Residential Requirements of the Texas Energy Code – 2009 IRC – Chap 11
The Family of I-Codes

- International Building Code
- International Mechanical Code
- International Fuel Gas Code
- International Property Maintenance Code
- International Fire Code
- International Zoning Code
- International Plumbing Code
- Code Requirements for Housing Accessibility
- International Private Sewage Disposal Code
- ICC Electrical Code
- International Residential Code
- International Energy Conservation Code
Relationship Between IRC & IECC

- IECC addresses only energy
- IRC addresses all topics (*structural, plumbing, etc.*)
  - Allows builder to carry only one code book
  - Chapter 11 covers energy efficiency
- IECC addresses both residential and commercial; IRC addresses subset of residential, detached one- and two-family dwellings and townhouses 3 stories or fewer
Structure of the IECC

Chapter 1  Administrative
Chapter 2  Definitions
Chapter 3  Climate Zones
Chapter 4  **Residential Energy Efficiency**
Chapter 5  Commercial Energy Efficiency
Chapter 6  Referenced Standards
Scope
Section 1101

Residential Buildings:

- IECC has one- and two-family R-2, R-4 ≤ 3 stories
- All buildings that are not “residential” by definition are “commercial”
- Includes additions, alterations, renovations and repairs
Scope

Section 101.4 - Exempted Buildings

- Very low energy use buildings \(<3.4 \text{ Btu/h-ft}^2 \text{ or } 1 \text{ watt/ft}^2\) (Section 101.5.2)

- Buildings (or portions of) that are neither heated nor cooled

- Existing buildings (Section 101.4.1)
  - Electrical power, lighting, and mechanical systems still apply

- Buildings designated as historic (Section 101.4.2)
✔ Treat as a stand-alone building

✔ Additions must meet the prescriptive requirements in Table 402.1.1 (or U-factor or total UA alternatives)
Code applies to any new construction

Unaltered portion(s) do not need to comply

Additions can comply alone or in combination with existing building

Replacement fenestration that includes both glazing and sash must meet

- 0.30 SHGC in Climate Zones 1-3
- U-factors in all Zones
Exceptions

✔ Storm windows over existing fenestration
✔ Glass-only replacements
✔ Exposed, existing ceiling, wall or floor cavities if already filled with insulation
✔ Where existing roof, wall or floor cavity isn’t exposed
✔ Reroofing for roofs where neither sheathing nor insulation exposed
  - Insulate above or below the sheathing
    • Roofs without insulation in the cavity
    • Sheathing or insulation is exposed

✔ Lighting alterations if:
  - <50% of luminaries in a space are replaced
  - Only bulbs and ballasts within existing luminaries are replaced (provided installed interior lighting power isn’t increased)

Any non-conditioned space that is altered to become conditioned space is required to be brought into full compliance with code.
Any non-conditioned space that is altered to become conditioned space shall be required to be brought into full compliance with this code

**Examples:**

- Converting a garage to a family room
- Heating an unfinished basement
Scope
Section 101.4.6 - Mixed Use Buildings

✓ Treat the residential occupancy under the applicable residential code
✓ Treat the commercial occupancy under the commercial code
Climate-Specific Requirements:

 ✓ Foundations
   • Basements
   • Slabs
   • Crawlspace
 ✓ Above grade walls
 ✓ Skylights, windows, and doors
 ✓ Roofs
 ✓ Solar Heat Gain Coefficient in warm climates

Mandatory Requirements (apply everywhere):

 ✓ Duct insulation and sealing
 ✓ Infiltration control
 ✓ HVAC controls
 ✓ Piping Insulation
 ✓ Equipment sizing
 ✓ Dampers
IECC Terminology

✓ **Prescriptive**
  • Required but can be lessened or eliminated in trade for compensating improvements elsewhere

✓ **Mandatory**
  • Required and cannot be traded down, even in the simulated performance path

Some elements have “hard limits”

✓ aka, “trade-off limits”
✓ a prescriptive requirement that can only be traded so far
✓ performance requirements can only be traded so far
Overview of Residential Code Requirements

✓ Focus is on building envelope
  – Ceilings, walls, windows, floors, foundations
  – Sets insulation and fenestration levels, and solar heat gain coefficients
  – Infiltration control - caulk and seal to prevent air leaks

✓ Ducts – seal and insulate

✓ Limited space heating, air conditioning, and water heating requirements
  – Federal law sets most equipment efficiency requirements, not the I-codes

✓ No appliance requirements

✓ Lighting equipment – 50% of lamps to be high-efficacy lamps
IECC Compliance - Three Options

- **PRESCRIPTIVE**
  - Insulation & Fenestration Only 402.1.1

- **U-FACTOR & “UA” ALTERNATIVES**
  - U-factor 402.1.3 Total Building UA 402.1.4

- **SIMULATED PERFORMANCE (software)**
  - Simulated Performance Alternative 405
Code Compliance Tools

