Providing effective energy strategies for buildings and communities

2018 International Energy Conservation Code Updates
05.09.2018
Who we are

Our goal: Reduce the energy footprint of Illinois.
SEDAC is the Illinois Energy Conservation Code Training Provider

This training program is sponsored by Illinois EPA
Energy Code Assistance

- Technical support
  - 800.214.7954
  - energycode@sedac.org
- Online resources at sedac.org/energy-code
- Workshops
- Webinars
- Online on-demand training modules
Energy Code Training

SEDAC is the Illinois Energy Conservation Code training provider

The Smart Energy Design Assistance Center (SEDAC), in partnership with the Illinois EPA Office of Energy, is providing training to increase awareness of the Illinois Energy Conservation Code and to improve the energy efficiency of new construction and renovation in Illinois. Community code officials, construction professionals and trades, and design professionals such as architects and engineers are invited to participate. SEDAC will be offering workshops, webinars, online training, resources, and technical support.

Funding provided in whole or in part by the Illinois EPA Office of Energy.
Why learn about the Illinois Energy Conservation Code?

According to Architecture 2030, an estimated 75% of the buildings in the US will be constructed or renovated in the next 20 years. This presents a tremendous opportunity.

- Will we continue to design buildings that are inefficient, wasting billions of dollars in energy costs and harming the environment?
- Or will we design buildings that are energy efficient, reducing energy costs and contributing to a healthier environment?

It is always easier (and less expensive) to build or renovate for energy efficiency from the start, rather than trying to make a building more energy efficient later. Upfront decisions made when the building is designed or constructed largely determine how energy efficient it will be.

In making these decisions, building energy codes can be extremely useful. According to the US Department of Energy, building energy codes govern up to 80% of a building's energy load. The code's requirements are based on energy efficiency best practices for HVAC, building envelope, and lighting. Meeting or exceeding code requirements will lead to substantial energy and cost savings over the life of the building.

Illinois Law

Illinois is a leader in energy conservation code compliance. It is one of a handful of states that requires that all new and renovated buildings comply with the
As you take this quiz, feel free to refer to the [2015 IECC](http://www.sedac.org/energy-code), the [Illinois Amendments](http://www.sedac.org/energy-code) or the [Chicago Amendments](http://www.sedac.org/energy-code).

Which of the following details must be on the construction documents? (Choose all that are required)

Choose ALL answers that apply.

- **A** Mechanical and service water-heating system and equipment types, sizes, and efficiencies
- **B** Air sealing details
- **C** Light fixture specifications
- **D** Insulation materials and their R-values
- **E** Circuit breaker details
- **F** Equipment and system controls
Illinois Energy Conservation Code
Illinois Energy Conservation Code

• Presently 2015 International Energy Conservation Code (IECC), with Illinois Amendments

• 2018 IECC, with Illinois Amendments planned for adoption Q3 2018 with effective date in Q1 2019

• Amendment proposals now posted on CDB website
• Meeting Minutes are also posted

• All commercial and residential construction in the State of Illinois must follow the Illinois Energy Conservation Code
Why Energy Code is important?

Buildings use a lot of energy and create a lot of emissions:

• Commercial & residential buildings in the US consumes nearly (___)% of the nation’s total primary energy

• Buildings consume (___) % of electricity in the US.

• (___) % of US total CO₂ emission is attributed to building services
Why Energy Code is important?

Electricity Consumption by Sector (2013):
Commercial, Industrial, and Residential

- Transportation: 0.2%
- Commercial: 35%
- Residential: 37%
- Industrial: 27%

Commercial (2013)
- Other uses: 36%
- HVAC: 26%
- Lighting: 20%
- Water heating: 2%

Manufacturing (2010)
- Machine drive: 50%
- Direct uses: other process: 20%
- Direct uses: total nonprocess: 17%
- Indirect uses: boiler fuel: 2%
- End-use not reported: 2%

Residential (2013)
- Other uses: 25%
- Appliances and electronics: 29%
- Water heating: 10%
- Lighting: 12%
- HVAC: 26%
Benefits of Energy Code?

• Reduced Energy Consumption: approximately 3.5 quad Btu per year by 2030 (equivalent to power generated by 260 medium power plants)

• Reduced CO₂ Emission: approximately 3% of the projected national CO₂ emission in 2030.

• Total annual $ savings to building owners would be $30 billion by 2030.
Access to 2018 IECC

https://codes.iccsafe.org/public/document/iecc2018

2018 International Energy Conservation Code

This title is available for premiumACCESS. Click to purchase a premium subscription to this content.

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- PREFACE
- EFFECTIVE USE OF THE INTERNATIONAL ENERGY CONSERVATION CODE
- IECC—COMMERCIAL PROVISIONS
- CHAPTER 1 [CE] SCOPE AND ADMINISTRATION
Commercial
2018 IECC Commercial Changes: Highlights

• No significant energy efficiency improvement (initial estimate of 2-5% improvement)

• Mechanical Section (C 403): Reorganized, so all provisions for a type of equipment or system are in one place

• Additional efficiency package options: Enhanced envelope performance (C406.8) & Reduced air infiltration (C406.9)

• More detailed requirements for controls: Change from “be capable of” to “be configured”
2018 IECC Commercial Changes: Highlights

- Appendix CA Solar-Ready Zone
- ASHRAE 90.1-2016
- New climate zone map (6 counties in Illinois – Calhoun, Clark, Coles, Cumberland, Greene, Jersey: from 5A to 4A)
- New performance-based compliance path (Appendix G)
C101.4.1 Mixed residential & commercial buildings: from “mixed occupancy of both residential and commercial occupancy” to “a building includes both residential and commercial building portion”

... each portion shall be separately considered and meet the applicable provisions of the IECC - Commercial or Residential.

