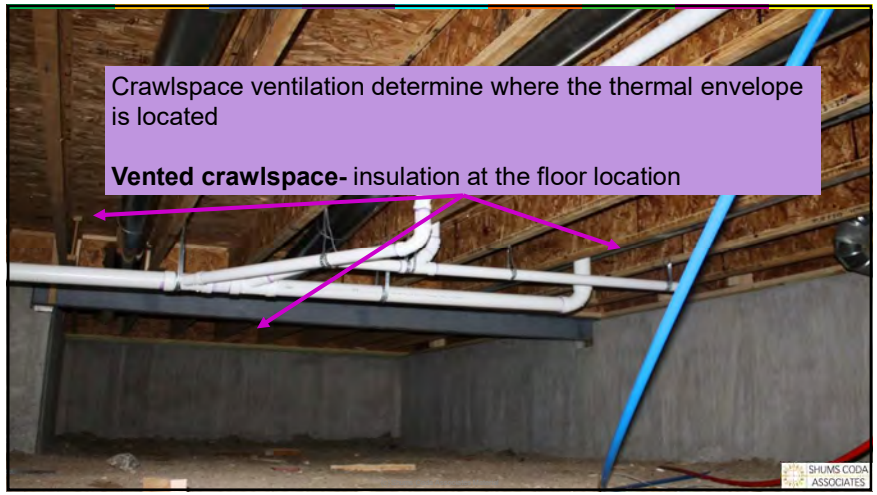

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TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	BASEMENT[c,g] WALL *R*-VALUE
0	0
1	0
2	0
3	5ci or 13[f]
4 except Marine	10ci or 13
5 and Marine 4	15ci or 19 or 13&5ci
6	15ci or 19 or 13&5ci
7 and 8	15ci or 19 or 13&5ci

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13&5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

f. Basement wall insulation is not required in Warm Humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13&5" means R-13 cavity insulation plus R-5 continuous insulation.

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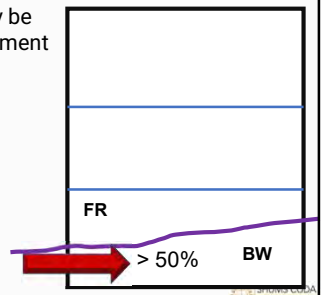
BASEMENT WALLS R402.2.8

BASEMENT WALL- defined as A wall 50 percent or more below grade and enclosing *conditioned space*.

- Walkout basements walls may be wood framed values and basement wall values



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R402.2.8 Basement walls.

Basement walls shall be insulated in accordance with Table R402.1.3.

Exception: Basement walls associated with unconditioned basements where all of the following requirements are met:

1. The floor overhead including the underside stairway stringer leading to the basement, is insulated in accordance with Section R402.1.3 and applicable provisions of Sections R402.2 and R402.2.7.
2. There are no uninsulated duct, domestic hot water, or hydronic heating surfaces exposed to the basement.
3. There are no HVAC supply or return diffusers serving the basement.
4. The walls surrounding the stairway and adjacent to conditioned space are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2.
5. The door(s) leading to the basement from conditioned spaces are insulated in accordance with Sections R402.1.3 and applicable provisions of Section R402.2, and weatherstripped in accordance with Section R402.4.
6. The building thermal envelope separating the basement from adjacent conditioned spaces complies with Section R402.4.

R402.2.8.1 Basement wall insulation installation.

Where basement walls are insulated, the insulation shall be installed from the top of the basement wall down to 10 feet (3048 mm) below grade or to the basement

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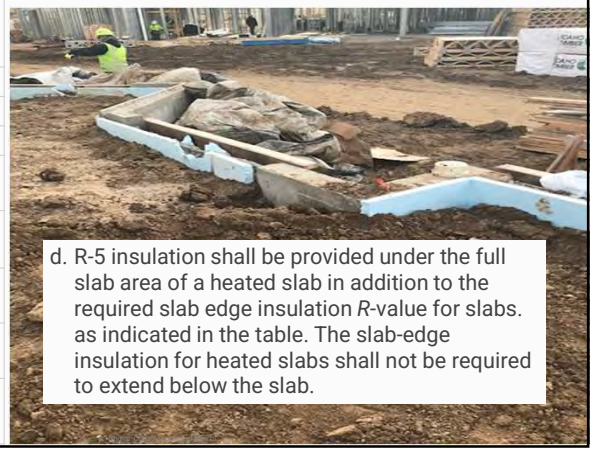
TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	SLAB[d] *R*-VALUE & DEPTH
0	0
1	0
2	0
3	10ci, 2 ft
4 except Marine	10ci, 4 ft
5 and Marine 4	10ci, 4 ft
6	10ci, 4 ft
7 and 8	10ci, 4 ft



d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab-edge insulation for heated slabs shall not be required to extend below the slab.

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R402.2.9 Slab-on-grade floors.

Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table R402.1.3.

Exception: Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

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R402.2.9.1 Slab-on-grade floor insulation installation.

Where installed, the insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table R402.1.3 or the distance of the proposed design, as applicable, by any combination of vertical insulation, insulation extending under the slab or insulation extendi from the building. Insulation extending away from shall be protected by pavement or by not (254 mm) of soil. The top edge of th ied between the exterior wall an nterior slab shall be permitted to be cu (0.79 rad) angle away from the exterior wa

SLAB EDGE IS NOT TRADEABLE

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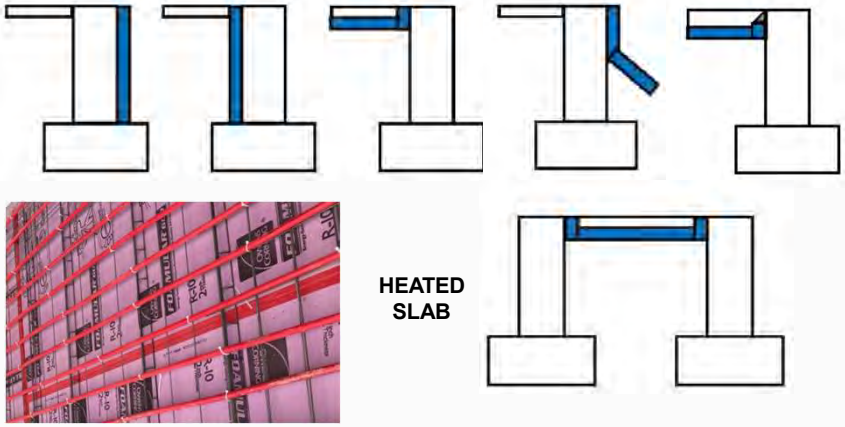

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PROTECTION OF EXPOSED FOUNDATION INSULATION 303.2.1

The protective covering shall cover the exposed exterior insulation and extend not less than 6 inches below grade.

10. INSULATION APPLIED TO THE EXTERIOR OF BASEMENT WALLS, CRAWLSPACE WALLS AND THE PERIMETER OF SLAB-ON-GRADE SHALL HAVE A RIGID, OPAQUE AND WEATHER-RESISTANT PROTECTIVE COVERING. THE PROTECTIVE COVERING SHALL COVER THE EXPOSED EXTERIOR INSULATION AND EXTEND A MINIMUM OF 6" BELOW GRADE.

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TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	CRAWL SPACE[c,g] WALL *R*-VALUE
0	0
1	0
2	0
3	5ci or 13[f]
4 except Marine	10ci or 13
5 and Marine 4	15ci or 19 or 13& 5ci
6	15ci or 19 or 13& 5ci
7 and 8	15ci or 19 or 13& 5ci

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13&5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

f. Basement wall insulation is not required in Warm Humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13&5" means R-13 cavity insulation plus R-5 continuous insulation.

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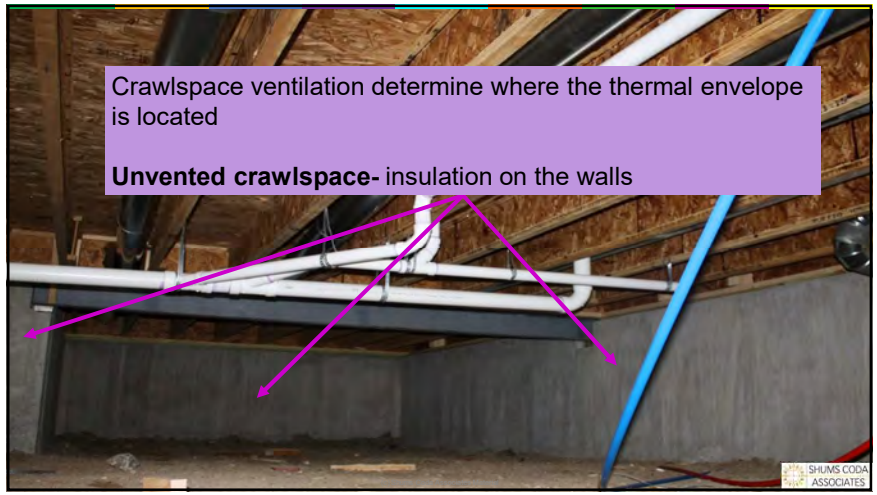

98

R402.2.10 Crawl space walls.
Crawl space walls shall be insulated in accordance with Table R402.1.3.
Exception: Crawl space walls associated with a crawl space that is vented to the outdoors and the floor overhead is insulated in accordance with Table R402.1.3 and Section R402.2.7.

R402.2.10.1 Crawl space wall insulation installations.
Where crawl space wall insulation is installed, it shall be permanently fastened to the wall and shall extend downward from the floor to the finished grade elevation and then vertically or horizontally for not less than an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the International Building Code or International Residential Code, as applicable. Joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up stem walls and shall be attached to the stem walls.

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CRAWL SPACE WALLS R402.2.10

- **Alternative to floor insulation(vented) insulate walls(unvented)**
- **Permanently attached to wall**
- **Start at top of wall extend down**
- **Exposed earth covered with Class 1 vapor retarder**
  - **Overlap seams by 6 inches**
  - **Extend 6inched up stem wall and attached**

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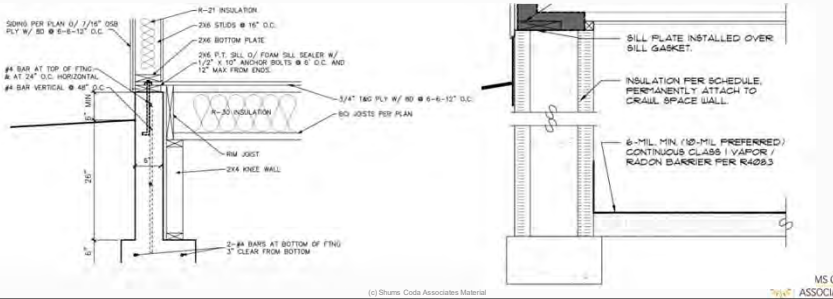
CRAWL SPACE WALLS R402.2.10

Is it vented or unvented?



