Nebraska's Energy Code

Multifamily Buildings and Mixed-Use, IECC and ASHRAE

Nebraska Energy Code Training Program

Instructor: Matt Belcher

December 13, 2023

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Housekeeping

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

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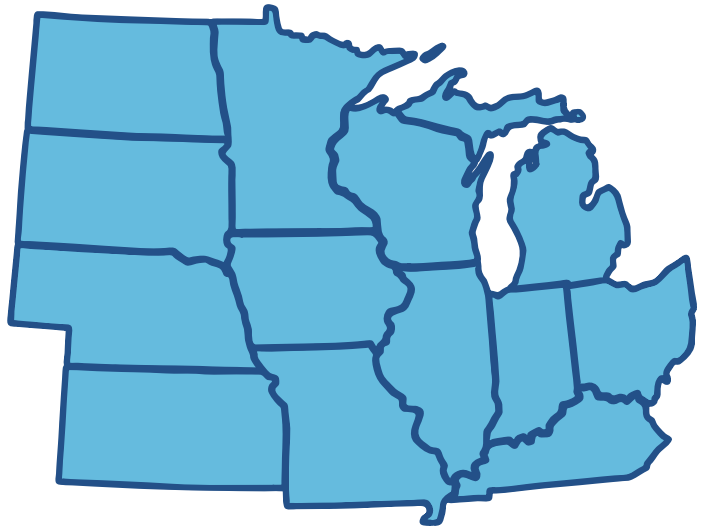
Midwest Energy Efficiency Alliance

The Midwest Energy Efficiency Alliance (MEEA) is a collaborative network, promoting energy efficiency to optimize energy generation, reduce consumption, create jobs and decrease carbon emissions in all Midwest communities.



MEEA is a non-profit membership organization with 150+ members, including:

Energy service companies & contractors

State & local governments

Academic & research institutions

Electric & gas utilities

About the Nebraska Training Program

- Goal: prepare the Nebraska workforce for upcoming changes in construction best practices
  - Residential and Commercial Energy Code
  - Building Science
  - Practical Solutions
- Focused on providing training to builders, code officials, design professionals, public officials and students
- For more information, visit: https://www.mwalliance.org/nebraska-energy-codes-training-program

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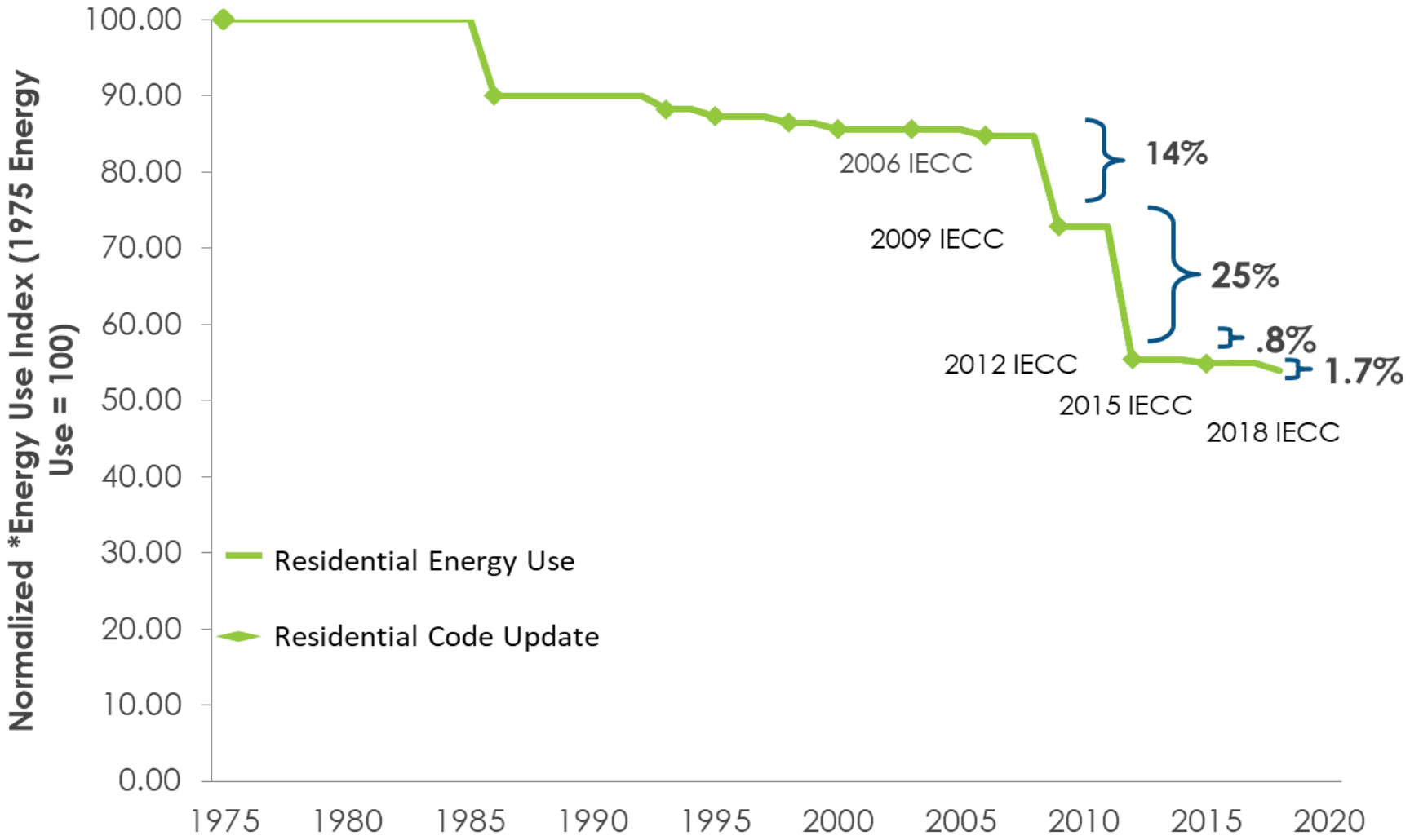
About Matt/Verdatek Solutions

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

What is the 2018 IECC?