**Prescriptive**
- None Needed

**Total Building UA Trade-Off**
- REScheck Software (Web-based & Desktop)

**Energy Analysis**
- Software (example) REM/Design REM/Rate EnergyGauge
Building Envelope consists of:

- **Fenestration**
- Ceilings
- Walls
  - Above grade
  - Below grade
  - Mass walls
- Floors
- Slabs
- Crawlspace

Conditioned Space
Table 402.1.1
Insulation and Fenestration Requirements by Component

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>FENESTRATION U-FACTOR</th>
<th>SKYLIGHT U-FACTOR</th>
<th>GLAZED FENESTRATION U-FACTOR</th>
<th>CEILING R-VALUE</th>
<th>WOOD FRAME WALL R-VALUE</th>
<th>MASS WALL R-VALUE</th>
<th>FLOOR R-VALUE</th>
<th>BASEMENT WALL R-VALUE</th>
<th>SLAB R-VALUE &amp; DEPTH</th>
<th>CRAWL SPACE WALL R-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.20</td>
<td>0.75</td>
<td>0.30</td>
<td>0.35</td>
<td>30</td>
<td>13</td>
<td>3 / 4</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0.65</td>
<td>0.75</td>
<td>0.30</td>
<td>0.35</td>
<td>30</td>
<td>13</td>
<td>4 / 6</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0.50</td>
<td>0.65</td>
<td>0.30</td>
<td>0.35</td>
<td>30</td>
<td>13</td>
<td>5 / 8</td>
<td>19</td>
<td>5 / 13</td>
<td>0</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>0.35</td>
<td>0.60</td>
<td>NR</td>
<td>38</td>
<td>13</td>
<td>5 / 10</td>
<td>19</td>
<td>10 / 13</td>
<td>10, 2 ft</td>
<td>10 / 13</td>
</tr>
<tr>
<td>5 and</td>
<td>0.35</td>
<td>0.60</td>
<td>NR</td>
<td>38</td>
<td>13 or 13+5</td>
<td>13 / 17</td>
<td>30</td>
<td>10 / 13</td>
<td>10 / 13</td>
<td>10 / 13</td>
</tr>
</tbody>
</table>

a. R-values are minimums, U-factors and SHGC are maximums, R-19 batts compressed into a nominal 2 x 6 framing cavity such that the R-value is reduced by R-1 or more shall be marked with the compressed batt R-value in addition to the full thickness R-value.
b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
c. “15/19” means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. “15/19” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home. “10/13” means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.
d. R-5 shall be added to the required slab edge R-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.
e. There are no SHGC requirements in the Marine Zone.
f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.
g. Or insulation sufficient to fill the framing cavity, R-19 minimum.
h. “13+5” means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
i. The second R-value applies when more than half the insulation is on the interior of the mass wall.
j. For impact rated fenestration complying with Section R301.2.1.2 of the IRC or Section 1608.1.2 of the IBC, maximum U-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.
Doors and windows

- NFRC rating or default table
  - If no labeled U-factor and SHGC, use default table
- No glass area limits
- Exemptions (*prescriptive path only*)
  - Up to 15 ft² of glazing per dwelling unit (*Section 402.3.3*)
  - One side-hinged opaque door assembly up to 24 ft² (*Section 402.3.4*)
Can be used to satisfy U-factor and SHGC requirements

Subject to hard limits, even in trade-offs

- Window U = 0.48 in CZ 4-5
- Skylight U = 0.75 in 4-8
- SHGC = 0.5 in CZ 1-3 (for Section 405 trade-offs)
Skylights
Section 402.3

✓ Meet U-factor
✓ Meet SHGC
Building Envelope Specific Requirements

Building Envelope consists of:

- Fenestration
- **Ceilings**
- Walls
  - Above grade
  - Below grade
  - Mass walls
- Floors
- Slabs
- Crawlspace
Requirements based on

- Assembly type
- Continuous insulation
- Insulation between framing (cavity insulation)

Meet or exceed R-values
R-values are to be printed on the batt insulation or rigid foam board.

Blown-in insulation must have an insulation certificate at or near the opening of the attic.

The certificate should include:
- R-value of installed thickness
- Initial installed thickness
- Installed density
- Settled thickness/settled R-value
- Coverage area
- Number of bags installed

Insulation markers must be installed every 300 square feet and be marked with the minimum installed thickness and affixed to the trusses or joists.
Ceilings with Attics  
Section 402.2.1

Ceiling insulation requirements in R-value table assume standard truss systems.
Prescriptive R-value path encourages raised heel truss (aka, energy truss)

- If insulation is full height over exterior wall top plate
  - R-30 complies where R-38 is required
  - R-38 complies where R-49 is required

Note: This reduction ONLY applies to the R-value prescriptive path, not the U-factor or Total UA alternatives.
Ceilings without Attic Spaces
Section 402.2.2 - (e.g., vaulted)

✓ Where insulation levels are required > R-30
✓ Not sufficient amount of space to meet higher levels
✓ R-30 allowed for 500 ft² or 20% total insulated ceiling area, whichever is less