Situation: 5-story residential building vs. 5-story mixed use building
• C103.6 Building documentation and closeout submittal requirements: Record documents, compliance documents shall be provided to the owner within 90 days of certificate of occupancy. Also training for maintenance shall be provided.

• C105.1 Inspection: from “Construction work shall remain accessible and exposed” to “visible and accessible”
2018 IECC Commercial Changes: Admin

- C105.2.2 Thermal envelope inspection: from “Framing and rough-in inspection” to “Thermal envelope inspection”

- C202 Definition
- Air barrier: added “continuous manner”
- Approved: from “Approval by the code official as a result of investigation and tests conducted by him or her, or by nationally recognized organizations” to “Acceptable to the code official”
- Fenestration: added definition of “skylights and vertical fenestration”
Table C303.1.3(2)
DEFAULT OPAQUE DOOR U-FACTORS

<table>
<thead>
<tr>
<th>DOOR TYPE</th>
<th>OPAQUE U-FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsulated Metal</td>
<td>1.20</td>
</tr>
<tr>
<td><strong>Insulated Metal (Rolling)</strong></td>
<td><strong>0.90</strong></td>
</tr>
<tr>
<td>Insulated Metal (Other)</td>
<td>0.60</td>
</tr>
<tr>
<td>Wood</td>
<td>0.50</td>
</tr>
<tr>
<td>Insulated, nonmetal edge, max 45% glazing, any glazing double pane</td>
<td>0.35</td>
</tr>
</tbody>
</table>
Low-energy Building

Space conditioning peak load of <1.0 watt per square foot (<3.41 Btuh per square foot)
R-5 continuous insulation required under heated slabs for both commercial and residential.
Roof Insulation

Requires a minimum of 2 layers of insulation for continuous roof insulation.

Image courtesy of Pacific Northwest National Labs
Skylight curb

Specifies insulation for skylight curbs of minimum R-5 unless NFRC 100 listed and labeled
Masonry Walls with Integrated Insulation

Allows for using u-value table (C402.1.4) for concrete masonry units with integrated insulation

May NOT use r-value table (C402.1.3), but previously, neither path was available
Mass Floors

Created definition and specification of mass floors where used as part of the thermal envelope

35 pounds per square foot or
25 pounds per square foot for light weight material
Below-grade walls

New section on below grade walls includes C-factor and R-value

C-factor is inverse of R-value
Airspaces

New section provides guidance on treatment of airspaces

Cavity shall be enclosed, unventilated, and sealed
Skylight Area

Increases maximum skylight area limit from 5% to 6%

Image courtesy of DOE
Decreases SHGC for fenestration from 0.4-0.64 to 0.36-0.61
Daylight Zones

New section on Daylight zones, includes both top lit and side lit daylight zones

Image courtesy of International Code Council
Air sealing

Requires sealing to allow for expansion, contraction, vibration, etc.

Photo Courtesy of Matt Risinger
Door Types

Adds power operating sliding or folding doors to the Maximum Air Leakage Rate for Fenestration Table.

Table C402.5.2 (excerpt)
MAXIMUM AIR LEAKAGE RATE FOR FENESTRATION ASSEMBLIES

<table>
<thead>
<tr>
<th>FENESTRATION ASSEMBLY</th>
<th>MAXIMUM RATE (CFM/SF²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtain walls</td>
<td>0.06</td>
</tr>
<tr>
<td>Storefront glazing</td>
<td>0.06</td>
</tr>
<tr>
<td>Commercial glazed swinging entrance doors</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Power-operated sliding doors and power-operated folding doors</strong></td>
<td><strong>1.00</strong></td>
</tr>
<tr>
<td>Revolving doors</td>
<td>1.00</td>
</tr>
</tbody>
</table>
### Low Energy Building

<table>
<thead>
<tr>
<th>Q</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How does the Code apply to a proposed building without heating or cooling?</td>
<td>• C402.1.1 May qualify as a “low-energy building”. But if the building is changed in the future and no longer qualifies as a low-energy building, it may require removal of slab to install insulation under slab to comply with the Code.</td>
</tr>
<tr>
<td>Q</td>
<td>A</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>• Do net zero buildings (geothermal wells, natural roof area, roof-mounted photo voltaic panels) need to comply with the Code?</td>
<td>• C402.1.1 If a building qualifies as a “low-energy building”, it is not required to comply with the envelope provisions. But the building needs to be comply with the electrical and lighting provisions (C405)</td>
</tr>
</tbody>
</table>
Isolating Combustion Appliances