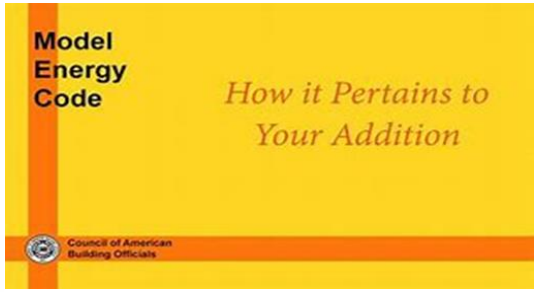
Model Energy Code Efficiency

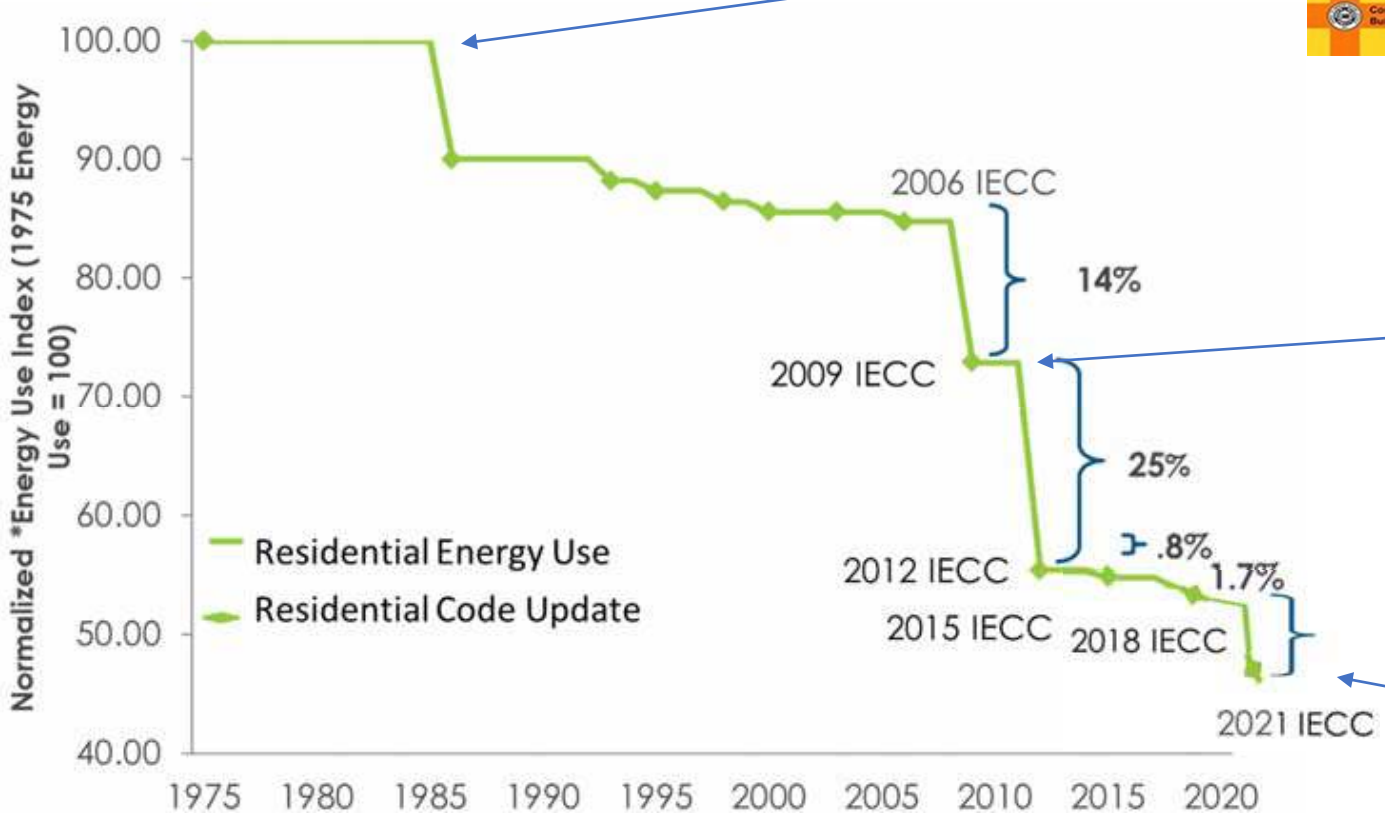


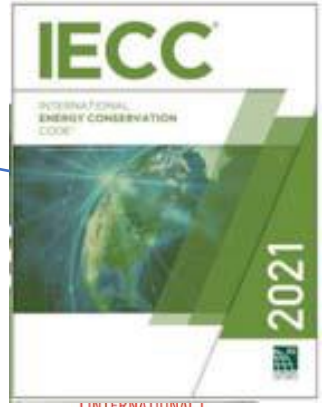
* Energy Use Index: National average energy use by building type and size.

Source: MEEA based on PNNL Analysis

Residential Energy Code Background







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Nebraska Residential Field Study

- Conducted in 2017 by **Nebraska Department of Environment and Energy.** 2009 IECC was the baseline.
- Collected and analyzed several data points for new homes, including:
  - Envelope air leakage
  - Efficacy in lighting
  - Duct leakage
  - Ceiling & exterior wall insulation
  - Basement & slab insulation
  - Windows

For More Information and Data:

https://www.energycodes.gov/sites/default/files/documents/Nebraska_Residential_Compliance_Evaluation_final.pdf

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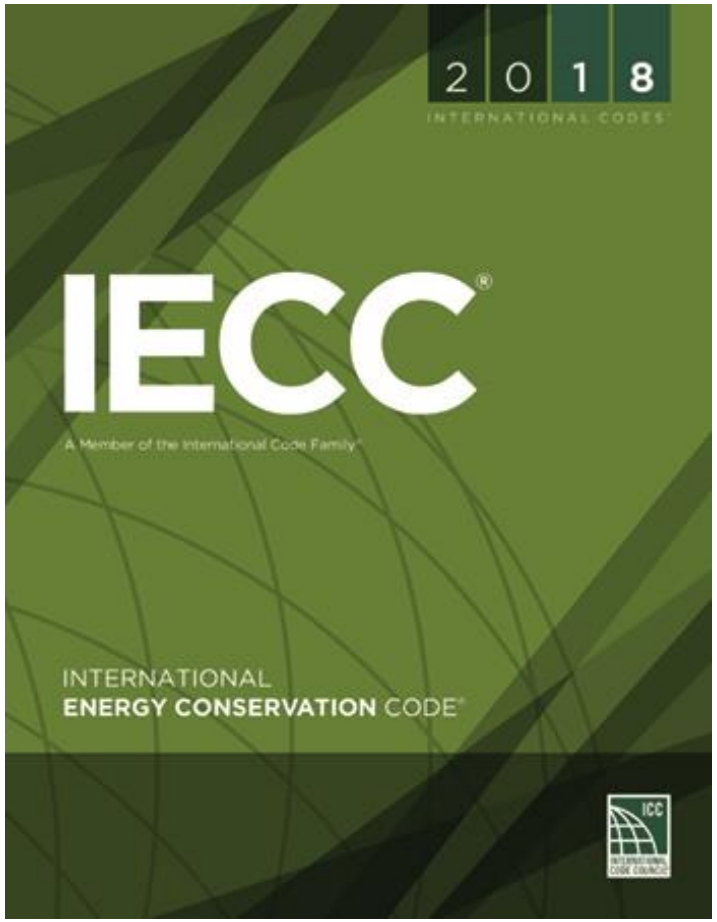
So, What's Changed since 2009?



2018 IECC / IRC Section 11

- Creates a Residential Energy Code separate from the Commercial Energy Code
- Adds testing and verification requirements
- Promotes Innovation through Energy Ratings Index (ERI)
  - Uses a HERS-type index as an "equivalent" for residential applications
  - Mandatory requirements still apply

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Nebraska's New Energy Code

- Nebraska adopted the full suite of 2018 International Code Council's (ICC) Codes, including the unamended International Energy Conservation Code (IECC)
- The IECC…
  - Applies to new and renovated buildings
  - Sets minimum requirements for energy features and performance
  - Reduces energy use and polluting emissions over the life of complying buildings
  - Benefits commercial building owner, homeowners, and society by improving cost-effectiveness, comfort, productivity, and durability
- The IECC covers both residential and commercial buildings, but we are focused on Mixed Use/Multi-Family today

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What About Mixed Use? – C101.4.1

- Treat the residential building portion under the applicable residential code
- Treat the commercial building portion under the commercial code
- Code Official has final authority

Image: agarch.com

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What About Mixed Use? – C101.4.1

- Treat the residential building portion under the applicable residential code
- **Residential Building**. *Includes Detached one- and two-family dwellings and multiple single-family dwellings (townhomes) and Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.*

Image: agarch.com

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What About Mixed Use? – C101.4.1