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R402.2.4 ACCESS HATCHES AND DOORS.

Access hatches and doors from conditioned to unconditioned spaces such as attics and crawl spaces shall be insulated to the same R-value required by Table R402.1.3 for the wall or ceiling in which they are installed.

Exceptions:

1. Vertical doors providing access from conditioned spaces to unconditioned spaces that comply with the fenestration requirements of Table R402.1.3 based on the applicable climate zone specified in Chapter 3.

2. Horizontal pull-down, stair-type access hatches in ceiling assemblies that provide access from conditioned to unconditioned spaces in Climate Zones 0 through 4 shall not be required to comply with the insulation level of the surrounding surfaces provided the hatch meets all of the following:

2.1. The average U-factor of the hatch shall be less than or equal to U-0.10 or have an average insulation R-value of R-10 or greater.

2.2. Not less than 75 percent of the panel area shall have an insulation R-value of R-13 or greater.

2.3. The net area of the framed opening shall be less than or equal to 13.5 square feet (1.25 m2).

2.4. The perimeter of the hatch edge shall be weatherstripped.

The reduction shall not apply to the total UA alternative in Section R402.1.5.

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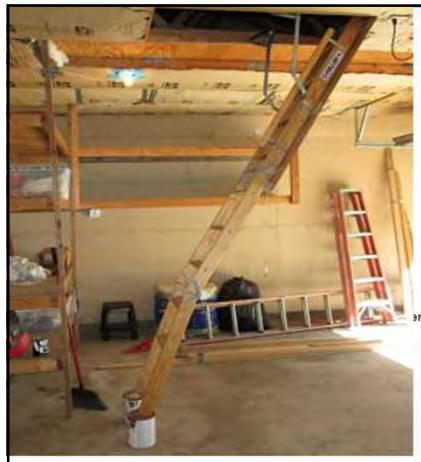

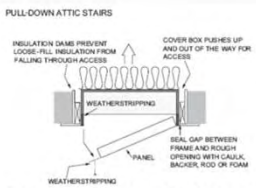

entary Figure R402.2.4.1 ACCESS HATCH AND DOOR INSULATION INSTALLATION

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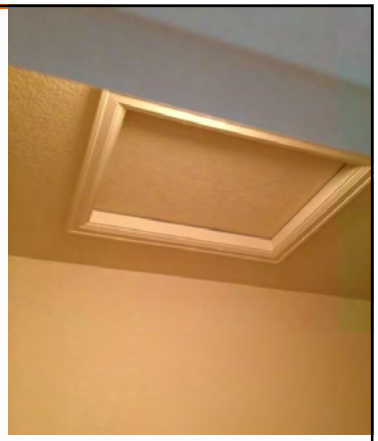

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R402.2.12 SUNROOM AND HEATED GARAGE INSULATION.

Sunrooms enclosing conditioned space and heated garages shall meet the insulation requirements of this code.

Exception: For sunrooms and heated garages provided thermal isolation, and enclosed conditioned space, the following exceptions to the insulation requirements of this code shall apply:

1. The minimum ceiling insulation R-values shall be R-19 in Climate Zones 0 through 4 and R-24 in Climate Zones 5 through 8.
2. The minimum wall insulation R-value shall be R-13 in all climate zones. Walls separating a sunroom or heated garage with thermal isolation from conditioned space shall comply with the building thermal envelope requirements of this code.

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Table 402.4.1.1
Component – Walls

Insulation Installation Criteria

- **Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R3 per inch minimum**
- **Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier**

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Table 402.4.1.1
Component – Walls

Insulation Installation Criteria

- **Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R3 per inch minimum**
- **Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier**

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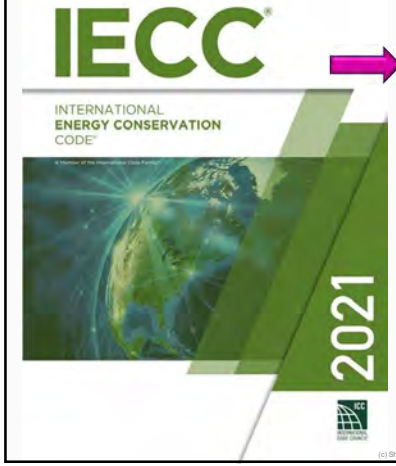

1. Energy Compliance Path ✓
2. Insulation materials and their R-values ✓
3. Fenestration U-factors and solar heat gain coefficients (SHGC).
4. Area-weighted U-factor and solar heat gain coefficients (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.

R103.2.1 – Define the Thermal Envelope ✓

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TABLE R402.1.3 INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]
0	NR	0.75	0.25
1	NR	0.75	0.25
2	0.40	0.65	0.25
3	.30	0.55	0.25
4 except Marine	.30	0.55	0.40
5 and Marine 4	0.30[i]	0.55	0.40
6	0.30[i]	0.55	NR
7 and 8	0.30[i]	0.55	NR

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

i. A maximum U-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the International Residential Code.

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DEFINED BY IECC

U-FACTOR

The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h • ft2 • º;F) [W/(m2 • K)].

SOLAR HEAT GAIN COEFFICIENT (SHGC)

The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, that is then reradiated, conducted or convected into the space.

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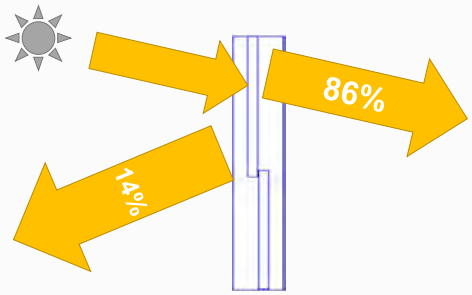
Solar Heat Gain Coefficient

Clear Glass SHGC: 0.86

Lower the number better the SHGC



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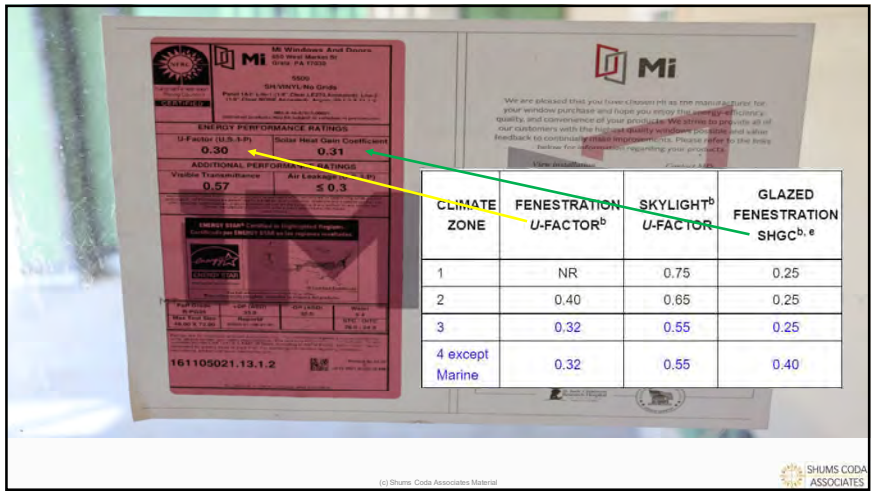

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]
1	NR	0.75	0.25
2	0.40	0.65	0.25
3	0.32	0.55	0.25
4 except Marine	0.32	0.55	0.40

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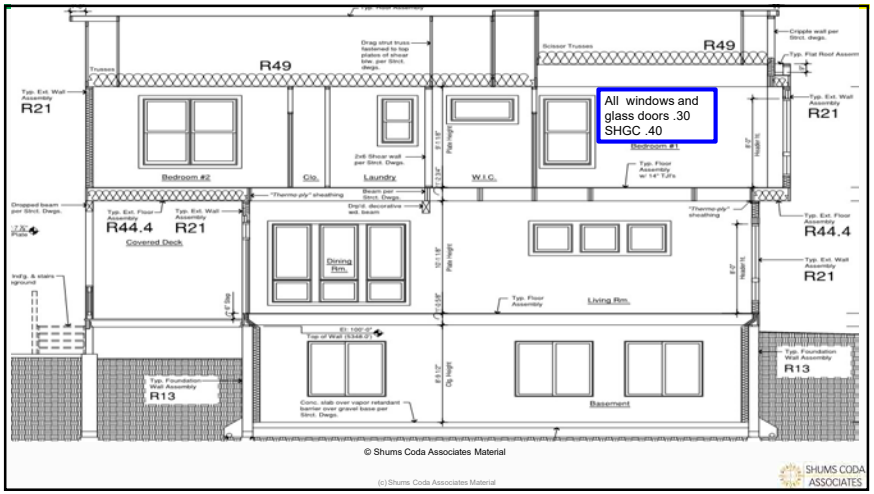

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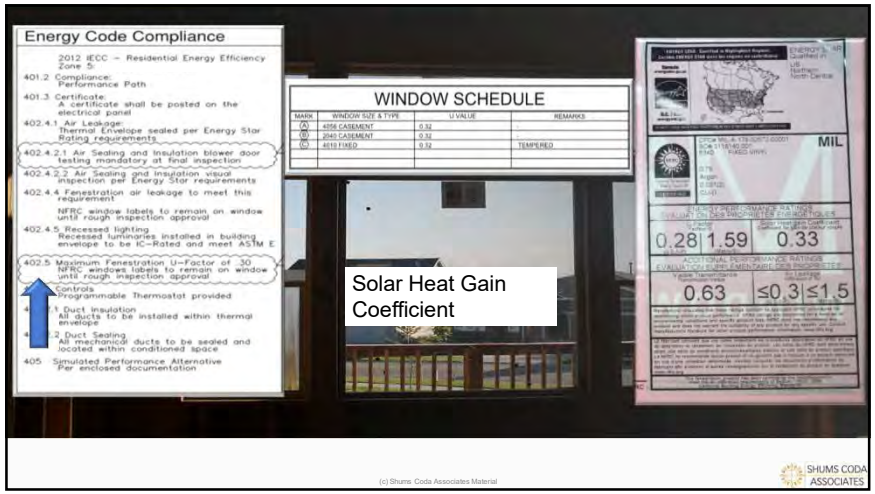

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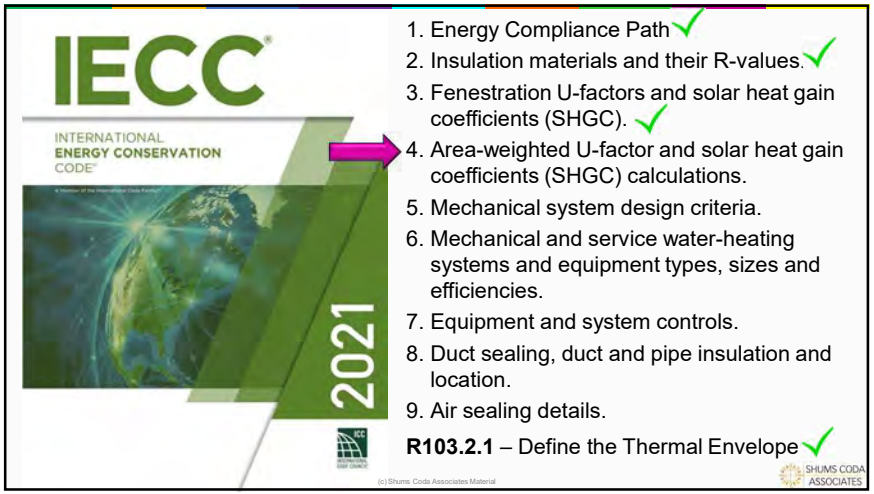

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- **R402.3.1 – U-Factor**
  - Area weighted average
- **R402.3.2 – Glazed Fenestration SHGC**
  - Area weighted average
  - Dynamic Glazing

R402.3.3 Glazed fenestration exemption.
Not greater than 15 square feet of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements in Section R402.1.2. This exemption shall not apply to the Total UA alternative in Section R402.1.5.