- Specifies minimum construction methods for rooms containing open combustion appliances (Water heaters, furnaces, etc.)
- This was amended out in 2015 IL Energy Conservation Code due to increased cost of building these isolated rooms. Likely to be amended out for 2018.
- Alternative is to install sealed combustion (higher efficiency) appliances

Images courtesy of DOE
Equipment Efficiency

Changes efficiency rating of room air conditioners from EER to CEER (Combined Energy Efficiency Rating) [takes into account standby energy]

12,000 BTUh room air conditioner w/ louvered sides
9.8 EER to 10.9 CEER
Equipment Efficiency

Increases minimum AFUE for furnaces from 78% to 80%
Boilers

Gas fired boilers <300 kbtu cannot have a constant burning pilot light

Hot water boilers <300 kbtu must have temperature reset unless providing tankless domestic hot water production
Heat Rejection

New section for hydronic heat pump systems using cooling towers for heat rejection

Specifically talks about automatic control of the bypass valve or turning off the circulation pump
Expanded VFDs

- Pumps and fans with 2hp and larger now required
- Increased allowance for DDC controlled systems
Improved HVAC Turndown

Reduced minimum airflow from 30% to 20% of maximum

2015 IECC

2018 IECC
Parallel-flow VAV

New section for parallel-flow fan powered VAV air terminal control

Requires fan be off unless trying to provide heating, then fan comes on to provide heat before activating heating coil
Ventilation system controls now mandatory

• Demand Control Ventilation
• Enclosed Parking Garage Ventilation Controls
• Ventilation Air Heating Control
• Energy Recovery Ventilation Systems
• Kitchen Exhaust Systems
• Automatic Control of HVAC Systems Serving Guestrooms
• Shutoff Dampers
New section for Ventilation air heating control

Ventilation air can not exceed 60F when majority of zones require cooling
Ventilation Energy Recovery

Provides for de minimis ventilation without requiring energy recovery

Table C403.7.4(2) (excerpt)
ENERGY RECOVERY REQUIREMENT [Zone 4A, 5A, 6A, 6B, 7, 8]
(Ventilation systems operating not less than 8,000 hours per year)

<table>
<thead>
<tr>
<th>PERCENT (%) OF OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE</th>
<th>10-19%</th>
<th>20-29%</th>
<th>30-39%</th>
<th>40-49%</th>
<th>50-59%</th>
<th>60-69%</th>
<th>70-79%</th>
<th>80%+</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESIGN SUPPLY FAN AIRFLOW RATE (cfm)</td>
<td>200+</td>
<td>130+</td>
<td>100+</td>
<td>80+</td>
<td>70+</td>
<td>60+</td>
<td>50+</td>
<td>40+</td>
</tr>
</tbody>
</table>
Guestroom Automatic Controls

Automatic HVAC control now required for buildings with over 50 guestrooms

Image courtesy of Wattstopper
Pressure Drop Adjustment

Adds systems required to maintain a pressure differential between rooms for allowance for pressure drop adjustment

Clarifies adjustment for energy recovery devices for each air stream
Motor Nameplates

Fans smaller than 1 hp are not required to be listed on the drawings
Heat Rejection Fan Control

Changes the control scheme for fan speed control on heat rejection equipment (5hp or more total fan power)

Fan speed to vary based on leaving fluid temperature or condensing temperature and pressure of the heat rejection device (must use VFDs)
Most sections for equipment efficiency now mandatory

- Walk-in coolers/freezers, Warehouse coolers/freezers
- Walk-in coolers/freezers
- Refrigerated display cases
Walk-in Performance

New section for performance standards for walk-in coolers effective Jan 1, 2020
Sets maximum energy consumption
HVAC Construction

Consolidated section, now mandatory

• Duct and plenum insulation and sealing
• Duct construction
• Piping insulation
<table>
<thead>
<tr>
<th>Q</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Is the installation of an air curtain a suitable alternative to the vestibule requirements?</td>
<td>• C402.5.7 Yes. Exception 7 provides the technical specifications and performance standards of air curtains to be comply with the requirements.</td>
</tr>
</tbody>
</table>
Efficiency Improvements

Changes to table for efficiency requirements

Adds tabletop water heaters and grid-enabled water heaters

Image courtesy of A.O. Smith
Efficiency Exception

Changes on-site solar to on-site renewables, providing for other renewables
Heat Traps now required for hot water storage tanks, not just water heaters
Pool Cover Exception

Increases threshold to qualify for exception to a pool cover from 70% to 75%
SHW Commissioning

Requirement for commissioning for service water heating systems REMOVED
Residential Lighting Restriction

• Residential lighting provisions allowed ONLY for multifamily buildings
Luminaire Level Lighting Controls

- Allows for luminaire lighting controls to take the place of centralized controls
- Must include occupancy sensor and ambient light sensor

Image courtesy of Cree
Occupancy Sensors

Requires occupancy sensor control for lounges/breakrooms, enclosed offices, open office areas, and warehouse storage areas.
Occupancy Sensor Time

Reduces the occupancy sensor time delay from 30 minutes to 20 minutes
Daylight Responsive Exception