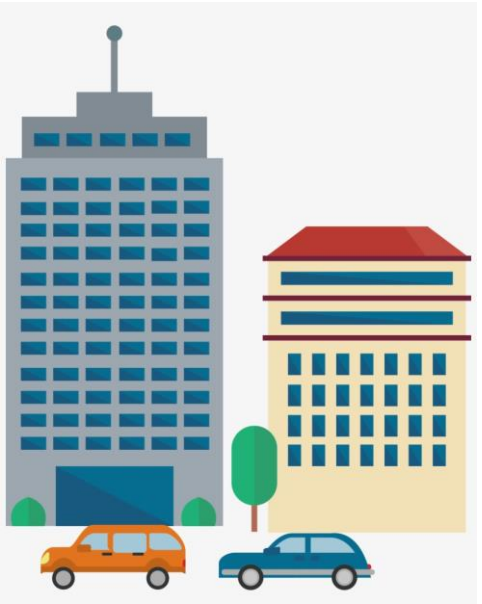
- Treat the commercial building portion under the applicable building code
- **Commercial Building**. *All buildings that are not included in Residential Building.*

Image: agarch.com

Commercial Buildings in the IECC

Under the Purview of the Commercial Code

- ✓ Buildings with commercial use
- ✓ Multifamily residential buildings four stories or greater in height



Not Under the Purview of the Commercial Code

- × One- and two-family residential
- × R-2, R-3, R-4 three stories or less in height

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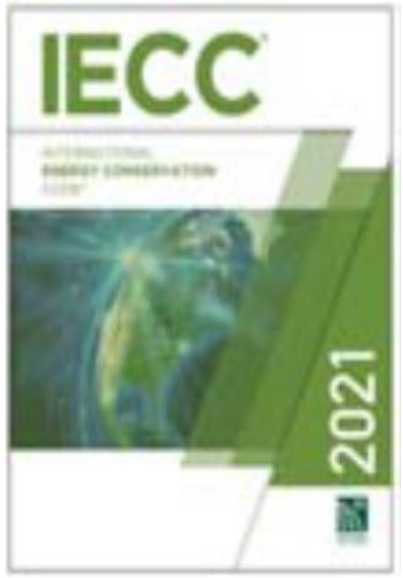
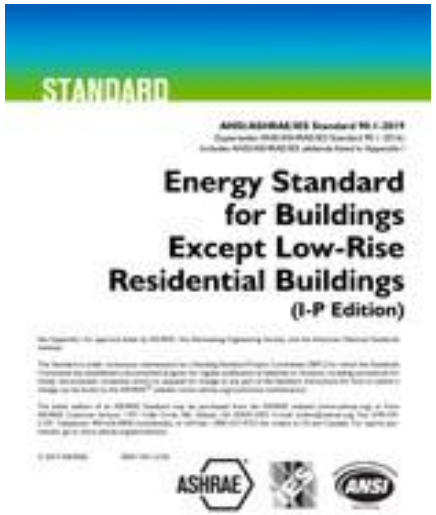
Two Commercial Compliance Options
(new in 2018)



ASHRAE 90.1-2019

Alternative Method to IECC



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Commercial Compliance Options

ASHRAE 90.1-2016

OR

2018 IECC – Prescriptive

- ✓ C402 – Envelope
- ✓ C403 – Mechanical
- ✓ C404 – SWH
- ✓ C405 – Lighting

AND Pick **at Least One C406**:

- ❑ C406.2 – Eff. HVAC Performance
- ❑ C406.3 – Reduced Lighting Power
- ❑ C406.4 – Enhanced Lighting Controls
- ❑ C406.5 – On-site Supply of Renewable Energy
- ❑ C406.6 – Dedicated Outdoor Air System
- ❑ C406.7 – High Eff. Service Water Heating
- ❑ C406.8 – Enhanced Envelope Performance
- ❑ C406.9 – Reduced Air Infiltration

OR

2018 IECC – Performance

- C407 – Total Building Performance
- C402.5 – Air Leakage
- C403– Mandatory Mechanical Provisions
- C404 – SWH
- C405 - Lighting
- Building energy cost to be < 85% of standard reference design building

Building Envelope Compliance Options

3 Methods for compliance of building components:

- C402.1.3 – Insulation component R-value based method
- C402.1.4 – Assembly U-factor, C-factor or F-factor based method
- C402.1.5 – Component Performance Alternative

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2018 IECC Mandatory Requirements

Energy Certificate

- Energy Certificate located on circuit breaker box includes key energy efficiency measures and is signed by the builder

Air Sealing

- All holes between floors and through exterior walls/ceilings have been sealed in **accordance with table R402.4.1.1**
- Building or dwelling unit is **tested to verify air leakage rate of ≤ 3 Air Changes per Hour (ACH)**
- Building or dwelling unit must have continuous air barrier installed

2018 IECC Mandatory Requirements

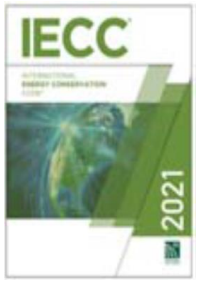
Ducts

- All ducts are sealed with approved materials (e.g. mastic or UL 181 tape) - duct tape is not acceptable
- All ducts outside conditioned space are tested to verify duct leakage with a total duct leakage or leakage to the outside test
- Supply & return ducts in attic insulated to ≥ R-6 when ducts are outside conditioned space and ≥ R-8 when ducts are outside the building thermal envelope

Building Cavities

- **Building framing cavities shall not be used as supply ducts or plenums**

2018 IECC Mandatory Requirements



Heating and Cooling

- Controls: Programmable thermostat installed
- Equipment sized per ACCA Manuals S & J

Lighting

- Minimum of **90% high-efficacy lamps** installed
- Recessed lighting in thermal envelope IC-rated and airtight

Mechanical Ventilation

- **Installed according to requirements in the International Mechanical Code**
- **Required for all homes ≤ 5 ACH per Section M303.4 (3 ACH is a 2018 IECC mandatory requirement)**

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Energy Code Compliance Pathways

Prescriptive Method Requirements

- All mandatory and prescriptive requirements must be met

Total UA Method Requirements

- All mandatory and prescriptive requirements (other than Table R402.1.2) must be met
- Include documentation to demonstrate compliance with the UA Trade-off method. Compliance software submittal must include completed compliance form, inspection checklist and certificate demonstrating compliance with 2018 IECC levels

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Energy Code Compliance Pathways

Simulated Performance Requirements (Section R405)

- All mandatory requirements must be met
- Submit an energy cost analysis report which demonstrates that the proposed design (as built) home is more efficient than the standard reference design home

Energy Rating Index Requirements (Section R406)

- All Mandatory requirements met. Meet or exceed 2009 IECC prescriptive envelope requirements
- ERI score of 61 or lower. Submit report demonstrating compliance

C401

Thermal Envelope Certificate Required

- Completed by an *Approved Party*
- Posted on a wall in the space where space conditioning equipment is located
- Shows R-Values, U-Values, Envelope Leakage Test Results, Etc.

In Addition:

- Updates to Greenhouse Requirements.
- More Insulation Installation requirements.