Note: This reduction ONLY applies to the R-value prescriptive path, not the U-factor or Total UA alternatives
### Table 402.2.5

Steel-Frame Ceiling, Wall and Floor Insulation (R-Value)

<table>
<thead>
<tr>
<th>Wood Frame R-value</th>
<th>Steel Truss Ceilings$^b$</th>
<th>Steel Framed Wall</th>
<th>Steel Joist Floor</th>
<th>Steel Truss Ceilings$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-13</td>
<td>R-38 + 3 or R-26 + 5</td>
<td>R-49</td>
<td>R-38</td>
<td>R-38 + 3 or R-26 + 5</td>
</tr>
<tr>
<td>R-20</td>
<td>R-38 + 3 or R-26 + 5</td>
<td>R-49</td>
<td>R-38</td>
<td>R-38 + 3 or R-26 + 5</td>
</tr>
<tr>
<td>R-19 + 6 in 2x6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-19 + 12 in 2x8 or 2x10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table keys on the wood-frame requirement for the corresponding building component**

- “R-X + Y” means R-X cavity plus R-Y continuous
- In ceilings, insulation that exceeds the height of the framing must cover the framing

---

**Steel-Frame Ceilings**

Section 402.2.5

- R-19 + 6 in 2x6
- R-19 + 12 in 2x8 or 2x10

---

**Steel Framed Wall**

- R-38 + 3 or R-26 + 5
- R-49 in 2x4, or 2x6, or 2x8, or 2x10
- R-30

---

**Steel Joist Floor**

- R-38 + 3 or R-26 + 5
- R-49 in 2x4, or 2x6, or 2x8
- R-13 + 5 or R-15 + 4, or R-21 + 3 or R-20 + 10

---

**Cold-Formed Steel Equivalent R-value$^a$**

- R-19 + 6 in 2x6
- R-19 + 12 in 2x8 or 2x10

---

**Wood Frame R-value**

- R-19, 2x6
- R-19, 2x8 or 2x10

---

**Table keys on the wood-frame requirement for the corresponding building component**

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- In ceilings, insulation that exceeds the height of the framing must cover the framing

---

**Steel-Frame Ceiling**

- R-38 + 3 or R-26 + 5
- R-49 in 2x4, or 2x6, or 2x8, or 2x10
- R-30
Weatherstrip and insulate doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces)

- Insulate to level equivalent to surrounding surfaces
  - e.g., required ceiling insulation = R-38, then attic hatch must be insulated to R-38

Provide access to all equipment that prevents damaging or compressing the insulation

Install a wood framed or equivalent baffle or retainer when loose fill insulation is installed
Conditioned Attics

- Insulate at roof deck
- Refer to IRC (Section R 806.4) for ventilation
- Insulation for condensation control (IRC Table R806.4)
  - Go to kenergy.us for a ppt specific to conditioned attics
Building Envelope consists of:

- Fenestration
- Ceilings
- Walls
  - Above grade
  - Below grade
  - Mass walls
- Fenestration
- Floors
- Slabs
- Crawlspace
Walls Covered by IECC

- Exterior above-grade walls
- Attic kneewalls
- Skylight shaft walls
- Perimeter joists
- Basement walls
- Garage walls (shared with conditioned space)
Above Grade Walls

Don’t forget to insulate rim joists

Insulate walls including those next to unconditioned spaces
Wood-Frame Walls
Section 402

Required R-value can be met with any combination of cavity or continuous insulation

**Exception in zones 5-6**: R-13 cavity plus R-5 sheathing meets R-20 requirement

h. “13+5” means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
## Table 402.2.5
### Steel-Frame Ceiling, Wall and Floor Insulation (R-Value)

<table>
<thead>
<tr>
<th>Wood Frame R-value</th>
<th>Cold-Formed Steel Equivalent R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steel Truss Ceilings</strong></td>
<td></td>
</tr>
<tr>
<td>R-30</td>
<td>R-38 or R-30 + 3 or R-26 + 5</td>
</tr>
<tr>
<td>R-38</td>
<td>R-49 or R-38 + 3</td>
</tr>
<tr>
<td><strong>Steel Framed Wall</strong></td>
<td></td>
</tr>
<tr>
<td>R-13</td>
<td>R-13 + 5 or R-15 + 4</td>
</tr>
<tr>
<td>R-19</td>
<td>R-13 + 9 or R-19 + 8</td>
</tr>
<tr>
<td>R-21</td>
<td>R-13 +10 or R-19 +10</td>
</tr>
<tr>
<td><strong>Steel Joist Floor</strong></td>
<td></td>
</tr>
<tr>
<td>R-13</td>
<td>R-19, 2x6</td>
</tr>
<tr>
<td></td>
<td>R-19 + 6 in 2x8 or 2x10</td>
</tr>
<tr>
<td>R-19</td>
<td>R-19 + 6 in 2x6</td>
</tr>
<tr>
<td></td>
<td>R-19 +12 in 2x8 or 2x10</td>
</tr>
</tbody>
</table>