R402.3.4 Opaque door exemption.
One side-hinged opaque door assembly not greater than 24 square feet in area shall be exempt from the U-factor requirement in Section R402.1.2. This exemption shall not apply to the Total UA alternative

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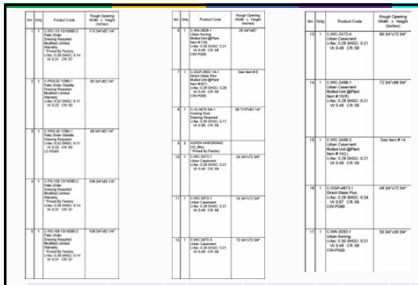

AREA WEIGHTED AVERAGE

Example of calculation used for submittal

Item	#1 Value		#1 Area		#2 Value		#2 Area		#3 Value		#3 Area		#4 Value		#4 Area		Total Area Sq Feet		Weighted Average Value
Window U-Value	0.32	x	59.5	+	0.3	x	45	+	0.29	x	219	+	0.28	x	187.5	÷	511	=	0.29

(.32 X 59.5) + (.3 X 45) + (.29 X 219) + (.28 X 187.5) ÷ 511 = .29
19.04 + 13.5 + 63.51 + 52.5 / 511 = .29

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IECC
INTERNATIONAL ENERGY CONSERVATION CODE
2021

1. Energy Compliance Path ✓
2. Insulation materials and their R-values. ✓
3. Fenestration U-factors and solar heat gain coefficients (SHGC). ✓
4. Area-weighted U-factor and solar heat gain coefficients (SHGC) calculations. ✓
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.

R103.2.1 – Define the Thermal Envelope ✓

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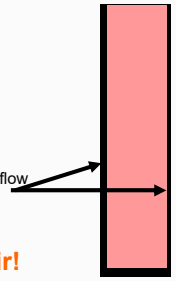
CONTROLLING THERMAL FLOW

Most insulation is NOT an air barrier

Resists Conduction

Does not resist Air Flow:
That is the job of the air barrier



* An Air Barrier is any solid material that blocks air flow including sealing at edges and seams

What is the biggest insulation Myth:
Insulation Stops the movement of air!

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Insulation

Insulation traps pockets of air

Stagnate Air Pockets create the R-value

Air Barrier

Stopping the movement of air from scrubbing away the stagnate air pocket
Now it works

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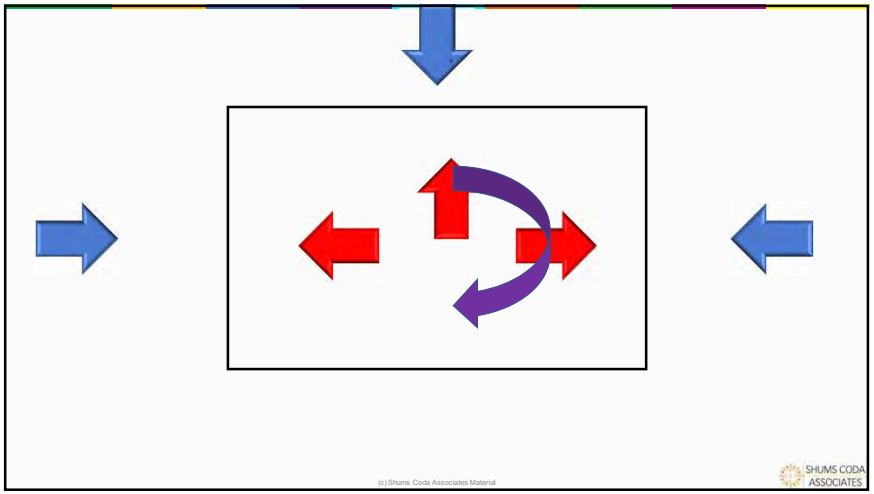

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WOULD I ACCEPT THESE?

THE BUILDING THERMAL ENVELOP SHALL BE DURABLY SEALED TO LIMIT AIR INFILTRATION. THE FOLLOWING SHALL BE CAULKED, GASKETED, WEATHERSTRIPPED OR OTHERWISE SEALED WITH AN AIR BARRIER MATERIAL, SUITABLE FILM OR SOLID MATERIAL.

ALL JOINTS, SEAMS AND PENETRATIONS
SITE-BUILT WINDOWS, DOORS AND SKYLIGHTS
OPENINGS BETWEEN WINDOW AND DOOR ASSEMBLIES AND THEIR RESPECTIVE JAMBS AND FRAMING
UTILITY PENETRATIONS
DROPPED CEILINGS OR CHASES ADJACENT TO THE THERMAL ENVELOPE
KNEE WALLS
WALLS AND CEILINGS SEPARATING THE GARAGE FROM CONDITIONED SPACES
BEHIND TUBS AND SHOWERS ON EXTERIOR WALLS
CANTILEVERS
ATTIC ACCESS OPENINGS
RIM JOISTS JUNCTION
OTHER SOURCES OF INFILTRATION

3. Openings between window and door assemblies and their respective jambs and framing
• All windows and doors will be foamed with a closed cell spray foam

11. Rim joists junction.
• 2" closed cell spray foam and R12 batt insulation

10. Attic access openings.
• rigid insulation will be attached to the top side of the attic access panel for an R-50

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WOULD I ACCEPT THESE?

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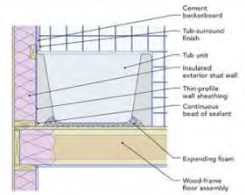

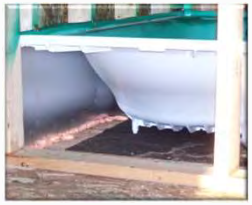

A PICTURE IS WORTH A THOUSAND WORDS

- Plans examiners can verify the requirement is demonstrated on the plans
- Builders understands how to build the component to comply with the code and how the architect designed the building
- Inspectors have a tool to aid in enforcing the requirements

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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

General requirements A continuous air barrier shall be installed in the building envelope.

- Breaks or joints in the air barrier shall be sealed.

Air-permeable insulation shall not be used as a sealing material

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18. Durably seal thermal envelope to limit air infiltration. The following shall be caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, or solid material.
    a. All joints, seams, and penetrations. Any breaks or joints in the air barrier shall be sealed.

AIR SEALING NOTE:

A CONTINUOUS AIR BARRIER SHALL BE INSTALLED IN THE BUILDING ENVELOPE USING THE AIRTIGHT DRYWALL APPROACH. ALL JOINTS AND SEAMS TO BE TAPED AND SEALED.

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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Ceiling/attic

- The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed.
- Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.

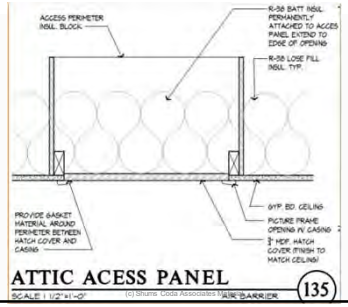

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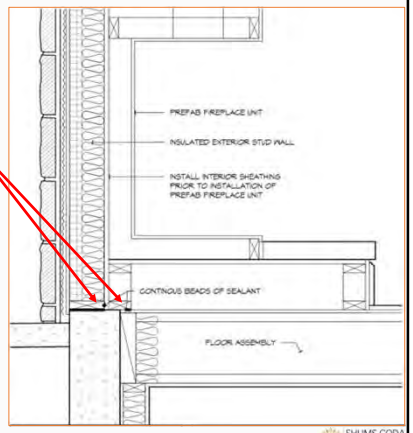
Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Walls -

- The junction of the foundation and sill plate shall be sealed.
- The junction of the top plate and the top of exterior walls shall be sealed.
- Knee walls shall be sealed.



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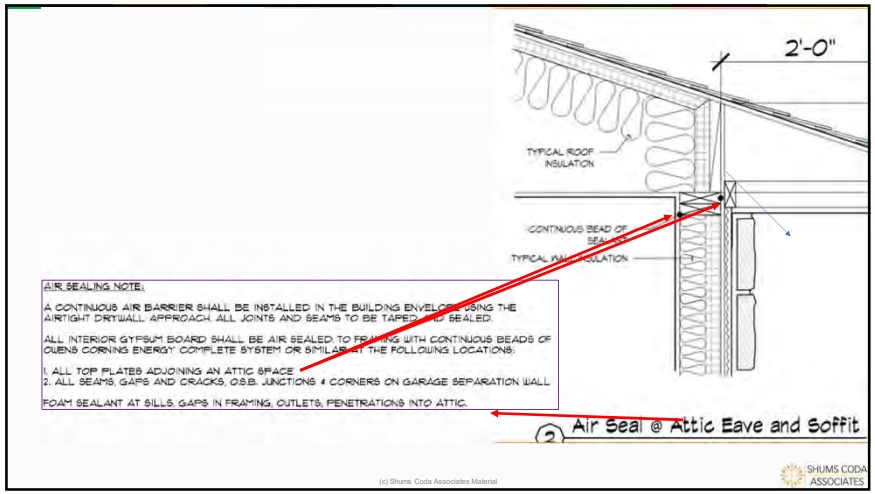