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Dwelling Electrical Meter
Section C405.5 (Mandatory)

Separate metering required for each dwelling unit

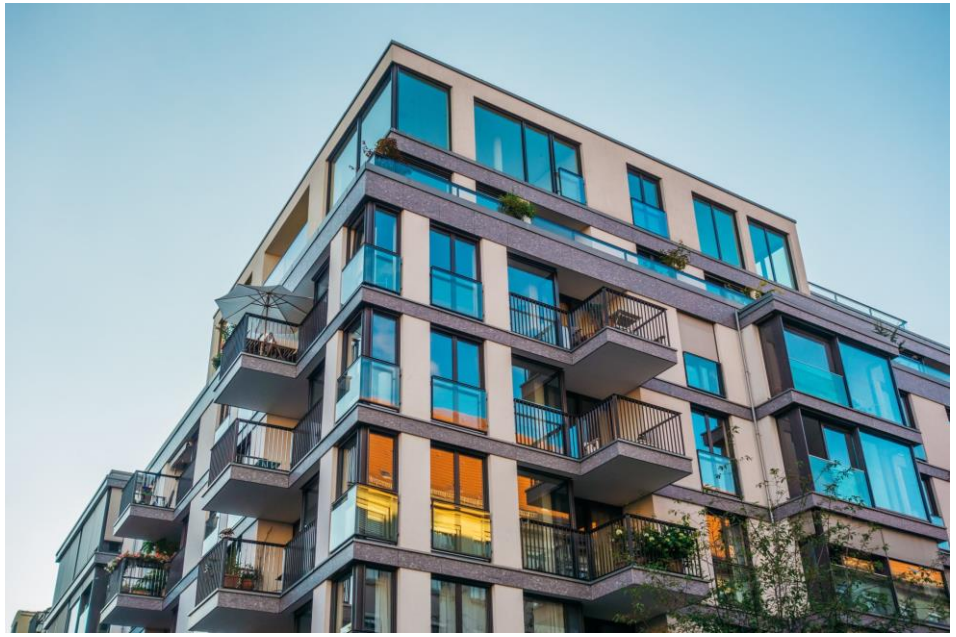

Image: chariotenergy.com

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Space Conditioning Categories

- Envelope requirements are specified by space-conditioning categories
- Conditioned space must be:
  - a cooled space with a cooling system sensible cooling output capacity larger than 3.4 Btu/h·ft^2 of floor area
  - a heated space with a heating system output capacity larger than that specified in table provided
  - Or, an indirectly conditioned space

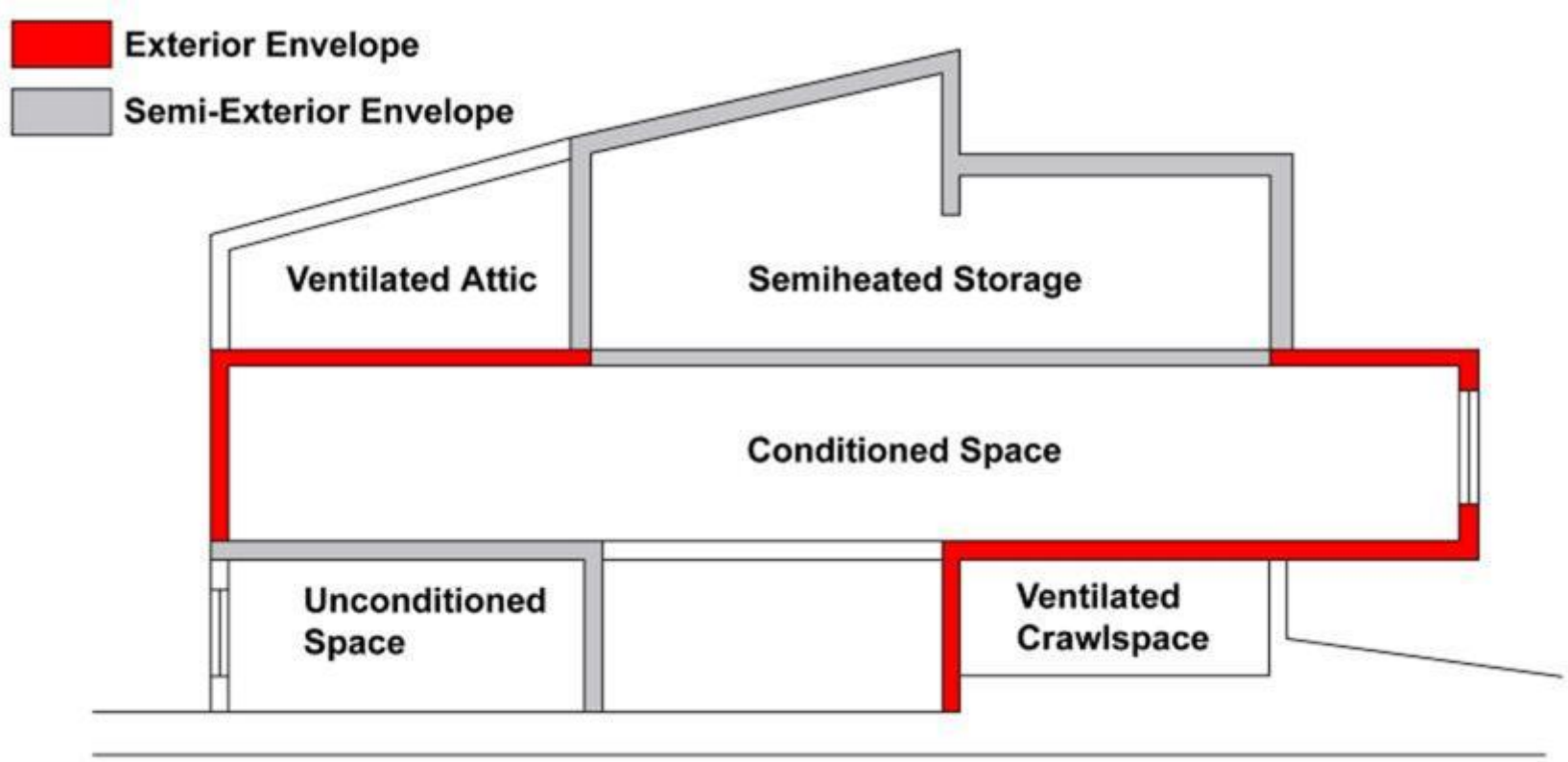
Heating Output, Btu/h·ft^2	Climate Zone
>5	0, 1, 2
>9	3A, 3B
>7	3C
>10	4A, 4B
>8	4C
>12	5
>14	6
>16	7
>19	8

Space Conditioning Categories

Separate envelope component requirements apply to three types of conditioned spaces

- 90.1: *Nonresidential* – IECC: "All other"
- 90.1: *Residential* – IECC: "Group R"
- 90.1: *Semiheated* – spaces are heated, but not to comfort levels, and not cooled.
  (Only if approved by the building official - Uncommon)

Semi-Exterior Envelope



**IECC does not have a definition for semiheated*

Space Conditioning Categories

A semiheated space has a heating system with a capacity ≥ 3.4 Btu/h.ft^2 of floor area but is not conditioned space