Table keys on the wood-frame requirement for the corresponding building component:

- "R-X + Y" means R-X cavity plus R-Y continuous
- Exception: In climate zones 1 and 2, the continuous R-value can be reduced to R-3 for walls on 24” centers
Mass Walls
Section 402.2.4

What type

✓ Concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth, and solid timber/logs

Provisions

✓ Are assumed to be above grade walls
Mass Wall Requirements
Section 402.2.4

<table>
<thead>
<tr>
<th>ZONE</th>
<th>FENESTRATION U-FACTOR</th>
<th>SKYLIGHT U-FACTOR</th>
<th>GLAZED FENESTRATION SHGC</th>
<th>CEILING R-VALUE</th>
<th>WOOD FRAME WALL R-VALUE</th>
<th>MASS WALL R-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>3/4</td>
</tr>
<tr>
<td>2</td>
<td>0.65</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>4/6</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td>5/8</td>
</tr>
<tr>
<td>4 except Marine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td>5/10</td>
</tr>
<tr>
<td>5 and Marine 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20 or 13-5^h</td>
<td>13/17</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20 or 13-5^h</td>
<td>15/19</td>
</tr>
<tr>
<td>7 and 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td>19/21</td>
</tr>
</tbody>
</table>

Second (higher) number applies when more than half the R-value is on the interior of the mass (i.e., when the thermal mass is insulated from the conditioned space)
Building Envelope consists of:

- **Fenestration**
- **Ceilings**
- **Walls**
  - Above grade
  - Below grade
  - Mass walls
- **Floors**
- **Slabs**
- **Crawlspace**

---

**Conditioned Space**

**attic**
Floors Over Unconditioned Space

Section 402.2.6

**TABLE 402.1.1**

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>FENESTRATION U-FACTOR&lt;sup&gt;b&lt;/sup&gt;</th>
<th>SKYLIGHT&lt;sup&gt;b&lt;/sup&gt; U-FACTOR</th>
<th>GLAZED FENESTRATION SHGC&lt;sup&gt;b,e&lt;/sup&gt;</th>
<th>CEILING R-VALUE</th>
<th>WOOD FRAME WALL R-VALUE</th>
<th>MASS WALL R-VALUE</th>
<th>FLOOR R-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>3/4</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>0.65&lt;sup&gt;j&lt;/sup&gt;</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>4/6</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>0.50&lt;sup&gt;j&lt;/sup&gt;</td>
<td>0.65</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>5/8</td>
<td>19</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 and Marine 4</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 and 8</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Exception:** If framing members are too small to accommodate R-30, insulation that fills the framing cavity, not less than R-19, complies.
Unconditioned space includes unheated basement, vented crawlspace, or outdoor air.

<table>
<thead>
<tr>
<th>Climate Zones</th>
<th>R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>13</td>
</tr>
<tr>
<td>3-4ab</td>
<td>19</td>
</tr>
<tr>
<td>4c-6</td>
<td>30 *</td>
</tr>
<tr>
<td>7-8</td>
<td>38 *</td>
</tr>
</tbody>
</table>

* Exception

Climate Zones 4c-8
R-19 permitted if cavity completely filled.

Insulation must maintain permanent contact with underside of subfloor.
## Table 402.2.5
**Steel-Frame Ceiling, Wall and Floor Insulation (R-Value)**

<table>
<thead>
<tr>
<th>Wood Frame R-value</th>
<th>Cold-Formed Steel Equivalent R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steel Truss Ceilings</strong></td>
<td></td>
</tr>
<tr>
<td>R-30</td>
<td>R-38 or R-30 + 3 or R-26 + 5</td>
</tr>
<tr>
<td>R-38</td>
<td>R-49 or R-38 + 3</td>
</tr>
<tr>
<td><strong>Steel Framed Walls</strong></td>
<td></td>
</tr>
<tr>
<td>R-13</td>
<td>R-13 + 5 or R-13 + 4 or R-21 + 3</td>
</tr>
<tr>
<td>R-19</td>
<td>R-19 + 9 or R-19 + 8 or R-25 + 7</td>
</tr>
<tr>
<td>R-21</td>
<td>R-19 + 10 or R-19 + 9 or R-25 + 8</td>
</tr>
<tr>
<td><strong>Steel Joist Floor</strong></td>
<td></td>
</tr>
<tr>
<td>R-13</td>
<td>R-19, 2x6</td>
</tr>
<tr>
<td></td>
<td>R-19 + 6 in 2x8 or 2x10</td>
</tr>
<tr>
<td>R-19</td>
<td>R-19 + 6 in 2x6</td>
</tr>
<tr>
<td></td>
<td>R-19 +12 in 2x8 or 2x10</td>
</tr>
</tbody>
</table>

Table keys on the wood-frame requirement for the corresponding building component: “R-X + Y” means R-X cavity plus R-Y continuous.
Defining Below-Grade Walls