- Does not require daylight-responsive controls if 40% lower than wattage allowance
- Office Allowance – 0.79 w/sf
- Threshold for Daylight-responsive controls – 0.47 w/sf
Roof Monitors

- Provides calculation methodology for roof monitors

(a) Section view and
(b) Plan view of daylit area under a rooftop monitor
Lighting [C405.2.4]

Lighting Controls

• No longer allows captive key systems for sleeping units
Increased Exterior Lighting Controls

- Daylight shutoff
- Decorative lighting shut off during non-business hours
- Lighting setback – 30% watts minimum
- Time switch control functionality
- Exception for dwelling controlled exterior lighting
Exit Signs

Power limits for exit signs removed
Track Lighting Demand Reduction

Reduces demand from 30W/ft to 8W/ft
Reduced Lighting Power Allowances

- Office 0.82 to 0.79 – 4% reduction
- Library 1.19 to 0.78 – 34% reduction
Exterior Lighting Exceptions

Additional exceptions to exterior lighting calculations

• Approved lighting for safety considerations
• Emergency lighting
• Exit signs
• Art
• National flag
• Water features and swimming pools
• Lighting controlled from within dwelling units in compliance with R404.1
Exterior Lighting Allowance

• Lower power allowances for exterior lighting
• ~30% Lower
• Zone 1 and 2 much more restrictive for sales areas
  • 0.6 W/ft² to 0.04 W/ft²
Gas Lighting Pilot

• Continuous burning pilot light for gas lighting is prohibited

Image courtesy of This Old House
Stairwell Lighting

**Q**

- Is it acceptable for a stairwell with no manual switches to have 100% of the lighting on occupancy sensor that takes a few seconds to respond?

**A**

- This may pose a life-safety risk as stairwell lighting that goes off 100% seems potentially dangerous.
- C405.2 exempts interior exit stairways from requiring lighting controls.
Daylighting Control

Q

• Are manual daylighting controls permitted?

A

• C405.2.3 No. Daylight-responsive controls are required to be automatic, not manual.
Increased Efficiencies

Dry-type transformers & Motors

Images courtesy of Schneider Electric

Image courtesy of Baldor
• Allows variable voltage drives to meet reduced speed control for escalators and moving walkways
Enhanced Envelope

• New section for enhanced envelope performance
• 15% better UA
Reduced Infiltration

• New section for enhanced envelope performance
• Building tested air leakage of 0.25 cfm/ft$^2$ at 75 Pascals
• Buildings over 250,000 ft$^2$ may be tested in sections of not less than 25% of floor area
Electric Vehicles

• Electric vehicles excluded from energy calculation

Image courtesy of Chevrolet
Renewable Energy Credit Limits

- Limits on-site renewable credits to 5%
- Allows Code Official to request documentation on renewables used for credit
Energy Cost or EUI?

Q

• Is energy usage for performance-based compliance determined by the energy cost method or site energy EUI?

A

• C407.3 Commercial applications require the energy cost method (but can use site energy use if jurisdiction requires)
• R405.3 Residential applications requires energy cost (but can use source energy or source energy per sf).
Building O&M must be provided to building owner

Image courtesy of Berkeley
Commissioning Report

Adds functional performance test procedures to the commissioning report, required to be provided to the Code Official.
Allows for performance alternatives for compliance

- Can not exceed 110% of either allowed UA or allowed annual energy cost depending on path chosen
Excess Fenestration

• Provides exception for buildings with fenestration areas above code

Image courtesy of Providence Daily
Lighting Alteration

Q

• If we relocate 7% of the fixtures and replace 2% of the luminaires without increasing loads, are we within the allowable limits for Chapter 5 Existing Buildings?

A

• C503.6 Yes. Alterations that replace less than 10% of the luminaires in the space are counted as exemptions, but removing or relocating fixtures are not included.
## Roof Insulation

<table>
<thead>
<tr>
<th>Q</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• If the cover is removed and replaced without repairing any substrate and a new roof covering applied, does the insulation need to be increased?</td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Roof Replacement. The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering</td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• C503.3.1 Roof replacement. Roof replacements shall comply with Section C402.1.3, C402.1.4, C402.1.5 or C407 where the existing roof assembly is part of the building thermal envelope and contains insulation entirely above the roof deck</td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Roof Recover. The process of installing an additional roof covering over an existing roof covering without removing the existing recovering</td>
<td></td>
</tr>
</tbody>
</table>
### Roof Alteration

<table>
<thead>
<tr>
<th>Q</th>
<th>• Is there any requirement to modify any parapets, doors, curbs, etc. in order to accommodate additional insulation thickness to meet code?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• C501.2 Existing buildings. Except as specified in this chapter, this code shall not be used to require the removal, alteration or abandonment of, nor prevent the continued use and maintenance of an existing building or building system lawfully in existence at the adoption of this code.</td>
</tr>
<tr>
<td></td>
<td>• C503.1 Exception: The following alterations need not comply with the requirements for new construction, provided that the energy use of the building is not increased:</td>
</tr>
<tr>
<td></td>
<td>• #3: Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation</td>
</tr>
</tbody>
</table>
IL Code Amendment Proposals
For roof replacement on existing buildings with a slope under (2:12) … and where the required R-value cannot be provided due to flashing height limitations presented by existing rooftop conditions … the maximum thickness of insulation compatible with the available space and existing uses shall be installed. Insulation used shall be a minimum R-3.5 per inch.
Where flashing heights are not minimum 8” above the roof covering surface, a reduction of the required roof assembly insulation thickness shall be allowed to accommodate the limited heights following roof covering manufacturer’s instructions.
R-value for roof assemblies with tapered insulation above deck with slope greater than 1/8 units vertical in 12 units horizontal (1/8:12) shall provide an average R-20 ci.
Roof Covering Replacement: Where an existing roof covering is removed, exposing insulation or sheathing and only a new roof covering is installed.