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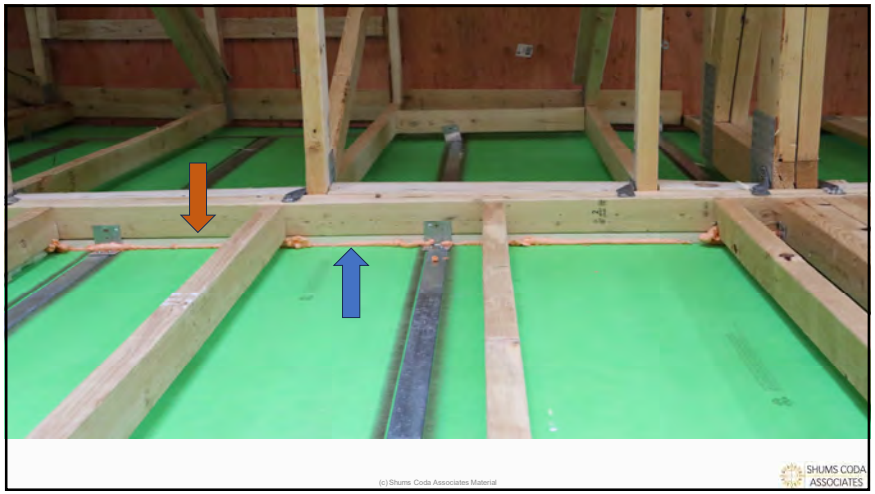

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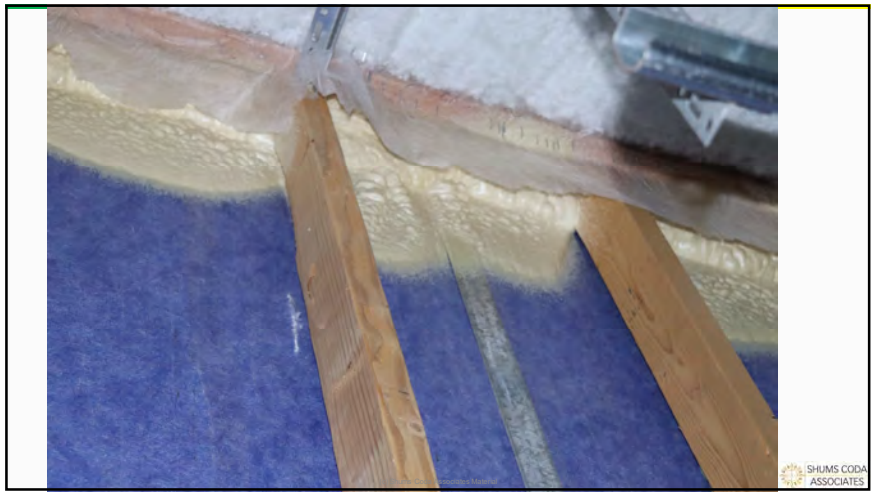

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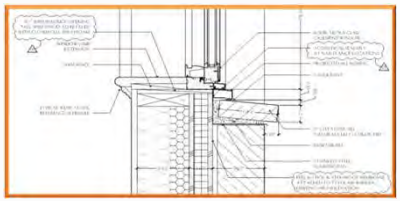
Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Windows, skylights and doors –

- The space between framing and skylights, and the jambs of windows and doors, shall be sealed.



Openings between window and door assemblies and their respective jambs and framing shall be sealed and insulated with sprayed foam with a thermal resistance of R-3 per-inch minimum.

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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Rim joists -

- Rim joists shall include the air barrier.
- The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.

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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Floors, including cantilevered floors and floors above garages

- The air barrier shall be installed at any exposed edge of insulation.

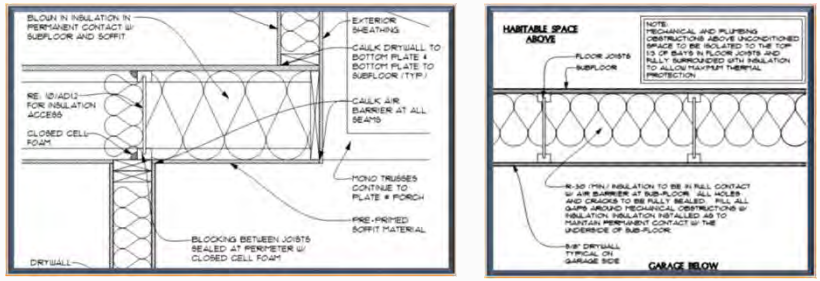

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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Basement, Crawl space walls, and Slab Foundations -

- Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10.
- Penetrations through concrete foundation walls and slabs shall be air sealed.
- Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the International Residential Code.

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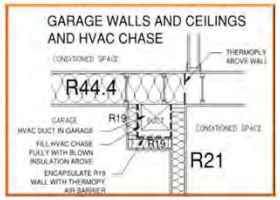
Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Shafts, penetrations -

- Duct and flue shafts to exterior or unconditioned space shall be sealed.
- Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.



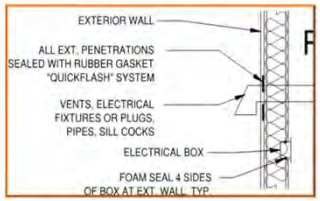


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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Narrow cavities -

- Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.

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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Garage separation –

- Air sealing shall be provided between the garage and conditioned spaces.

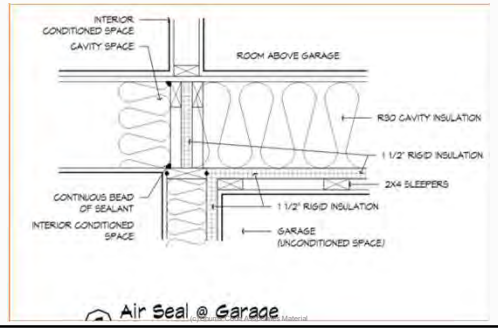

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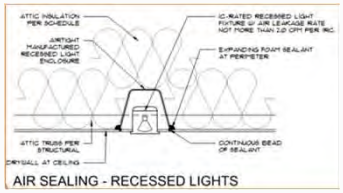
Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Recessed lighting -

- Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5.



AIR SEALING - RECESSED LIGHTS

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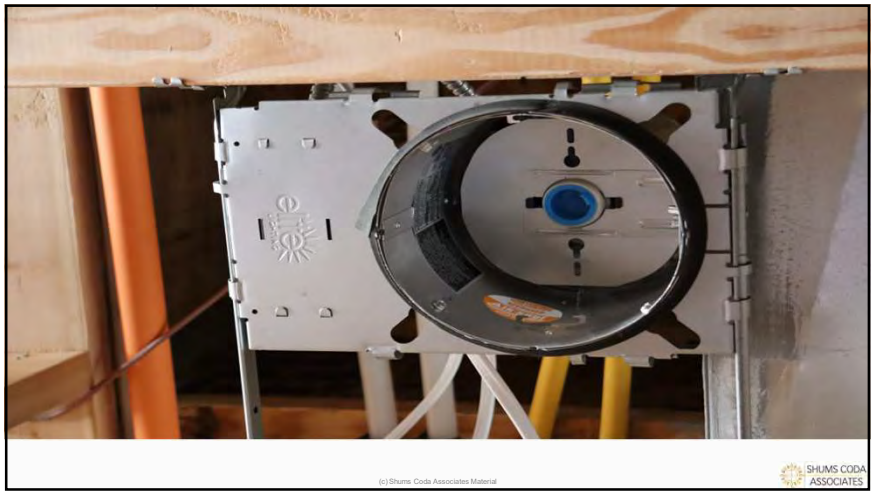

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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Plumbing, wiring, or other obstructions- cavities -

- All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.

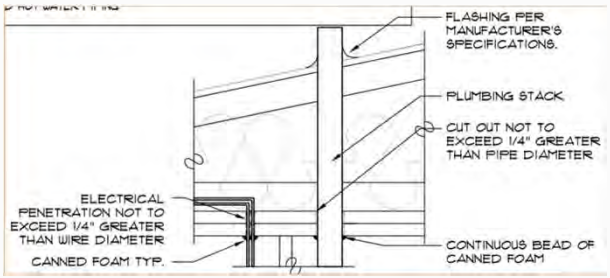

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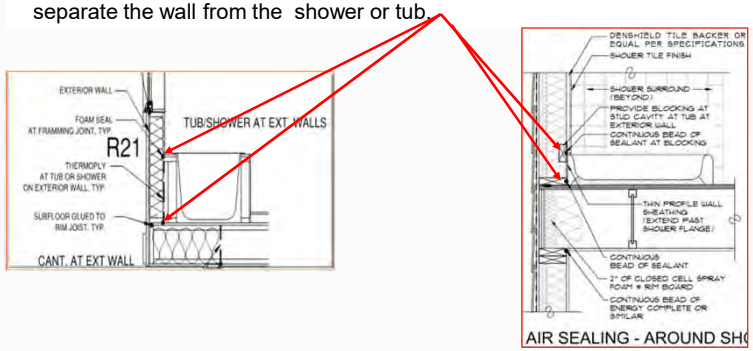
Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Shower/tub on exterior wall

- The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.



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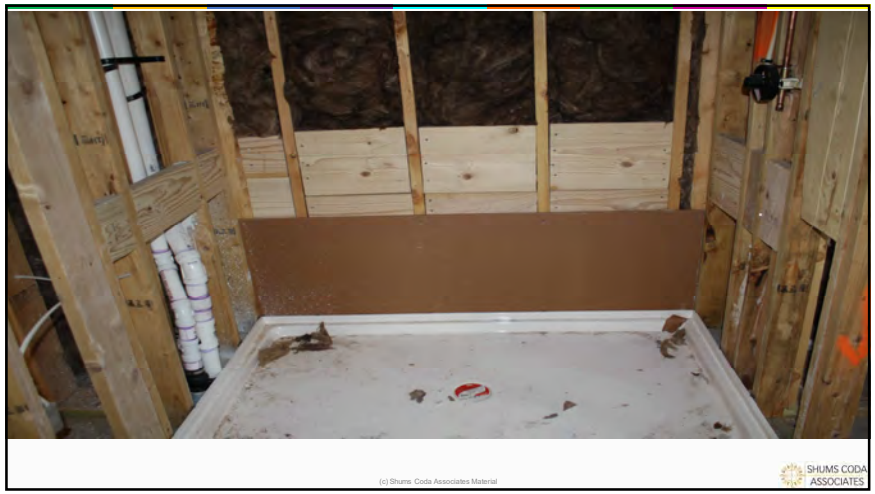

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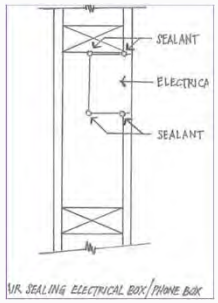
Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Electrical/phone box on exterior walls –

- The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.