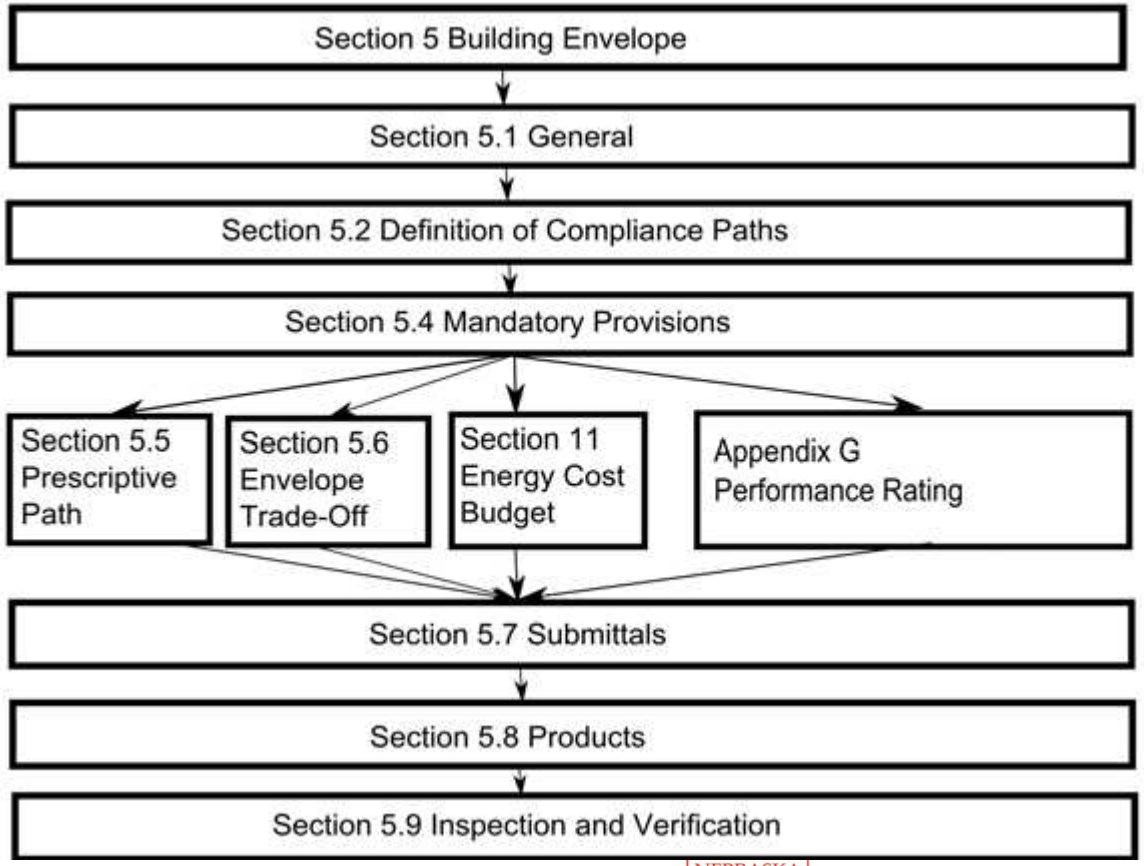
Spaces are assumed to be conditioned space and comply with requirements of conditioned space at time of construction regardless of whether the mechanical or electrical equipment is included in the building permit application or installed at that time

Exceptions:

- Space is designated as semiheated or unconditioned and approved as such by the building official

Compliance Options

- Mandatory provisions apply to all compliance pathways
- Prescriptive is a recipe that you have to follow
- Other pathways require energy modeling



Compliance Options - Prescriptive

- Building must comply with
- C402 Envelope
- C403 Mech
- C404 SWH
- C405 Lighting
- Plus pick one additional efficiency package

Additional Efficiency Package Options

- One additional efficiency feature must be selected to comply with the IECC
- C406.2 More efficient **HVAC** performance, OR
- C406.3 Reduced **lighting** power density system, OR
- C406.4 Enhanced lighting **controls**, OR
- C406.5 On-site supply of **renewable** energy
- C406.6 Dedicated outdoor air system (**DOAS**), OR
- C406.7 More efficient SWH (**hot water**) OR
- C406.8 Enhanced **envelope** performance OR
- C406.9 Reduced air **infiltration**

Compliance Options - Performance

- C407 Total Building Performance
- Building energy cost to be less than 85% of standard reference design building
- C402.5 Air Leakage
- C403.2 Provisions applicable to all mechanical
- C404 SWH
- Mandatory Lighting C405.2, C405.3, C405.4, C405.6

  (Multifamily: Lighting Power Density: 0.68)

Compliance Options – Performance (Multifamily)

- C407 Total Building Performance

  C407.5 Calculation Procedure
- Compares Standard Reference Design and Proposed design (using identical methods).
- C407.5.2.3 *Group 2 occupancy Buildings* (multifamily >4 stories) Modeled using one thermal block per space *except*: those facing same orientation are permitted into one thermal block. Corner units and units with roof floor loads shall only be combined with units that share the same features.

Compliance Note: Mechanical Inspections:

- R403.8 (Mechanical) Systems serving multiple dwelling units (Mandatory).

Shall Comply with Sections C403 and C404 of the IECC Commercial Provisions instead of Section R403

(Applies to each unit served.. No matter number of stories)

- Includes changes to existing Buildings..

Compliance Note: Mechanical Inspections:

- R105.4.2 Mechanical Inspections.

  (Exception: Systems serving multiple dwelling units shall be inspected in accordance with C105.2.4*

C105.2.4 requires shall verify the correct type and size, controls, *insulation R-values* ,system, and damper air leakage, minimum fan efficiency, energy recovery and economizer…as required..

*Applies to each unit served.. No matter number of stories

Compliance Note: Compliance Report – Residential

- R405.4.2 Compliance Reports are required but Multifamily buildings are allowed to use "Batch Sampling" for compliance of units for stacked units only…

- Compliance software (Rescheck) is easily used to accommodate this!

Compliance Options – Performance (Multifamily)

- R407.5.2.(1) (Table, note h.)
- *R2 and R4 occupancy Buildings* (multifamily 4 stories or less) with conditioned basements can use a modified Total area calculation for Fenestration:

Commissioning

Section 408

Building Controls are Complicated

- Since 2004, about 30% of all new requirements have been related to building controls
- Control requirements can be difficult to implement and verification is beyond the expertise of most building code officials
- Assumption is that they are implemented and working correctly
- Source: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26348.pdf

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Systems Commissioning and Completion Requirements

Section C408

- Commissioning is critical to ensure that buildings are **working as designed**
- Preliminary and final reports required
- Mechanical and lighting commissioning detailed in section C408

Mechanical Systems and SWH Commissioning

Section C408.2

- Prior to the final mechanical and plumbing sections, the registered design professional or approved agency shall provide evidence of mechanical systems commissioning and completion in accordance with section C408.2
- Mechanical Systems exempt from commissioning requirements (all other systems must comply)
  - In buildings where total mechanical equipment capacity is < 480,000 Btu/h (40 tons) cooling capacity **and** < 600,000 Btu/h combined service water heating and space-heating capacity
  - Included in Section C403.3 that serve individual dwelling units and sleeping units

Air Sealing Testing Compliance Options

1. Whole-Building Testing
2. Materials Testing
3. Assemblies of Materials Testing

Sweet NEW – Using Comcheck

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COMcheck Who may submit:

- The commercial energy code requires that a registered professional submit compliance documentation (construction documents and compliance verification).

- In the IECC, Section C103.1 Construction Documents, General, the wording states that construction documentation *and other supporting data* shall be submitted in one or more sets with each application for a permit. The construction documents shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed. Where special conditions exist, the code official is authorized to require necessary construction documents to be prepared by a registered design professional.