Basement Wall – >50% below grade

Below grade
Basement wall

Exterior Wall – <50% below grade
Below-Grade Walls

✓ ≥ 50% below grade
✓ Otherwise treat as above-grade wall

<table>
<thead>
<tr>
<th>Climate Zones</th>
<th>R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>5/13</td>
</tr>
<tr>
<td>4-5</td>
<td>10/13</td>
</tr>
<tr>
<td>6-8</td>
<td>15/19</td>
</tr>
</tbody>
</table>

Insulated from top of basement wall down to 10 ft below grade or basement floor, whichever is less
Below-Grade Walls
Section 402.1

TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>FENESTRATION U-FACTORb</th>
<th>SKYLIGHTU-FACTOR</th>
<th>GLAZED FENESTRATION SHGCb, c</th>
<th>CEILING R-VALUE</th>
<th>WOOD FRAME WALL R-VALUE</th>
<th>MASS WALL R-VALUE</th>
<th>FLOOR R-VALUE</th>
<th>BASEMENT WALL R-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>3/4</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>4/6</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>5/8</td>
<td>19</td>
<td>5/13</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>5/10</td>
<td>19</td>
<td>10/13</td>
</tr>
<tr>
<td>5 and Marine 4</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>13/17</td>
<td>30e</td>
<td>10/13</td>
</tr>
<tr>
<td>6</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>15/19</td>
<td>30e</td>
<td>15/19</td>
</tr>
<tr>
<td>7 and 8</td>
<td>1.2</td>
<td>0.75</td>
<td>0.30</td>
<td>30</td>
<td>13</td>
<td>19/21</td>
<td>38e</td>
<td>15/19</td>
</tr>
</tbody>
</table>

- “X/Y” means R-X continuous or R-Y cavity
- 15/19 requirement can be met with R-13 cavity (interior) plus R-5 continuous (exterior)
- In zone 3, no insulation required in warm-humid counties
Building Envelope Specific Requirements

Building Envelope consists of:

- Fenestration
- Ceilings
- Walls
  - Above grade
  - Below grade
  - Mass walls
- Floors
- Slabs
- Crawlspace
Applies to slabs with a floor surface < 12 inches below grade

✓ R-10 (typically 2 inches) insulation in Zones 4 and above

✓ Must extend downward from top of slab a minimum of 24” (Zones 4 and 5) or 48” (Zones 6, 7, and 8)

✓ Insulation can be vertical or extend horizontally under the slab or out from the building

✓ Insulation extending outward must be under 10 inches of soil or pavement
  • An additional R-5 is required for heated slabs
  • Insulation depth of the footing or 2 feet, whichever is less in Zones 1-3 for heated slabs
Slab Edge Insulation
Section 402.2.8

Bevel Cut

Rigid Insulation

Slab
Building Envelope consists of:

- Fenestration
- Ceilings
- Walls
  - Above grade
  - Below grade
  - Mass walls
- Floors
- Slabs
- Crawlspaces
Implies an unvented crawlspace *(aka, conditioned crawlspace)*

- Space must be mechanically vented or receive minimal supply air *(see Section R408 of the IRC)*
- Exposed earth must be covered with a continuous Class I vapor retarder
Vented Crawlspace Requirements:

- The raised floor over the crawlspace must be insulated.
- A vapor retarder may be required as part of the floor assembly.
- Ventilation openings must exist that are equal to at least 1 square foot for each 150 square feet of crawlspace area and be placed to provide cross-flow (IRC 408.1, may be less if ground vapor retarder is installed).
- Ducts in crawlspace must be sealed and have R-6 insulation.

Unvented Crawlspace Requirements:

- The crawlspace ground surface must be covered with an approved vapor retarder (e.g., plastic sheeting).
- Crawlspace walls must be insulated to the R-value requirements specific for crawlspace walls (IECC Table 402.1.1).
- Crawlspace wall insulation must extend from the top of the wall to the inside finished grade and then 24” vertically or horizontally.
- Crawlspaces must be mechanically vented (1 cfm exhaust per 50 square feet) or conditioned (heated and cooled as part of the building envelope).
- Ducts are inside conditioned space and therefore don’t need to be insulated.
U-Factor and Total UA Alternatives

Section 402.1

U-factor Alternative

✓ Similar to Prescriptive R-Value but uses U-factors instead
  • Allows for innovative or less common construction techniques such as structural insulated panels or advanced framing
  • Allows no trade-offs between building components

Total UA Alternative

✓ Same as U-factor alternative but allows trade-offs across all envelope components
  • Primary approach used in REScheck software