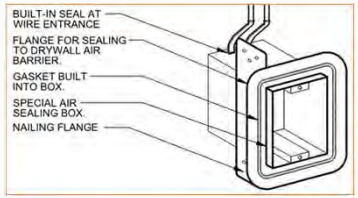


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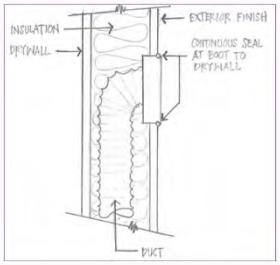
Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

HVAC register boots –

- HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.



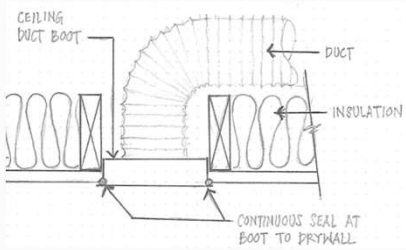


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Table R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

Concealed sprinklers

- Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.

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NEW TESTING REQUIREMENTS – Not so new

Leakage Rate R402.4.1.3
- Maximum leakage rate set at 5.0 Climate Zones 0-2
- Maximum leakage rate set at 3.0 Climate Zones 3-8

Testing R402.4.1.2
- New metric was introduced (By way of exception in R402.4.1.3)
  - CFM/SQ FT
  - Multifamily and SF ≤ 1,500 sq ft

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1. Energy Compliance Path ✓
2. Insulation materials and their R-values. ✓
3. Fenestration U-factors and solar heat gain coefficients (SHGC). ✓
4. Area-weighted U-factor and solar heat gain coefficients (SHGC) calculations. ✓
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details. ✓

R103.2.1 – Define the Thermal Envelope ✓

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Controls R403.1 & Programable thermostat R403.1.1

- A minimum of one thermostat shall be provide for each separate heating and cooling system
- The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of day and different days of the week. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures of not less than 55°F (13°C) to not greater than 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F (21°C) and a cooling temperature setpoint of not less than 78°F (26°C).

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R403.1.2 HEAT PUMP SUPPLEMENTARY HEAT

Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

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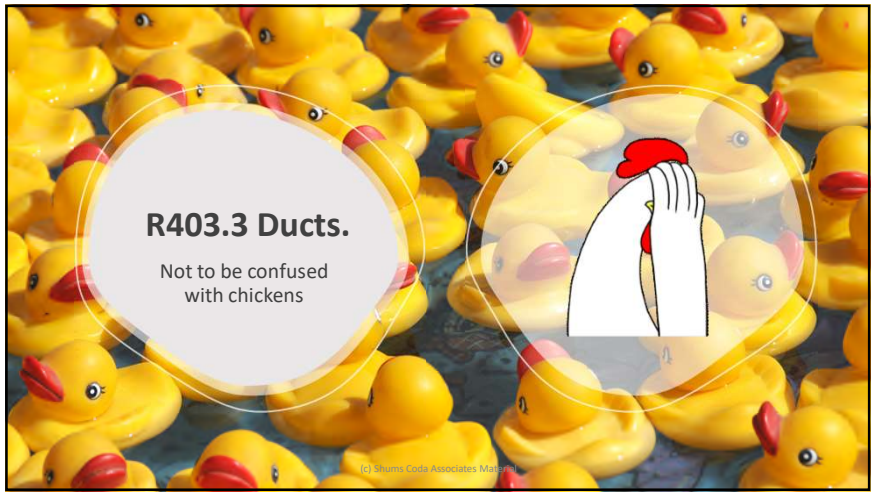

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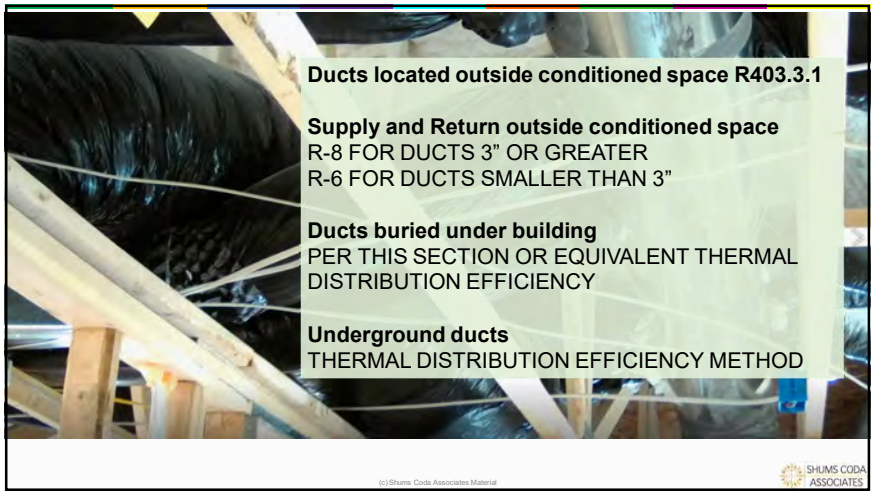

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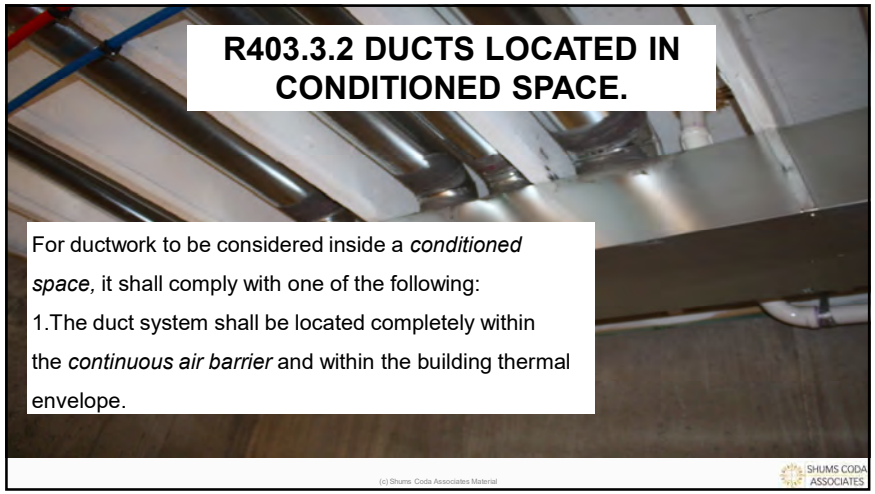

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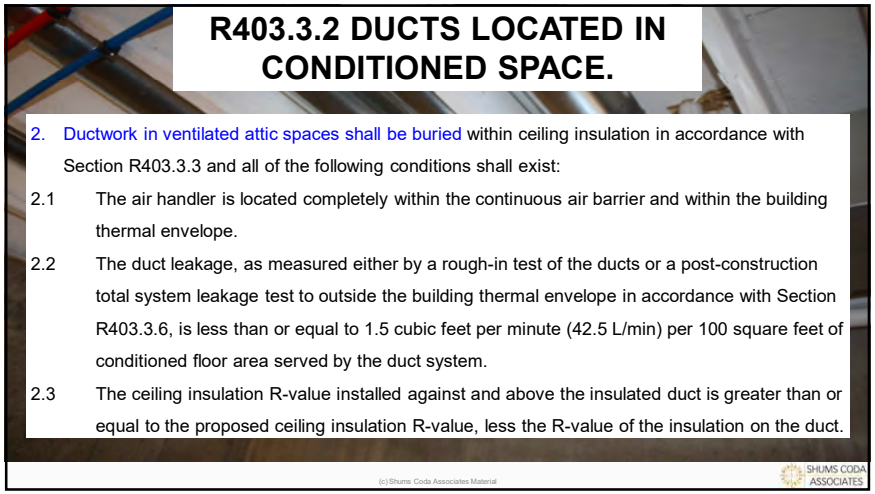

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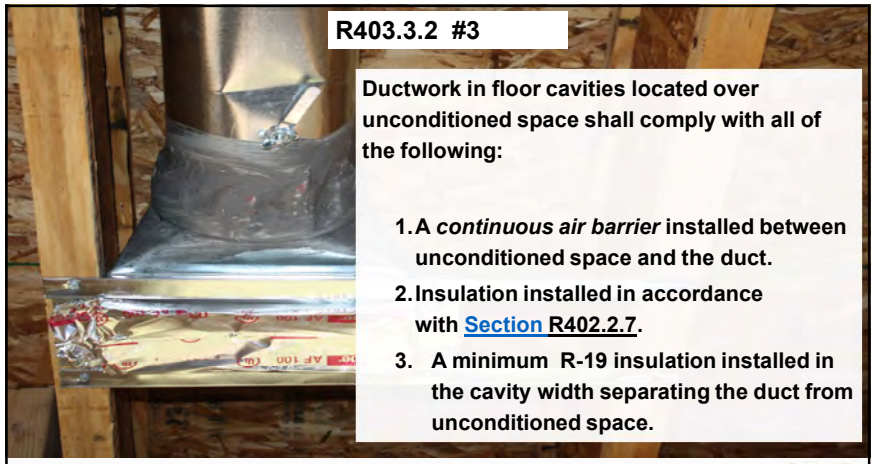

R403.3.2 #3

Ductwork in floor cavities located over unconditioned space shall comply with all of the following:

1. **A *continuous air barrier* installed between unconditioned space and the duct.**
2. **Insulation installed in accordance with Section R402.2.7.**
3. **A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.**

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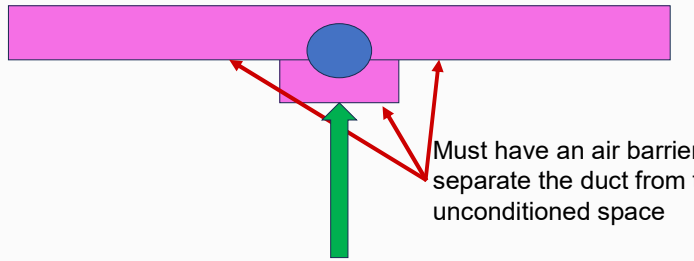

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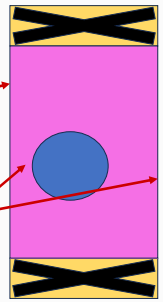
R403.3.2 #4

Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:

1. ***A continuous air barrier* installed between unconditioned space and the duct.**
2. **Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.**
3. **The remainder of the cavity insulation shall be fully insulated to the drywall side.**



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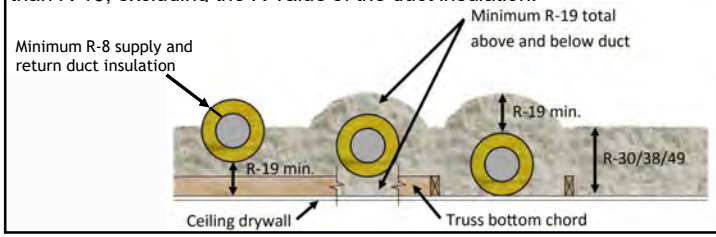
DUCTS BURIED WITHIN CEILING INSULATION R403.3.6

Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return duct shall have an insulation R-value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation R-values against and above the top of the duct, and against and below the bottom of the duct shall be not less than R-19, excluding the R-value of the duct insulation.