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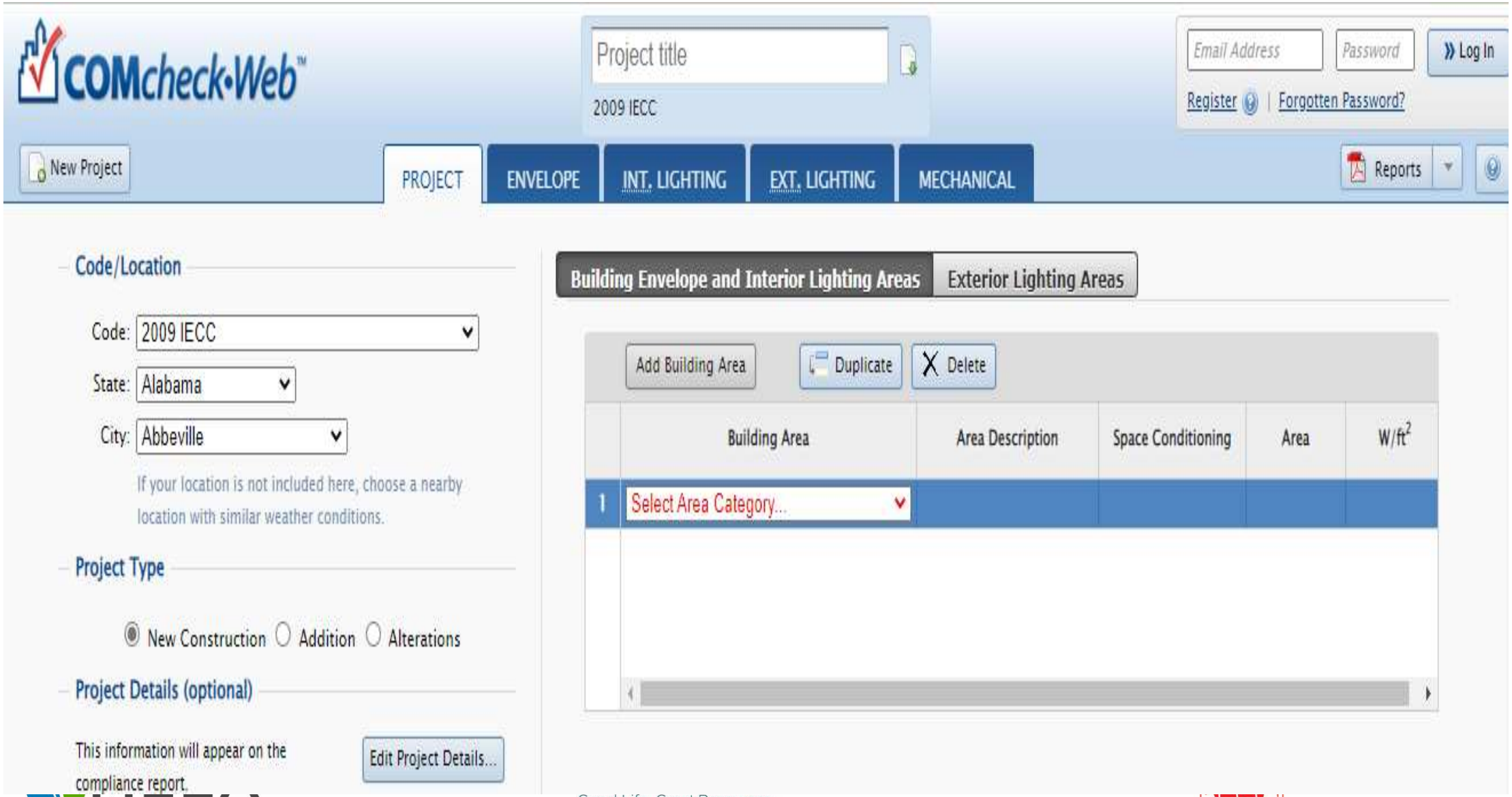
Landing Page



Information You will need:

- Energy Code Path and Year
- Builder and project location
- Area take-offs for envelope assemblies
- Insulation R-values, fenestration performance data
- Lighting fixture details
- Heating and cooling system details
- Service water heating details

COMcheck

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Performance Testing

A Great Quality Control Tool Assures Value

Air Leakage
Section C402.5 (Mandatory)

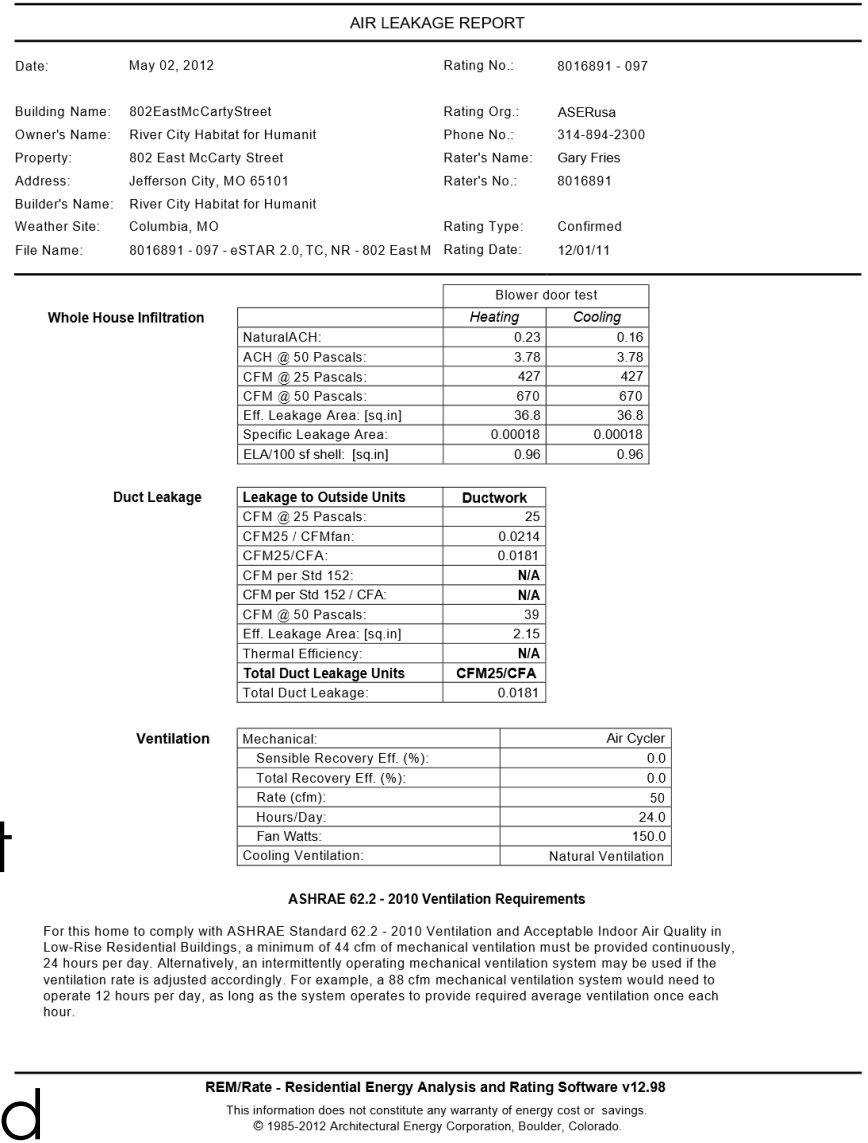
- Tested (blower door) in accordance with ASTM E 779 at pressure differential of 0.3 inch water gauge or an equivalent method approved by code official when tested air leakage rate < 0.40 cfm/ft^2

OR

- Comply with Sections C402.5.1 through 5.8

Air Leakage Report

- Blower door test documents a home's air leakage performance
- Required by code
- Third party verification (some areas; performed by Inspectors)
- Provides solid data for final equipment adjustment and energy use/cost forecast
- Great liability protection for all involved



AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit		
Weather Site:	Columbia, MO	Rating Type:	Confirmed
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage

Leakage to Outside Units	**Ductwork**
CFM @ 25 Pascals:	25
CFM25 / CFMfan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	**N/A**
CFM per Std 152 / CFA:	**N/A**
CFM @ 50 Pascals:	39
Eff. Leakage Area: [sq.in]	2.15
Thermal Efficiency:	**N/A**
Total Duct Leakage Units	**CFM25/CFA**
Total Duct Leakage:	0.0181

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

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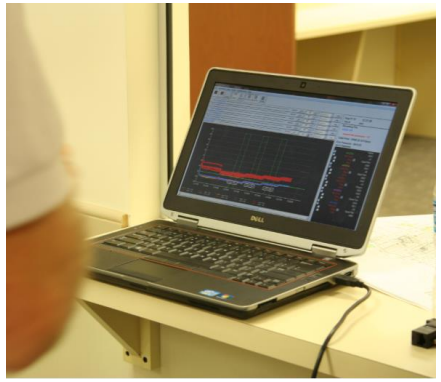
Verifying an Energy Efficient Building Envelope (C402.5)