UA – U factor x area of assembly
### Table 402.1.3
**Equivalent U-Factors**

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>FENESTRATION U-FACTOR</th>
<th>SKYLIGHT U-FACTOR</th>
<th>CEILING U-FACTOR</th>
<th>FRAME WALL U-FACTOR</th>
<th>MASS WALL U-FACTOR&lt;sup&gt;b&lt;/sup&gt;</th>
<th>FLOOR U-FACTOR</th>
<th>BASEMENT WALL U-FACTOR&lt;sup&gt;d&lt;/sup&gt;</th>
<th>CRAWL SPACE WALL U-FACTOR&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.20</td>
<td>0.75</td>
<td>0.035</td>
<td>0.082</td>
<td>0.197</td>
<td>0.064</td>
<td>0.360</td>
<td>0.477</td>
</tr>
<tr>
<td>2</td>
<td>0.65</td>
<td>0.75</td>
<td>0.035</td>
<td>0.082</td>
<td>0.165</td>
<td>0.064</td>
<td>0.360</td>
<td>0.477</td>
</tr>
<tr>
<td>3</td>
<td>0.50</td>
<td>0.65</td>
<td>0.035</td>
<td>0.082</td>
<td>0.141</td>
<td>0.047</td>
<td>0.091&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.136</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>0.35</td>
<td>0.60</td>
<td>0.030</td>
<td>0.082</td>
<td>0.141</td>
<td>0.047</td>
<td>0.059</td>
<td>0.065</td>
</tr>
<tr>
<td>5 and Marine 4</td>
<td>0.35</td>
<td>0.60</td>
<td>0.030</td>
<td>0.057</td>
<td>0.082</td>
<td>0.033</td>
<td>0.059</td>
<td>0.065</td>
</tr>
<tr>
<td>6</td>
<td>0.35</td>
<td>0.60</td>
<td>0.026</td>
<td>0.057</td>
<td>0.060</td>
<td>0.033</td>
<td>0.050</td>
<td>0.065</td>
</tr>
<tr>
<td>7 and 8</td>
<td>0.35</td>
<td>0.60</td>
<td>0.026</td>
<td>0.057</td>
<td>0.057</td>
<td>0.028</td>
<td>0.050</td>
<td>0.065</td>
</tr>
</tbody>
</table>

<sup>a</sup> Nonfenestration U-factors shall be obtained from measurement, calculation or an approved source.

<sup>b</sup> When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.10 in Zone 4 except Marine, and the same as the frame wall U-factor in Marine Zone 4 and Zones 5 through 8.

<sup>c</sup> Basement wall U-factor of 0.360 in warm-humid locations as defined by Figure 301.1 and Table 301.2.
Provisions

- When more than half the insulation is on the interior, the mass wall U-factors:

<table>
<thead>
<tr>
<th>Climate Zones</th>
<th>U-Factor Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.17</td>
</tr>
<tr>
<td>2</td>
<td>0.14</td>
</tr>
<tr>
<td>3</td>
<td>0.12</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>0.10</td>
</tr>
<tr>
<td>4 Marine</td>
<td>0.57 \textit{same as above grade frame wall}</td>
</tr>
<tr>
<td>5-8</td>
<td>0.57 \textit{same as above grade frame wall}</td>
</tr>
</tbody>
</table>
Fenestration Trade-off Limits

Hard limits on U-factor in northern U.S. (cannot be exceeded, even in trade-offs)

<table>
<thead>
<tr>
<th>Climate Zones</th>
<th>U-Factor Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5</td>
<td>0.48</td>
</tr>
</tbody>
</table>

- U-0.75 for skylights in Zones 4-8
- U-factors of individual windows or skylights can be higher if maximum area-weighted average is below these limits.
Sunrooms

Less stringent insulation
R-value and glazing
U-factor requirements

Sunroom definition:

✓ One story structure
✓ Glazing area >40% glazing of gross exterior wall and roof area
✓ Separate heating or cooling system or zone
✓ Must be thermally isolated (closeable doors or windows to the rest of the house)
✓ Can always meet Table 402.1.1 requirements with unlimited glass
Sunroom Requirements
Section 402.2.11

- Ceiling Insulation
  - Zones 1-4  R-19
  - Zones 5-8  R-24

- Wall Insulation
  - All zones  R-13

- Fenestration U-Factor
  - Zones 4-8  0.50

- Skylight U-Factor
  - Zones 4-8  0.75
Simulated Performance Alternative

✓ Requires computer software with specified capabilities (local official may approve other tools)
✓ Includes both envelope and some systems
  – Are treated equally in standard and proposed design
✓ Allows greatest flexibility
  – Can trade-off tight duct systems
✓ Defines compliance based on equivalency of calculated energy or energy cost
✓ Section 405 specifies “ground rules”
  – These will generally be “hidden” in compliance software calculation algorithms
  – Very similar ground rules are used in home federal tax credits and ENERGY STAR Home guidelines
Mandatory Requirements

Section 402.4 - Air Leakage

- Building thermal envelope *(Section 402.4)*
- Recessed lighting
- Fenestration
- Fireplaces
Air Leakage Control
Section 402.4.1

Building thermal envelope
Durably sealed

✓ Caulked
✓ Gasketed
✓ Weatherstripped
✓ Air barrier material
✓ Suitable film or solid material
Areas for Air Leakage
Section 402.4.1 - Infiltration