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DUCTS BURIED WITHIN CEILING INSULATION R403.3.6

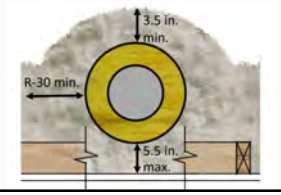
3. In Climate Zones 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation, insulated to an R-value of not less than R-13 and in compliance with the vapor retarder requirements of Section M1601.4.6

Exception: Sections of the supply duct that are less than 3 feet from the supply outlet shall not be required to comply with these requirements.

193

EFFECTIVE R-VALUE OF DEEPLY BURIED DUCTS R403.3.6.1

Where using a simulated energy performance analysis, sections of ducts that are installed in accordance with Section R403.3.6, located directly on, or within 5.5 inches of the ceiling, surrounded with blown-in attic insulation having an R-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches below the top of the insulation, shall be considered as having an effective duct insulation R-value of R-25



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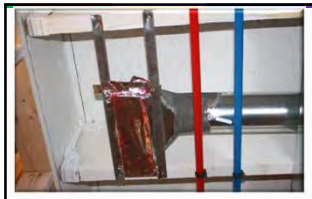
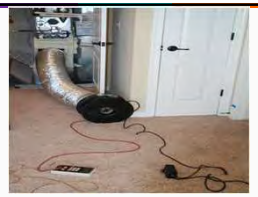




Rough-in test:

With air handler total leakage shall be less than or equal to 4.0 cubic feet per minute per 100 square feet of conditioned floor area.

Without air handler installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute per 100 square feet of conditioned floor area.

Postconstruction test:

Total leakage shall be less than or equal to 4.0 cubic feet per minute per 100 square feet of conditioned floor area.

Test for ducts within thermal envelope:

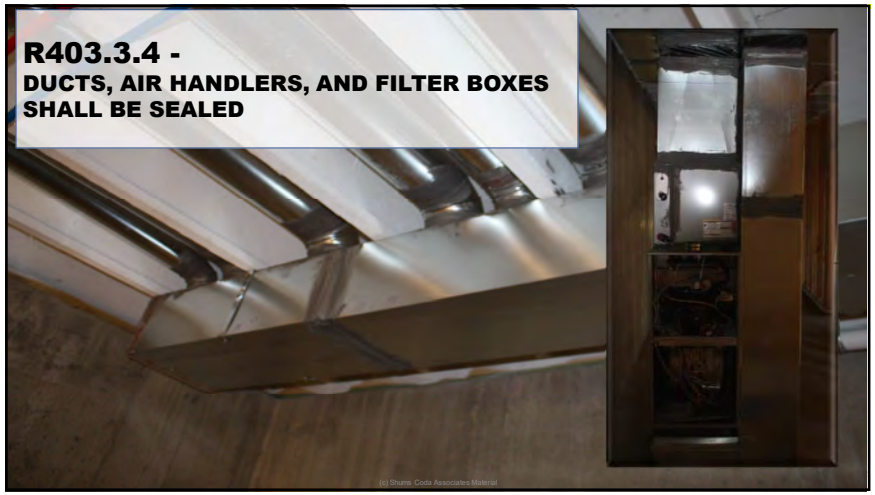
Where all ducts and air handlers are located entirely within the building thermal envelope, total leakage shall be less than or equal to 8.0 cubic feet per minute per 100 square feet of conditioned floor area.

195

R403.6 Mechanical ventilation

Automatic or Gravity damper

196



197

198

Mechanical ventilation testing R403.6.3

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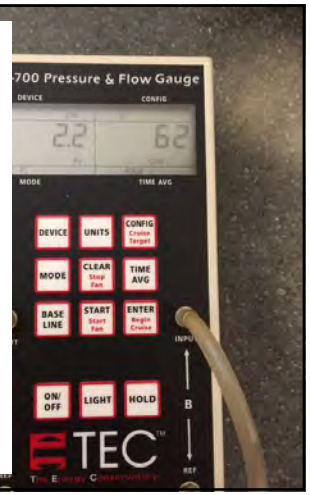
R403.6.3 Testing.
Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section R403.6. Testing shall be performed according to the ventilation equipment manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. Where required by the code official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official.
Exception: Kitchen range hoods that are ducted to the outside with 6-inch (152 mm) or larger duct and not more than one 90-degree (1.57 rad) elbow or equivalent in the duct run.



200

R403.7 Equipment sizing and efficiency rating (Mandatory)

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 technologies.

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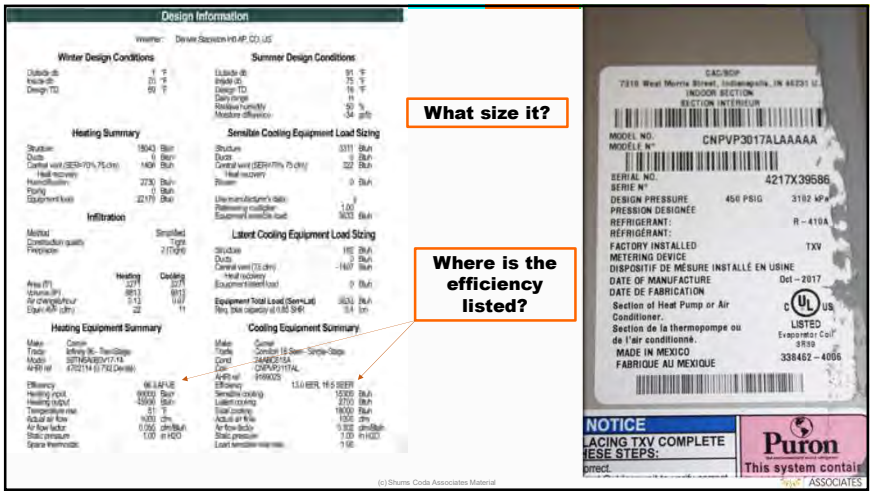

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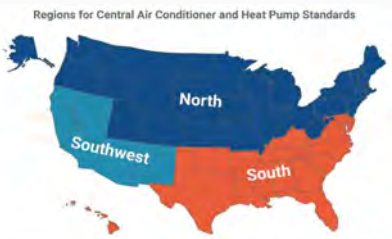

DOE Energy Efficiency Standards (Effective 2023)

System Type	North Region		South Region		Southwest Region		
	SEER2	HSPF2	SEER2	HSPF2	SEER2	HSPF2	EER2
Split System A/Cs with a Certified Cooling Capacity < 45,000 Btu/h	13.4	NA	14.3	NA	14.3	NA	11.7/9.8*
Split System A/Cs with a Certified Cooling Capacity ≥45,000 Btu/h	13.4	NA	13.8	NA	13.6	NA	11.2/9.8*
Split System Heat Pumps	14.3	7.5	14.3	7.5	14.3	7.5	NA
Package Air Conditioners	13.4	NA	13.4	NA	13.4	NA	10.6
Package Heat Pumps	13.4	6.7	13.4	6.7	13.4	6.7	NA

*The lower EER requirement is for equipment in its equipment or is equipment with SEER2 using the IRP.

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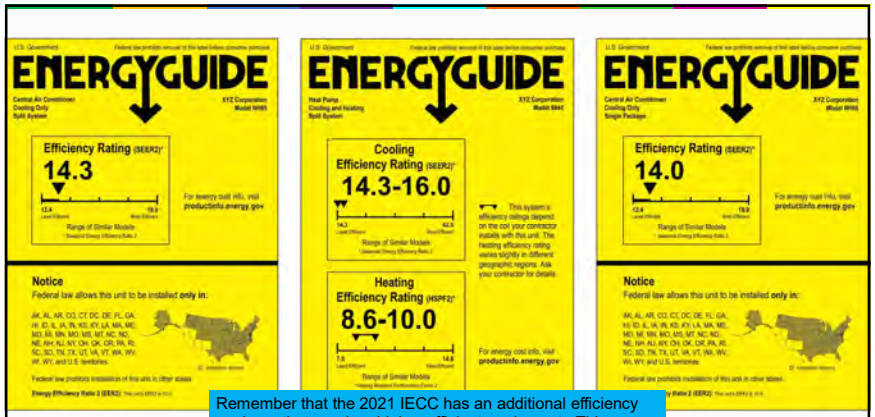

Remember that the 2021 IECC has an additional efficiency package that requires higher efficient equipment. This matters no matter the edition adopted.

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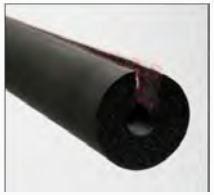
R403.4 Mechanical system piping insulation (Mandatory).

Mechanical system piping capable of carrying fluids greater than 105º;F or less than 55º;F shall be insulated to an R-3 minimum.

205

R403.4.1 Protection of piping insulation

Piping insulation exposed to weather shall be protected from damage including that caused by sunlight, moisture, equipment, maintenance, and wind and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.