Blower Door Testing
– Recognized by IECC

- Prove Air Sealing
- Envelope Integrity



$ELR_{75} \leq 0.40$

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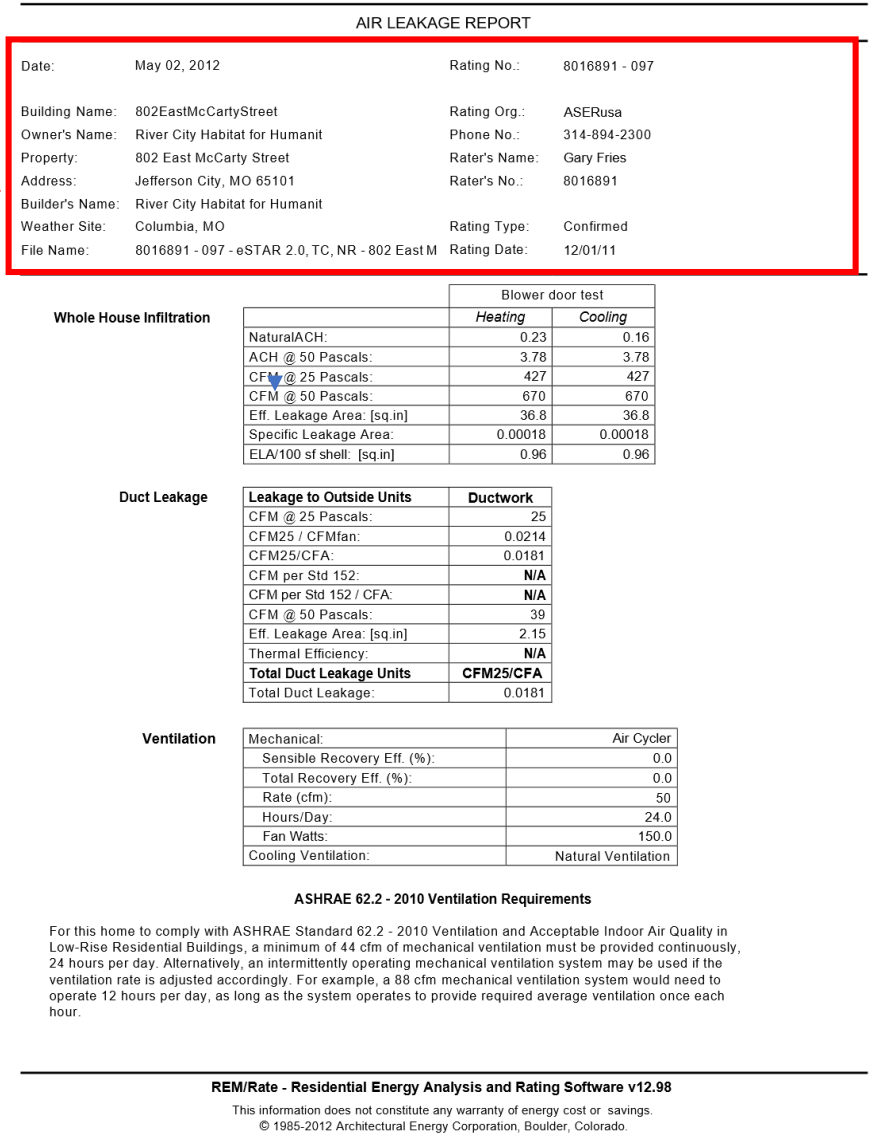
Air Leakage Report

Date:	May 02, 2012	**Rating No.:**	81158891-901
Building Name:	123 Main Street	**Rating Org.:**	Raters USA
Owners Name:	Jane Smith	**Phone:**	555-555-5555
Property Address:	123 Main Street Omaha, NE 68007	**Rater's Name:**	John Williams
Builder's Name:	ABC Construction	**Rater's No:**	1234567
Weather Site:	Omaha, NE	**Rating Type:**	Confirmed
File Name:	101682391-097 eSTAR	**Rating Date:**	12/01/20



AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit		
Weather Site:	Columbia, MO	Rating Type:	Confirmed
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage

Leakage to Outside Units	**Ductwork**
CFM @ 25 Pascals:	25
CFM25 / CFMfan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	**N/A**
CFM per Std 152 / CFA:	**N/A**
CFM @ 50 Pascals:	39
Eff. Leakage Area: [sq.in]	2.15
Thermal Efficiency:	**N/A**
Total Duct Leakage Units	**CFM25/CFA**
Total Duct Leakage:	0.0181

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

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Air Leakage Report

Whole House Infiltration

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Builder's Name:	River City Habitat for Humanit		
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Air Leakage Report

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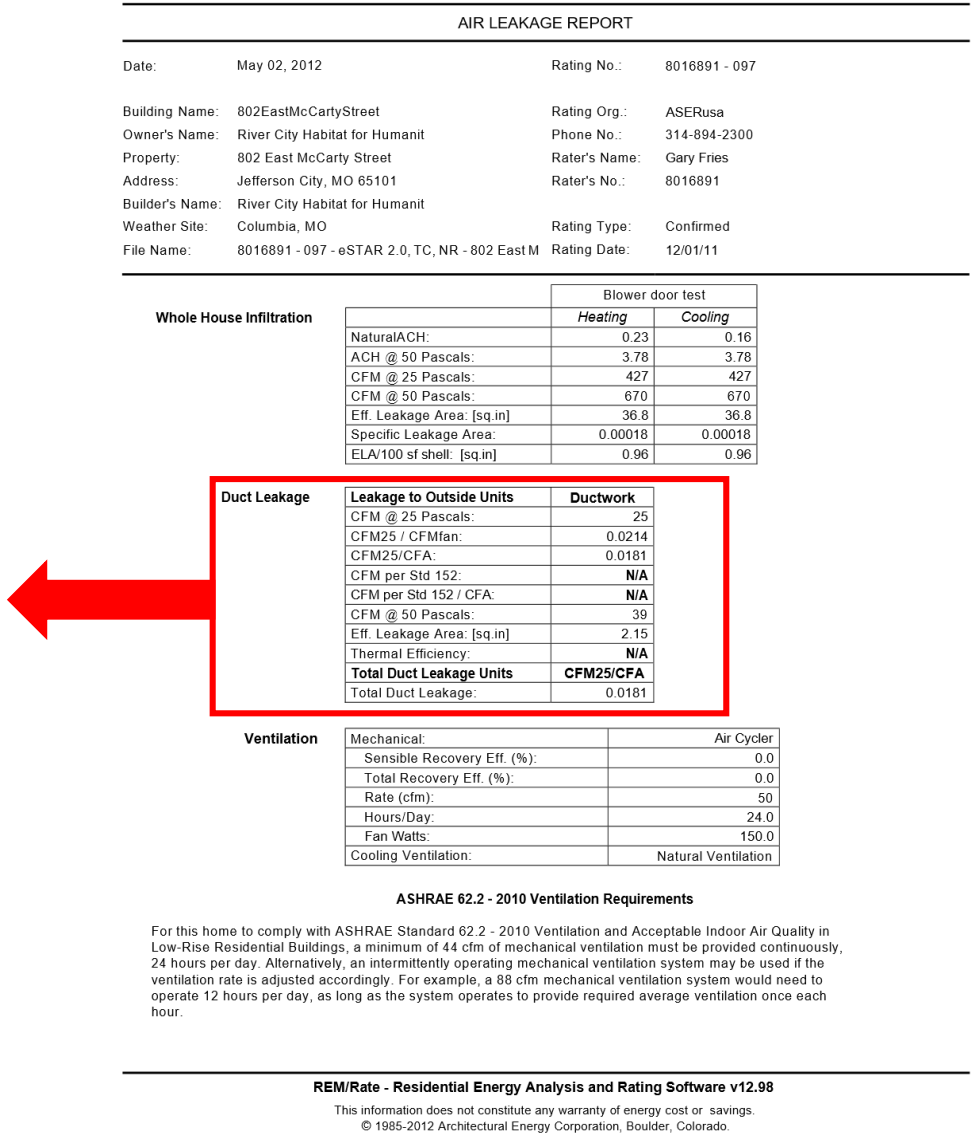