- Windows and doors
- Between sole plates
- Floors and exterior wall panels
- Plumbing
- Electrical
- Service access doors or hatches
- Recessed light fixtures
- Rim joist junction
Two options to demonstrate compliance

✓ Whole-house pressure test
  • Air leakage <7 ACH when tested at pressure of 50 Pascals
  • Testing may occur any time after rough in and installation of building envelope penetrations

✓ Field verification of items listed in Table 402.4.2
## Air Sealing and Insulation

### Section 402.4.2

#### TABLE 402.4.2

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>CRITERIA</th>
</tr>
</thead>
</table>
| Air barrier and thermal barrier | Exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with building envelope air barrier.  
                                | Breaks or joints in the air barrier are filled or repaired.  
                                | Air-permeable insulation is not used as a sealing material.  
                                | Air-permeable insulation is inside of an air barrier.                                                                                   |
| Ceiling/attic                   | Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed.  
                                | Attic access (except unvented attic), knee wall door, or drop down stair is sealed.                                                     |
| Walls                           | Corners and headers are insulated.  
                                | Junction of foundation and sill plate is sealed.                                                                                       |
| Windows and doors               | Space between window/door jambs and framing is sealed.                                                                                   |
| Rim joists                      | Rim joists are insulated and include an air barrier.                                                                                     |
| Floors (including above-garage and cantilevered floors) | Insulation is installed to maintain permanent contact with underside of subfloor decking.  
                                | Air barrier is installed at any exposed edge of insulation.                                                                             |
| Crawl space walls               | Insulation is permanently attached to walls.  
                                | Exposed earth in unvented crawl spaces is covered with Class I vapor retarder with overlapping joints taped.                             |
| Shafts, penetrations            | Duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditioned space are sealed.                        |
| Narrow cavities                 | Batts in narrow cavities are cut to fit, or narrow cavities are filled by sprayed/blown insulation.                                         |
| Garage separation               | Air sealing is provided between the garage and conditioned spaces.                                                                       |
| Recessed lighting               | Recessed light fixtures are air tight, IC rated, and sealed to drywall.  
                                | Exception—fixtures in conditioned space.                                                                                               |
| Plumbing and wiring             | Insulation is placed between outside and pipes. Batt insulation is cut to fit around wiring and plumbing, or sprayed/blown insulation extends behind piping and wiring. |
| Shower/tub on exterior wall     | Showers and tubs on exterior walls have insulation and an air barrier separating them from the exterior wall.                             |
| Electrical/phone box on exterior walls | Air barrier extends behind boxes or air sealed-type boxes are installed.                                                                  |
| Common wall                     | Air barrier is installed in common wall between dwelling units.                                                                           |
| HVAC register boots             | HVAC register boots that penetrate building envelope are sealed to subfloor or drywall.                                                   |
| Fireplace                       | Fireplace walls include an air barrier.                                                                                                  |
### Fenestration

Section 402.4.4 - Air Leakage

<table>
<thead>
<tr>
<th>TYPE</th>
<th>AIR INFILTRATION RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows, sliding glass doors, and skylights</td>
<td>≤ 0.3 cfm/ft²</td>
</tr>
<tr>
<td>Swinging doors</td>
<td>≤ 0.5 cfm/ft²</td>
</tr>
</tbody>
</table>

**Exceptions**

- ✓ Site-built windows, skylights, and doors
New wood-burning “Masonry” fireplaces shall have gasketed doors and outdoor combustion air*

An ICC interpretation states this is meant for masonry fireplaces and not factory built!
✔ Type IC rated and labeled as meeting ASTM E 283 when tested at 1.57 psf (75 Pa) pressure differential with no more than 2.0 cfm of air movement

✔ Sealed with a gasket or caulk between the housing and interior wall or ceiling covering
Equipment efficiency set by Federal law, not the I-Codes
Mandatory Requirements Systems
Section 403

✓ Controls
✓ Heat pump supplementary heat
✓ Ducts
  – Sealing (Mandatory)
  – Insulation (Prescriptive)
✓ HVAC piping insulation
✓ Circulating hot water systems
✓ Ventilation
  – Dampers
✓ Equipment sizing
✓ Systems serving multiple dwelling units
✓ Snow melt controls
✓ Pools
If primary heating system is a forced-air furnace

✓ At least one programmable thermostat/dwelling unit
✓ Capability to set back or temporarily operate the system to maintain zone temperatures
  – down to 55°F (13°C) or
  – up to 85°F (29°C)
✓ Initially programmed with:
  – heating temperature set point no higher than 70°F (21°C) and
  – cooling temperature set point no lower than 78°F (26°C)
Prevent supplementary electric-resistance heat when heat pump can meet the heating load

**Exception**

✓ During defrost
Insulation (Prescriptive)
- Supply ducts in attics: R-8
- All other ducts: R-6

Sealing (Mandatory)
- Joints and seams shall comply with IRC, Section M1601.4.1
- All ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed (Section 403.2.2)

Building framing cavities shall not be used as supply ducts
### Duct Location Examples