Roof covering replacement added to list of repairs
No less than 90% of the permanently installed lighting serving dwelling units shall be provided by lamps with an efficacy of not less than 65 lm/W or light fixtures with an efficacy of 55 lm/W, or with Sections C405.2.4 and C405.3
IL Code Amendment Proposal (C06)

Reduces Maximum U-values on table C402.4

Adds “Other vertical fenestration” category
C404.2.2 High input domestic water heating systems: In new buildings, not less than 40% of the annual service water-heating requirement serving residential occupancies, commercial kitchens, and laundries shall be provided by on-site renewable energy or site-recovered energy.
IL Code Amendment Proposal (C08)

Adds Corridor/transition areas and Dining areas to list of locations requiring occupancy sensors
IL Code Amendment Proposal (C09)

Adds requirement for occupancy sensor and emergency relay control function for egress illumination, this may also be a signal from the building control system to shut off lighting when unoccupied

Exception for illumination under 0.02 w/ft²
Residential
2018 IECC Residential Changes: Highlights

- No significant energy efficiency improvement (initial estimate of 0% improvement)
2018 IECC Residential Changes: Admin

- R101.4.1 Mixed residential and commercial buildings: from “mixed occupancy of both residential and commercial occupancies” to “a building includes both residential and commercial building portion”

- R105.1 Inspection: from “Construction work shall remain accessible and exposed” to “visible and accessible”
2018 IECC Residential Changes: Admin

- R202 Definition
- Air barrier: added “continuous manner”
- Air-impermeable insulation: An insulation that functions as an air barrier material
- Alteration: removal of “requires a permit” language
- Approved: from “Approval by the code official as a result of investigation and tests conducted by him or her, or by nationally recognized organizations” to “Acceptable to the code official”
- Fenestration: added definition of Skylights and Vertical fenestration
Is air sealing a big deal? ........ Yes!

Primary Energy Consumption attributed to building envelope components in 2010 (in quads)

<table>
<thead>
<tr>
<th>Building Component</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heating</td>
</tr>
<tr>
<td>Roofs</td>
<td>1.00</td>
</tr>
<tr>
<td>Walls</td>
<td>1.54</td>
</tr>
<tr>
<td>Foundation</td>
<td>1.17</td>
</tr>
<tr>
<td>Infiltration</td>
<td>2.26</td>
</tr>
<tr>
<td>Windows (Conduction)</td>
<td>2.06</td>
</tr>
<tr>
<td>Windows (Solar Heat Gain)</td>
<td>-0.66</td>
</tr>
<tr>
<td>Sum</td>
<td>7.37</td>
</tr>
</tbody>
</table>

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

R103.2.1 Building thermal envelope depiction: The building’s thermal envelope shall be represented on the construction documents.
Inspections

1. Footing & Foundation
2. Framing & rough-in
3. Plumbing
4. Mechanical
5. Final
Inspections associated with footings and foundations shall verify compliance with the code as to **R-value, location, thickness, depth of burial and protection of insulation** as required by the code and approved plans and specifications.
Framing & Rough-in Inspection

Inspections at framing and rough-in shall be made before application of interior finish and shall verify compliance with the code as to: **types of insulation and corresponding R-values and properties such as U-factor and SHGC and proper installation; and air leakage controls** as required by the code; and approved plans and specifications.
Inspections at plumbing rough-in shall verify compliance as required by the code and approved plans and specifications as to **types of insulation and corresponding R-values and protection, and required controls**.
Inspections at mechanical rough-in shall verify compliance as required by the code and approved plans and specifications as to installed HVAC equipment type and size, required controls, system insulation and corresponding R-value, system air leakage control, programmable thermostats, dampers, whole-house ventilation, and minimum fan efficiency.
Final Inspection

The building shall have a final inspection and shall not be occupied until approved. The final inspection shall include verification of the installation of all required building systems, equipment and controls and their proper operation and the required number of high-efficacy lamps and fixtures.
Residential Certificate

Permanent certificate shall be completed by the builder or other approved party and posted …

• Predominant R-values of insulation
• U-factors of fenestration
• SHGC of fenestration
• Results for components covering largest areas where multiples occur
• Results from duct/envelope leakage tests
• Types & efficiencies of heating, cooling, and service water heating equipment
# Residential Certificate

![Image of Energy Efficiency Certificate](image)