INSUL-LOCK® Seam-Seal pipe insulation is made from a UV resistant elastomeric blend. For moderate UV exposure, no additional protective coating needed. However, for severe UV exposure (roof-top applications) or where optimum performance is required, 374 Protective Coating or approved jacketing or clad-ding should be used. *For more detailed information refer to the Installation Guidelines.*

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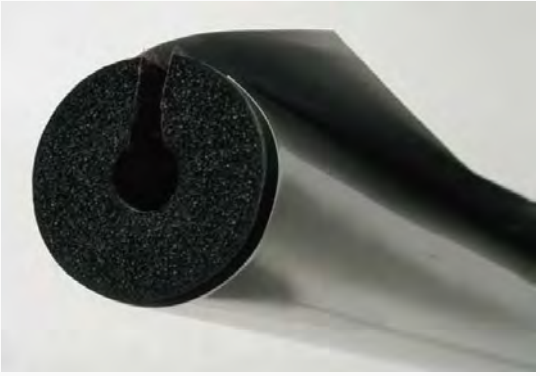

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R403.5.1.1 Circulation systems 2021

- **Provide circulation pump**
- **Dedicated return pipe or cold water supply**
- **Gravity and thermosyphon systems prohibited**
- **Controls to start pump on demand for hot water**
- **Controls to shut off pump when loop at temp and when there is no demand for hot water**
- **Controls to limit temperature not greater than 104*F**

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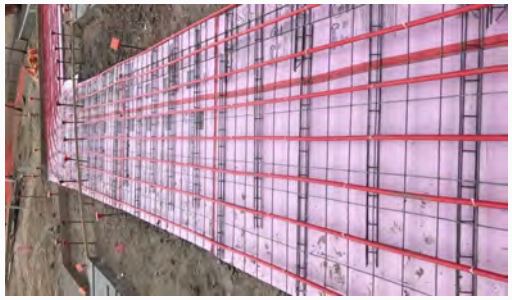
R403.5.2 Hot water pipe insulation 2021

Insulation for service hot water piping with a thermal resistance, R-value, of not less than R-3 shall be applied to the following:

1. **Piping 3/4 inch (19.1 mm) and larger in nominal diameter located inside the conditioned space.**
2. **Piping serving more than one dwelling unit.**
3. **Piping located outside the conditioned space.**
4. **Piping from the water heater to a distribution manifold.**
5. **Piping located under a floor slab.**
6. **Buried piping.**
7. **Supply and return piping in circulation and recirculation systems other than cold water pipe return demand recirculation systems.**

209

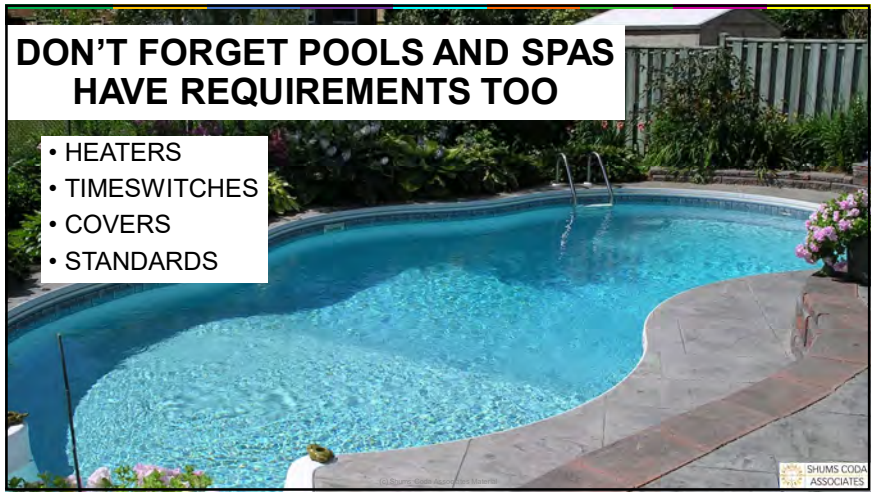


SNOW AND ICE MELT SYSTEM CONTROLS R403.9 (MANDATORY)

- Auto controls to shut system off when surface temperature is above 50˚ and no precipitation falling, and outdoor temperature is above 40˚

210

DON'T FORGET POOLS AND SPAS HAVE REQUIREMENTS TOO



- HEATERS
- TIMESWITCHES
- COVERS
- STANDARDS

211

1. Energy Compliance Path ✓
2. Insulation materials and their R-values. ✓
3. Fenestration U-factors and solar heat gain coefficients (SHGC). ✓
4. Area-weighted U-factor and solar heat gain coefficients (SHGC) calculations.
5. Mechanical system design criteria. ✓
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies. ✓
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location. ✓
9. Air sealing details. ✓

R103.2.1 – Define the Thermal Envelope ✓

212

R404.1.1Exterior lighting.

Connected exterior lighting for residential buildings shall comply with Section C405.5.

Exceptions:

1. Detached one- and two- family dwellings.
2. Townhouses.
3. Solar-powered lamps not connected to any electrical service.
4. Luminaires controlled by a motion sensor.
5. Lamps and luminaires that comply with Section R404.1.

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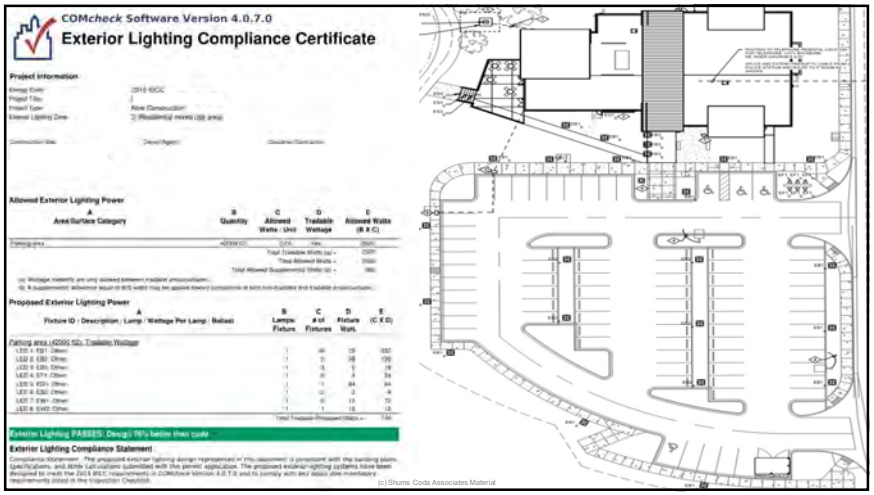

COMcheck Software Version 4.0.7.0

Exterior Lighting Compliance Certificate

Project Information

Allowed Exterior Lighting Power

A Area/Surface Category	B Quantity	C Allowed Watts / Unit	D Tradable Wattage	E Allowed Watts (B X C)
Parking area	42000 SQ	0.15	Yes	6300
			Total Tradable Watts (a) =	6300
			Total Allowed Watts =	6300
			Total Allowed Supplemental Watts (c) =	0

(a) Wattage credits are only allowed between tradable areas/surfaces.
(b) A supplemental allowance equal to 0.15 watts may be applied toward components in both non-tradable and tradable areas/surfaces.

Proposed Exterior Lighting Power

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
Parking area (42000 SQ) - Tradable Wattage				
LED 1: EB1 - Other	1	30	32	960
LED 2: EB2 - Other	1	5	38	190
LED 3: EB3 - Other	1	3	6	18
LED 4: ST1 - Other	1	6	9	54
LED 5: ED1 - Other	1	1	84	84
LED 6: ED2 - Other	1	2	3	6
LED 7: EW1 - Other	6	1	12	72
LED 8: EW2 - Other	1	1	12	12
			Total Tradable Proposed Watts =	1396

Exterior Lighting PASSES: Design 78% better than code

Exterior Lighting Compliance Statement

Compliance Statement: The proposed exterior lighting design represented in this document is consistent with the building plans, specifications, and site calculations submitted with this permit application. The proposed exterior lighting systems have been designed to meet the 2015 IECC requirements in COMcheck Version 4.0.7.0 and to comply with any basic site mandatory requirements listed in the Inspection Checklist.

214

R404.2 Interior lighting controls

Permanently installed lighting fixtures shall be controlled with either a dimmer, an occupant sensor control or other control that is installed or built into the fixture.

Exception: Lighting controls shall not be required for the following:

1. Bathrooms.
2. Hallways.
3. Exterior lighting fixtures.
4. Lighting designed for safety or security.

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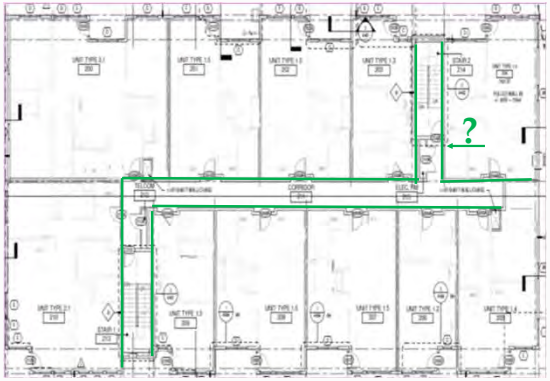

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OCCUPANT SENSOR CONTROL. An automatic control device that detects the presence or absence of people within an area and causes lighting, equipment or appliances to be regulated accordingly.

Occupancy Sensors

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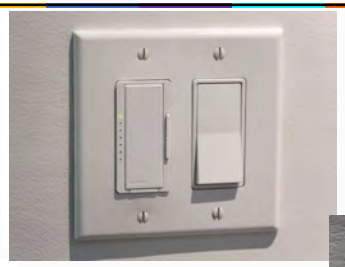

DIMMER. A control device that is capable of continuously varying the light output and energy use of light sources.

Dimmers

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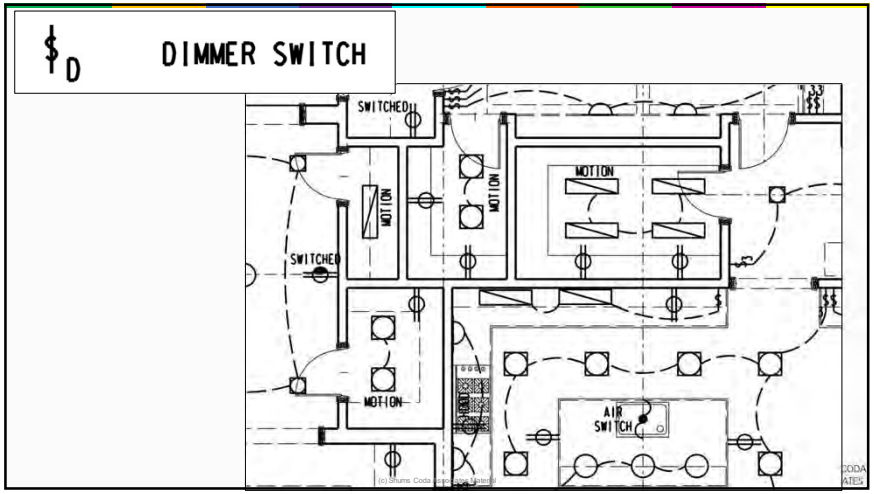
218



219

R404.3 Exterior lighting controls

Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions.

Exception: Lighting serving multiple dwelling units.

2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.