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Option 1: Whole-Building Testing:

≤ 0.40 CFM_{75}/ft^2

Buildings > 50,000 sf

Can comply by testing only (and all) the following portions and area-weighting measured air leakage:

a) Floor areas under roof or with building entrances

b) Representative above-grade wall sections totaling at least 25% of wall area, not including floor area above

Buildings < 50,000 sf

Must comply by testing entire building

Option 2: Materials Testing

- Acceptable materials must have an air permeance of <0.004 cfm/ft^2 under pressure differential of 0.3 in. of H^{2}O when tested in accordance with ATM E 2178

Material	Thickness (minimum)
Plywood	3/8 in.
Oriented strand board	3/8 in.
Extruded polystyrene insulation board	½ in.
Foil-faced urethane insulation board	½ in.
Exterior gypsum sheathing or interior gypsum board	½ in.
Cement board	½ in.
Built up roofing membrane	
Modified bituminous roof membrane	
Single-ply roof membrane	
A Portland cement/sand parge, stucco, or gypsum plaster	½ in.
Cast-in-place and precast concrete	
Sheet metal	
Closed cell 2 lb/ft^3 nominal density spray polyurethane foam	1 in.

Option 3: Assemblies Testing

Assemblies of materials and components (sealants, tapes, etc.) that have an average air leakage <0.04 cfm/ft^2 under a pressure differential of 0.3 in. of H_2O when tested in accordance with ASTM E 2357, 1677, 1680, or 283.

The following assemblies meet these requirements:

Concrete masonry walls that are

- Fully grouted, or
- Painted to fill the pores.

Key Takeaways

- 2018 IECC has new requirements for:
  - Air sealing
  - Duct sealing
  - U-Factor
  - R-Values
  - Performance Testing
- Controlling moisture is *critical*
  - Proper air sealing is key
  - Right-sizing HVAC is required
  - Mechanical ventilation must be installed and takes on new importance

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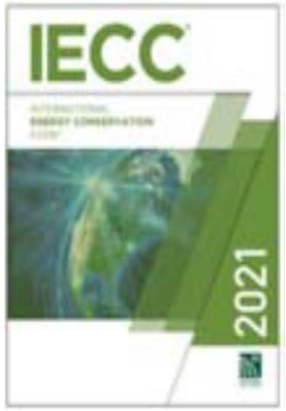
Key Takeaways

- There are several ways to comply with the commercial energy code
- Mandatory requirements must all be met
- System Commissioning is critical to ensure the building is operating as intended



Air Barrier

Location now required on Construction Docs. (C102)

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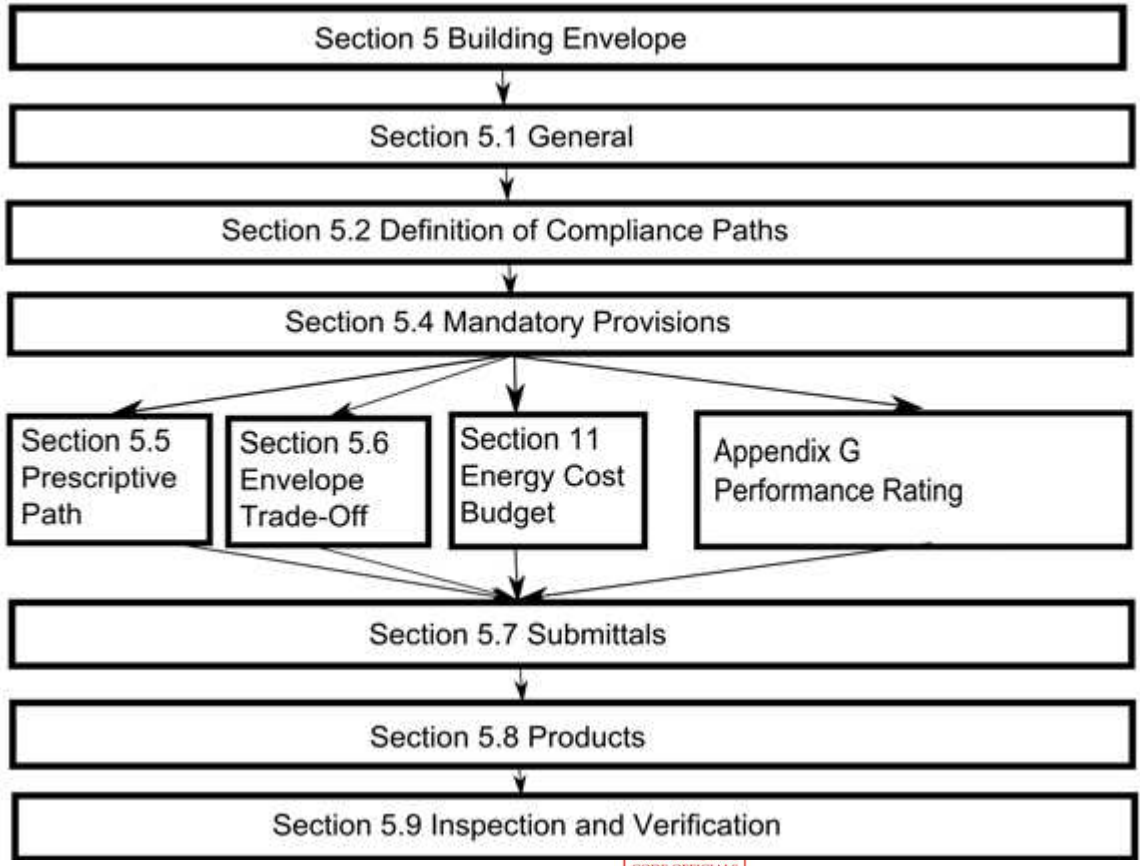
'21 IECC/ '19 90.1 Compliance Options –

- Building must comply with
  - C402 Envelope
  - C403 Mech
  - C404 SWH
  - C405 Lighting
  - Plus pick one additional efficiency package.



Continuous Air Barrier

Continuous air barrier required except in:

- Semiheated spaces in climate zones 0-6
- Single wythe concrete masonry buildings in climate zone 2B
- **The air barrier shall be designed and noted**
- *Air barrier components identified or noted in construction documents*
- Joints, intersections, and penetrations of air barrier components (incl. lighting fixtures) detailed
- Air barrier must extend over all surfaces of building envelope at lowest floor, exterior walls, and ceiling or roof
- Designed to resist positive and negative pressures from wind, stack effect, and mechanical ventilation

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Questions?

Live & Online Trainings in the New Year:

1/9/24

Nebraska Energy Codes Collaborative "Live"
9:30am-12pm
(NDEE, Lincoln)
Lunch Provided

1/17/24
Online 11am-12:30pm: IAQ & Water Efficiency

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Continuing Education Credits

- Participants of this session are eligible for continuing education credits from the International Code Council

- If you would like a certificate of completion for this session, email John at jgossman@mwalliance.org

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Thank you!

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John Gossman, MEEA
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