## Energy Efficiency Certificate

<table>
<thead>
<tr>
<th>Insulation Rating</th>
<th>R-Value</th>
<th>R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling /Roof Frame</td>
<td>R-</td>
<td></td>
</tr>
<tr>
<td>Ceiling /Roof Mass</td>
<td>R-</td>
<td></td>
</tr>
<tr>
<td>Walls Basement</td>
<td>R-</td>
<td></td>
</tr>
<tr>
<td>Floors Over unconditioned space</td>
<td>R-</td>
<td></td>
</tr>
<tr>
<td>Floors Slab edge</td>
<td>R-</td>
<td></td>
</tr>
<tr>
<td>Ducts Attic</td>
<td>R-</td>
<td></td>
</tr>
<tr>
<td>Ducts Other</td>
<td>R-</td>
<td></td>
</tr>
</tbody>
</table>

## Air Leakage Test Results

<table>
<thead>
<tr>
<th>Blower door</th>
<th>ACH/50 Pa.</th>
<th>Duct testing</th>
<th>Cfm/100 ft²</th>
</tr>
</thead>
</table>

## Fenestration Rating

<table>
<thead>
<tr>
<th>Window</th>
<th>NFRC U-Factor</th>
<th>NFRC SHGC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opaque door</td>
<td>U-</td>
<td></td>
</tr>
<tr>
<td>Skylight</td>
<td>U-</td>
<td></td>
</tr>
</tbody>
</table>

## Equipment Performance

<table>
<thead>
<tr>
<th>Heating system</th>
<th>Type</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling system</td>
<td></td>
<td>SEER</td>
</tr>
<tr>
<td>Water heater</td>
<td></td>
<td>EF</td>
</tr>
</tbody>
</table>

Indicate if the following have been installed (an efficiency shall not be listed):

- electric furnace
- gas-fire unvented room heater
- baseboard electric heater

Designer/builder: [Name]
Code edition: [Code]
Date: [Date]
Log homes designed in accordance with ICC 400 exempted from the thermal envelope requirements
## Window U-Factors

Modest improvement in window U-factors

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>2015 U-Factor</th>
<th>2018 U-Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>U-0.35</td>
<td>U-0.32</td>
</tr>
<tr>
<td>5</td>
<td>U-0.32</td>
<td>U-0.30</td>
</tr>
</tbody>
</table>
Reduced Insulation

Provides allowance for reduced insulation in ceilings without attic spaces, but insulation must extend over the top plate.

Image courtesy of Pacific Northwest National Labs
Sunrooms enclosing conditioned space shall meet the insulation requirements of this code

Exception: Sunrooms with thermal isolation and enclosing conditioned space

Min. ceiling insulation R-19 for zone 4 and R-24 for zone 5

Min. exterior wall insulation R-13
Sunroom Fenestration

Sunrooms enclosing conditioned space shall meet the fenestration requirements of this code.

Exception: Sunrooms with thermal isolation and enclosing conditioned space

Max U-factor of 0.45 for windows
Max U-factor of 0.70 for skylights
Fireplace in a 3-Season Room

Q

• Does a 3-season room have to meet the Code? Does a fireplace count as a heater for determining if a 3-season room is a low-energy building?

A

• R402.1 A 3-season room must comply with the Code, but may qualify as a low-energy building. Fireplaces do count as heaters for determining low-energy qualifications.
### Heated Garage

<table>
<thead>
<tr>
<th>Q</th>
<th>A</th>
</tr>
</thead>
</table>
| • If you install some form of permanent heating (radiant, warm-air, forced-air, or heat-pump) in a garage, does the garage have to meet the thermal envelope requirements? | • R402.1 If the space is considered "conditioned", the building thermal envelope must be insulated.  
• Per Exception 2 of R402.4.1.2 (IL Amendment), as long as the heated garage is “thermally isolated” from other habitable, conditioned areas of the home, the air-leakage testing provisions of the code (R402.4.1.2) do not apply to new construction. |
### Roof Insulation

<table>
<thead>
<tr>
<th>Q</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What is the minimum continuous insulation level required for low-sloped (flat) roofs without attic spaces?</td>
<td>• R402.2.2 These roofs must comply with residential building insulation provisions, R-49 (U-0.026), unless the AHJ determines that the installation of insulation above the structural roof deck is deemed &quot;technically infeasible&quot; to accommodate the added thickness.</td>
</tr>
</tbody>
</table>
Moisture Control Requirements

Q

• Please clarify the moisture control requirements of the Code, with regard to the use of vapor retarders in framed walls?

A

• The Code does not contain provisions for moisture control. The moisture control provisions have been relocated to Section R702.7 of the 2015 International Residential Code.
Table R402.4.1.1 can be very useful
Covers many errors in installation
Ductwork Testing

Provides exception for testing ERV and HRV ductwork from testing

Image courtesy of Panasonic
Ducts Buried in Ceiling Insulation

Provides allowance for duct insulation in buried duct work (for simulated energy performance analysis)
Drain water heat recover units shall comply with CSA B55.2.
• Minimum fan efficiency of 1.2 cfm/w is added for Heat Recovery Ventilator and Energy Recovery Ventilator for whole house mechanical ventilation system.

Image courtesy of Calcs Plus
Ducts in Conditioned Space

Provides criteria to determine if ducts are inside conditioned space or not.