**Section 403.2.1**

<table>
<thead>
<tr>
<th>Location</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attic</td>
<td>R-8</td>
</tr>
<tr>
<td>Conditioned Space</td>
<td>-</td>
</tr>
<tr>
<td>Vented Crawlspace</td>
<td>R-6</td>
</tr>
<tr>
<td>Conditioned Crawlspace</td>
<td>-</td>
</tr>
<tr>
<td>Basement – Conditioned</td>
<td>-</td>
</tr>
<tr>
<td>Basement – Unconditioned</td>
<td>R-6</td>
</tr>
<tr>
<td>Exterior Walls</td>
<td>R-6</td>
</tr>
</tbody>
</table>
Duct tightness shall be verified by either of the following:

✓ **Post construction test**
  - Leakage to outdoors: \( \leq 8 \text{ cfm/} \text{per 100 ft}^2 \) of conditioned floor area or
  - Total leakage: \( \leq 12 \text{ cfm/} \text{per 100 ft}^2 \) of conditioned floor area
    - tested at a pressure differential of 0.1 in w.g. (25Pa) across entire system, including manufacturer’s air handler enclosure
  - All register boots taped or otherwise sealed

✓ **Rough-in test**
  - Total leakage \( \leq 6 \text{ cfm/} \text{per 100 ft}^2 \) of conditioned floor area
    - tested at a pressure differential of 0.1 in w.g. (25Pa) across roughed-in system, including manufacturer’s air handler enclosure
    - all register boots taped or otherwise sealed
    - if air handler not installed at time of test
      » Total air leakage \( \leq 4 \text{ cfm/} \text{per 100 ft}^2 \)

**Exceptions:** Duct tightness test is not required if the air handler and all ducts are located within conditioned space
R-3 required on
- HVAC systems
  - Exception: Piping that conveys fluids between 55 and 105°F

R-2 required on
- All circulating domestic hot water systems
  - Systems also require a readily accessible manual switch

Image courtesy of Ken Baker, K energy
Ventilation

- Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

Equipment Sizing

- IECC references Section M1401.3 of the IRC.
- Load calculations determine the proper capacity (size) of equipment:
  - Goal is big enough to ensure comfort but no bigger.
- Calculations shall be performed in accordance with ACCA Manual J & S or other approved methods.
Snow Melt System Controls
Section 403.8

Snow- and ice-melting system controls

- Automatic shutoff when pavement temperature is > 50°F and no precipitation is falling
- Automatic or manual shutoff when outdoor temperature is > 40°F

Image courtesy of Ken Baker, K energy
Pool heaters
- with a readily accessible on-off switch
- fired by natural gas not allowed to have continuously burning pilot lights

Time switches to automatically turn off and on heaters and pumps according to a preset schedule installed on swimming pool heaters and pumps
- **Exceptions**
  - Public health standards requiring 24-hour pump operation
  - Pumps operating pools with solar-waste-heat recovery heating systems
On heated pools

✓ If heated to >90°F, vapor-retardant pool cover at least R-12

Exception:

✓ If >60% of energy from site-recovered or solar energy source
Systems serving multiple dwelling units shall comply with Sections 503 and 504 in lieu of Section 403.
A minimum of 50 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps.
Code Official has final authority
  - Software, worksheets
  - Above Code Programs

Electronic media can be used

Construction work for which a permit is required is subject to inspection

Certificate is required
✓ Code Officials Inspection
  – Successive and final inspections, and reinspections if necessary

✓ Code Validity
  – Code deemed to be illegal or void shall not affect the remainder of the code

✓ Codes and standards considered part of the requirements of the code
  – Provisions take precedence

✓ Fees
  – Must be paid before permit is issued
  – Required in accordance with schedule
Certificate

✓ Permanently posted on or in the electrical distribution panel
✓ Don’t cover or obstruct the visibility of other required labels
✓ Includes the following:
  – R-values of insulation installed for the thermal building envelope, including ducts outside conditioned spaces
  – U-factors for fenestration
  – SHGC for fenestration
  – HVAC efficiencies and types
  – SWH equipment
### REScheck Compliance Certificate

#### 2009 IECC Energy Efficiency Certificate

<table>
<thead>
<tr>
<th>Insulation Rating</th>
<th>R-Value</th>
<th>U-Factor</th>
<th>SHGC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling / Roof</td>
<td>40.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall</td>
<td>20.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor / Foundation</td>
<td>30.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductwork (unconditioned spaces):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass &amp; Door Rating</td>
<td></td>
<td>0.36</td>
<td>0.30</td>
</tr>
<tr>
<td>Window</td>
<td></td>
<td>0.50</td>
<td>NA</td>
</tr>
<tr>
<td>Door</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Heating & Cooling Equipment

<table>
<thead>
<tr>
<th>Heating System</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooling System</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Heater</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Name: __________________________________________ Date: ____________

Comments: ______________________________________________
Certificate lists “gas-fired unvented room heater”, “electric furnace”, or “baseboard electric heater”, rather than listing an efficiency for those heating types