3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

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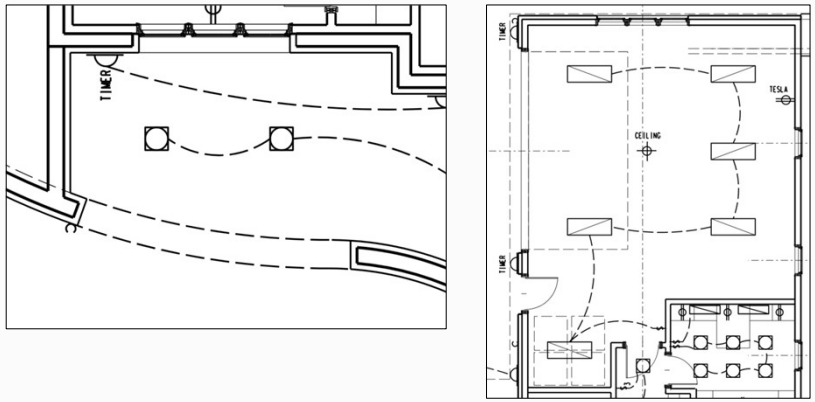
220



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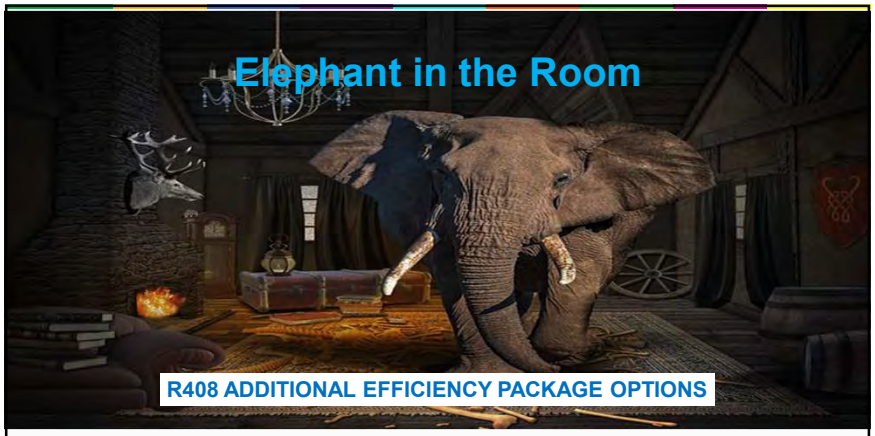

222

ALL COMPLIANCE PATHS MUST COMPLY WITH ONE OF THE FOLLOWING:

R408.2.1 Enhanced envelope performance option

≤ 95% of total UA


Generated by REScheck-Web Software
Compliance Certificate

Project 2022 CCICC ED Institute

Energy Code:	2021 IECC
Location:	Parker, Colorado
Construction Type:	Single-family
Project Type:	New Construction
Conditioned Floor Area:	3,460 ft2
Glazing Area	7%
Climate Zone:	5 (6343 HDD)
Permit Date:	
Permit Number:	

Construction Site: Owner/Agent: Designer/Contractor:

Compliance: Passes using UA trade-off

223

HOW TO COMPLY

R408.2.1 Enhanced envelope performance option

- This one may be difficult
  - The values in the tables are more efficient than in the past
- **Inspectors will need to verify all the insulation is installed correctly**
  - **Correct R-value**
  - **Correct Material**
  - **Installed per Manufacturer Installation Instructions**
- **Verify U-factor and SHGC of all fenestration**
- **Inspect air barriers**

224

ALL COMPLIANCE PATHS MUST COMPLY WITH ONE OF THE FOLLOWING:

- **R408.2.2 More efficient HVAC equipment performance option**
- 1. Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.
- 2. Greater than or equal to 10 HSPF/16 SEER air source heat pump.
- 3. Greater than or equal to 3.5 COP ground source heat pump.

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HOW TO COMPLY

R408.2.1 Enhanced envelope performance option

R408.2.2 More efficient HVAC equipment performance option

- Many builders are using higher efficient equipment
- Would be required if not fully electric
- Should be verified from Manual J/S and REScheck or the plans

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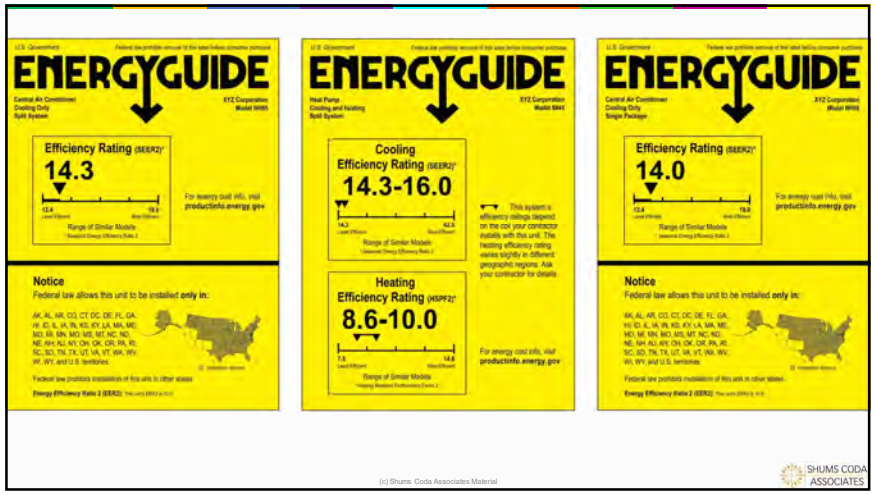

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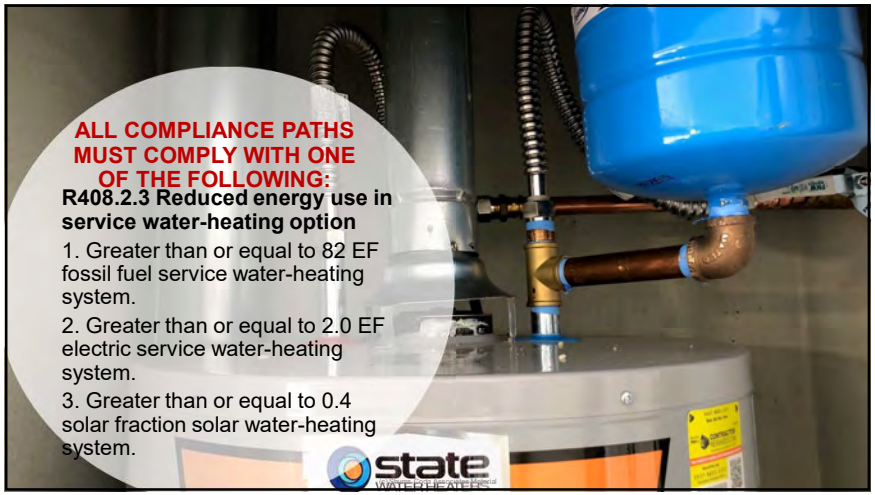

ALL COMPLIANCE PATHS MUST COMPLY WITH ONE OF THE FOLLOWING:

R408.2.3 Reduced energy use in service water-heating option

1. Greater than or equal to 82 EF fossil fuel service water-heating system.
2. Greater than or equal to 2.0 EF electric service water-heating system.
3. Greater than or equal to 0.4 solar fraction solar water-heating system.

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HOW TO COMPLY

R408.2.1 Enhanced envelope performance option

R408.2.2 More efficient HVAC equipment performance option

R408.2.3 Reduced energy use in service water-heating option

- Mindful of the efficiency of the equipment
- Would be required if not fully electric
- Should be verified from REScheck or the plans

Energy Factor 0.71

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ALL COMPLIANCE PATHS MUST COMPLY WITH ONE OF THE FOLLOWING:

R408.2.4 More efficient duct thermal distribution system option

1. 100 percent of ducts and air handlers located entirely within the building thermal envelope.
2. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the building thermal envelope.
3. 100 percent of duct thermal distribution system located in conditioned space as defined by Section R403.3.2.

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HOW TO COMPLY

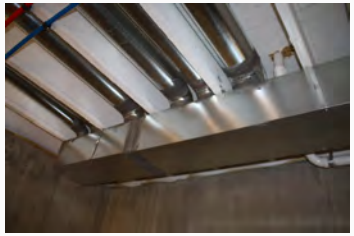
R408.2.1 Enhanced envelope performance option

R408.2.2 More efficient HVAC equipment performance option

R408.2.3 Reduced energy use in service water-heating option

R408.2.4 More efficient duct thermal distribution system option

- Place all ductwork inside the thermal envelope
- Remember Section R403.3.3
- Verify the installation, duct size, sealing, design found in Manual D and the plans



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ALL COMPLIANCE PATHS MUST COMPLY WITH ONE OF THE FOLLOWING:

R408.2.5 Improved Air Sealing And Efficient Ventilation System option

- < 3.0 ACH 50 +
- ERV or HRV +
- Lowest airflow tested > 75% sensible recovery efficiency (SRE) 1.1 cubic feet per minute watt
- No recirculation as defrost strategy
- ERV > 50% Latent Recovery/Moisture Transfer (LRMT)

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HOW TO COMPLY

R408.2.1 Enhanced envelope performance option

R408.2.2 More efficient HVAC equipment performance option

R408.2.3 Reduced energy use in service water-heating option

R408.2.4 More efficient duct thermal distribution system option

R408.2.5 Improved Air Sealing And Efficient Ventilation System option

- HRV/ERV can serve multi-requirements
- Verify the blower door test results less than 3 ACH
- Verify HRV/HRV
  - 75% sensible recovery efficiency SRE
  - No recirculation defront
  - ERV greater than 50% LRMT

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ADDITIONAL EFFICIENCY PACKAGE

TOTAL BUILDING PERFORMANCE

- Do One Additional Efficiency Package Without Including In Proposed Design - Or
- 95% Annual Energy Cost

ENERGY RATING INDEX

- ERI Number Is 5% Less Than What's In Table R406.5

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HOW TO COMPLY

R401.2.5 Additional energy efficiency.

- 2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.
- 3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.

CLIMATE ZONE	ENERGY RATING INDEX
5	55

5% better then 55 is 52.25

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R401.3 Certificate.

A permanent certificate shall be completed by the builder or other *approved* party and posted on a wall in the space where the furnace is located, a utility room or an *approved* location inside the *building*. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory *label*, service disconnect *label* or other required labels. The certificate shall indicate the following:

1. The predominant *R*-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, *basement walls*, *crawl space walls* and floors and ducts outside *conditioned spaces*.
2. *U*-factors of fenestration and the *solar heat gain coefficient* (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
3. The results from any required duct system and building envelope air leakage testing performed on the building.
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired unvented room heater, electric furnace or baseboard electric heater is installed in the residence, the certificate shall indicate "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.
5. Where on-site *photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.
6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.
7. The code edition under which the structure was permitted, and the compliance path used.

IECC 2018 Label
8925 Place to live

Building Envelope Specs
Ceiling: R-49
Above Grade Walls: R-23
Foundation Walls: R-15
Exposed Floor: R-30
Slab: R-0
Infiltration: 2.5 ACH50
Duct Insulation: R-8
Duct Leakage: 10 CFM25

Window & Door Specs
U-Value: 0.27, SHGC: 0.3
Door: R-5

Mechanical Equipment Specs
Heating: Furnace • Natural Gas • 96 AFUE
Cooling: Air Conditioner • Electric • 13 SEER
Hot Water: Water Heater • Natural Gas • 0.97 Energy Factor

Builder or Design Professional
Signature:

SHUMS CODA ASSOCIATES

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LET'S PLAY A GAME

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THANK YOU

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