• Completely inside air barrier OR
• Buried in the ceiling insulation AND
  • Air handler within air & thermal barrier
  • Duct leakage <1.5 cfm per 100 sf
  • Full depth insulation above duct
Equipment Sizing

Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies.
## Accu-Size Heating & Cooling Home Analysis

### Cooling load (heat gain) - 95 degree day

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF WINDOWS</th>
<th>HEAT GAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>North (single)</td>
<td>X 26 =</td>
</tr>
<tr>
<td>North (double)</td>
<td>X 21 =</td>
</tr>
<tr>
<td>NE &amp; NW (single)</td>
<td>X 45 =</td>
</tr>
<tr>
<td>NE &amp; NW (double)</td>
<td>X 35 =</td>
</tr>
<tr>
<td>East &amp; West (single)</td>
<td>X 60 =</td>
</tr>
<tr>
<td>East &amp; West (double)</td>
<td>X 49 =</td>
</tr>
<tr>
<td>SE &amp; SW (single)</td>
<td>X 50 =</td>
</tr>
<tr>
<td>SE &amp; SW (double)</td>
<td>X 40 =</td>
</tr>
<tr>
<td>South (single)</td>
<td>X 36 =</td>
</tr>
<tr>
<td>South (double)</td>
<td>X 25 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF DOORS</th>
<th>HEAT GAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood (no storm door)</td>
<td>X 13 =</td>
</tr>
<tr>
<td>Wood (w/storm door)</td>
<td>X 9 =</td>
</tr>
<tr>
<td>Insulated metal door</td>
<td>X 6 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF NET WALLS</th>
<th>HEAT GAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall perimeter X height</td>
<td>X 26 =</td>
</tr>
<tr>
<td>glass and door area net wall</td>
<td>X 26 =</td>
</tr>
<tr>
<td>No insulation</td>
<td>X 8 =</td>
</tr>
<tr>
<td>R-13 (3.5&quot; insulation)</td>
<td>X 3 =</td>
</tr>
<tr>
<td>R-19 (6&quot; insulation)</td>
<td>X 2 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF CEILING</th>
<th>HEAT GAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insulation</td>
<td>X 22 =</td>
</tr>
<tr>
<td>R-11 (3&quot; insulation)</td>
<td>X 4.1 =</td>
</tr>
<tr>
<td>R-19 (6&quot; insulation)</td>
<td>X 2.6 =</td>
</tr>
<tr>
<td>R-30 (10&quot; insulation)</td>
<td>X 1.6 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF FLOOR</th>
<th>HEAT GAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insulation</td>
<td>X 3 =</td>
</tr>
<tr>
<td>Carpet (no insulation)</td>
<td>X 2 =</td>
</tr>
<tr>
<td>R-11 (3&quot; insulation)</td>
<td>X 1 =</td>
</tr>
<tr>
<td>Floor on slab</td>
<td>X 0 =</td>
</tr>
</tbody>
</table>

### Heating load (heat loss) - 0 degree day

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF WINDOWS</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single glass</td>
<td>X 97 =</td>
</tr>
<tr>
<td>Double glass</td>
<td>X 69 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF DOORS</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single glass patio</td>
<td>X 99 =</td>
</tr>
<tr>
<td>Double glass patio</td>
<td>X 72 =</td>
</tr>
<tr>
<td>Wood (no storm door)</td>
<td>X 75 =</td>
</tr>
<tr>
<td>Wood (w/storm door)</td>
<td>X 46 =</td>
</tr>
<tr>
<td>Insulated metal door</td>
<td>X 35 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF NET WALLS</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame (no insulation)</td>
<td>X 20 =</td>
</tr>
<tr>
<td>Frame (3.5&quot; insulation)</td>
<td>X 7 =</td>
</tr>
<tr>
<td>Frame (6&quot; insulation)</td>
<td>X 5 =</td>
</tr>
<tr>
<td>Masonry (no insulation)</td>
<td>X 37 =</td>
</tr>
<tr>
<td>Masonry (1&quot; insulation)</td>
<td>X 11 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF CEILING</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insulation</td>
<td>X 25 =</td>
</tr>
<tr>
<td>R-11 (3&quot; insulation)</td>
<td>X 7 =</td>
</tr>
<tr>
<td>R-19 (6&quot; insulation)</td>
<td>X 4 =</td>
</tr>
<tr>
<td>R-30 (10&quot; insulation)</td>
<td>X 3 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF FLOOR OVER CRAWL AREA</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insulation</td>
<td>X 19 =</td>
</tr>
<tr>
<td>Carpet (no insulation)</td>
<td>X 9 =</td>
</tr>
<tr>
<td>R-11 (3&quot; insulation)</td>
<td>X 6 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE FOOTAGE OF FLOOR OVER BASEMENT</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insulation</td>
<td>X 2 =</td>
</tr>
<tr>
<td>Carpet or insulation</td>
<td>X 1 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PERIMETER OF SLAB FLOOR</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab (no insulation)</td>
<td>X 57 =</td>
</tr>
<tr>
<td>Slab (edge insulation)</td>
<td>X 22 =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSULATION/VENTILATION</th>
<th>HEAT LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home square feet</td>
<td>X 1250 =</td>
</tr>
</tbody>
</table>

### Internal Gains

| Number of people | X 530 = 1250 |

### Kitchen & Bath Allowance

| Total BTU/h heat gain |

### Losses from ductwork

<table>
<thead>
<tr>
<th>Losses from ductwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>In crawl space (subtotal BTU/h X 10)</td>
</tr>
<tr>
<td>In attic (subtotal BTU/h X 0.80)</td>
</tr>
</tbody>
</table>

### Total BTU/h heat loss

<table>
<thead>
<tr>
<th>Total BTU/h heat loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>80% furnace efficiency loss X 25 =</td>
</tr>
<tr>
<td>90% furnace efficiency loss X 12 =</td>
</tr>
</tbody>
</table>

### Total BTU/h input needed
Pool Cover Exception

Increases minimum renewable or site-recovered energy for pools from 70% to 75% to not need a pool cover.
High Efficiency Lighting

- Increases high efficiency lighting to 90% from 75%
- Eliminates the low-voltage exception
Ventilation system must be included in energy model

Image courtesy of Panasonic
Batch sampling is allowed for stacked multifamily units
Reference Model

Includes mechanical ventilation in the reference design
Energy Rating Reference

- Changes reference design from IECC 2006 to RESNET/ICC 301
- Clarifies electric vehicle charging is excluded from rating
Energy Rating Index

- Increase of Max. ERI score

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>2015 ERI Score</th>
<th>2018 ERI Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>54</td>
<td>62</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>61</td>
</tr>
</tbody>
</table>

Image courtesy of Energy IQ
Energy Rating Software

• Removes calculation software listing
• Adds International Existing Building Code to list of codes
Fenestration Compliance

• Allows for weighted area average for multiple fenestrations for compliance

Image courtesy of Providence Daily
## Permits for Window Replacement

<table>
<thead>
<tr>
<th>Q</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Are permits required for window replacements?</td>
<td>• R503.1 The Code considers window replacement an alterations to the building, and therefore a permit application may be required.</td>
</tr>
</tbody>
</table>
Insulation for Alterations

Q

• If a wood-framed wall of an existing home is being re-insulated, what is the required R-value? This is not for whole wall assembly, but rather interior alterations which require removing and replacing wall cavity insulation and applying new interior drywall finish.

A

• R503.1.1 The work constitutes an "alteration," requiring replacement with insulation having a density of at least R-3 per inch.
• Exception: Existing ceiling, wall or floor cavity exposed during construction provided that these cavities are filled with insulation.
IL Code Amendment Proposals
Roof Covering Replacement: Where an existing roof covering is removed, exposing insulation or sheathing and only a new roof covering installed.

Adds Roof covering replacement to the list of alterations so as to not require changing insulation level for replacing roofing or roof covering.
Change air tightness requirements to 2 ACH from 3 ACH (Presently 5 ACH for Illinois)

Recommendation changed to 4 ACH

Future plan to eliminate the IL amendment (2021 IECC)
R403.3 Ducts: Ducts and air handlers shall be insulated, sealed, tested, and installed in accordance with Sections R403.3.1 through R403.3.7. Where required by the code official, duct 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.
IL Code Amendment Proposal (R04)

Increases minimum efficacy of fixtures and lamps

- 65 lm/w for bulbs
- 55 lm/w for fixtures
For low-rise multifamily buildings, dwelling units shall be tested and verified as having a leakage rate of not exceeding 0.25 cfm/ft² of enclosure area (all six sides of the dwelling unit) … Testing shall be conducted with an unguarded blower door at a pressure of 50 Pa. Where required by the code official, testing shall be conducted by an approved third party…
For buildings with more than 7 units, a sampling protocol is allowed by an approved third party. The sampling protocol requires the first 7 units to be tested without any failures. Upon successful testing of those initial 7 units, remaining units can be sampled at a rate of 1 in 7. If any sample unit fails compliance with the maximum allowable air leakage rate, two additional units in the same sample set must be tested. If additional failures occur, all units in the sample set must be tested. In addition, all units in the next sample set must be tested for compliance before sample of further units can be continued.
Recommends ERI become a standard methodology for compliance

Most other IL amendments remain in place for 2018
Residential Garage Conversion

Q

• For an existing garage, I want to convert the space into living space. How do I meet the floor insulation requirements in the code?

A

• R505 – Change of Occupancy
• R402 – Insulation of slabs (R-10, 2’ depth)
• Option B – R405 Compliance (Performance)
• Proposed Alternative: Insulate top of slab w/ R-10
## Sealed Crawlspaces

<table>
<thead>
<tr>
<th>Challenge</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Can see problems during temperate times of year</td>
<td>• Use HRV/ERV to draw air out of crawl space, put air in occupied space thus preventing air from going stale by transferring air from conditioned space into crawl space</td>
</tr>
<tr>
<td>• One sample home, 79 days of no H/AC, 20 days ¼ hr of H/AC</td>
<td></td>
</tr>
<tr>
<td>• 27% of the year with nearly no H/AC</td>
<td></td>
</tr>
</tbody>
</table>
How should the indicated area be insulated?
Questions?

energycode@sedac.org
800-214-7954