

Nebraska Energy Code: 2018 IECC to 2021 IECC Update

Nebraska Energy Code Training Program

Instructor: Matt Belcher

March 6, 2024: 11 AM– 12:30 PM CST





Housekeeping

- Attendees are muted upon entry
- Enter questions in the chat box
- This training is being recorded
- Slides and recording will be emailed to attendees and posted on the MEEA website
- CEUs are provided (ICC and AIA)
- Email John at JGossman@mwalliance.org with any questions

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:



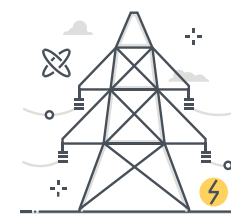
Energy service
companies &
contractors



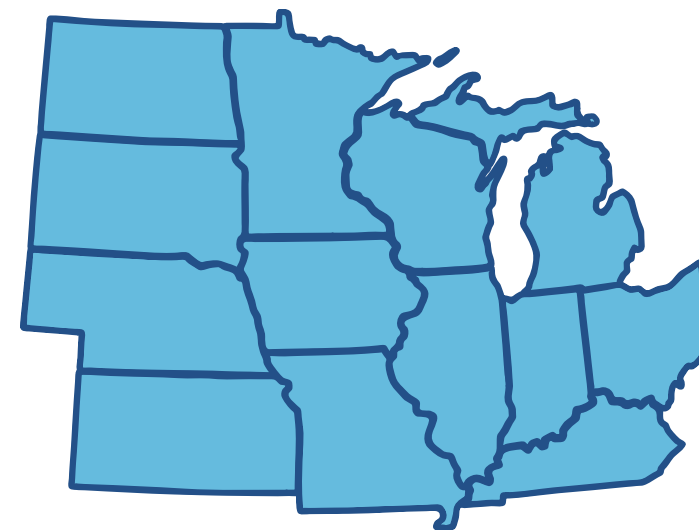
State & local
governments



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>





All about the 2018 IECC, 2021 IECC, and Beyond Learning Objectives

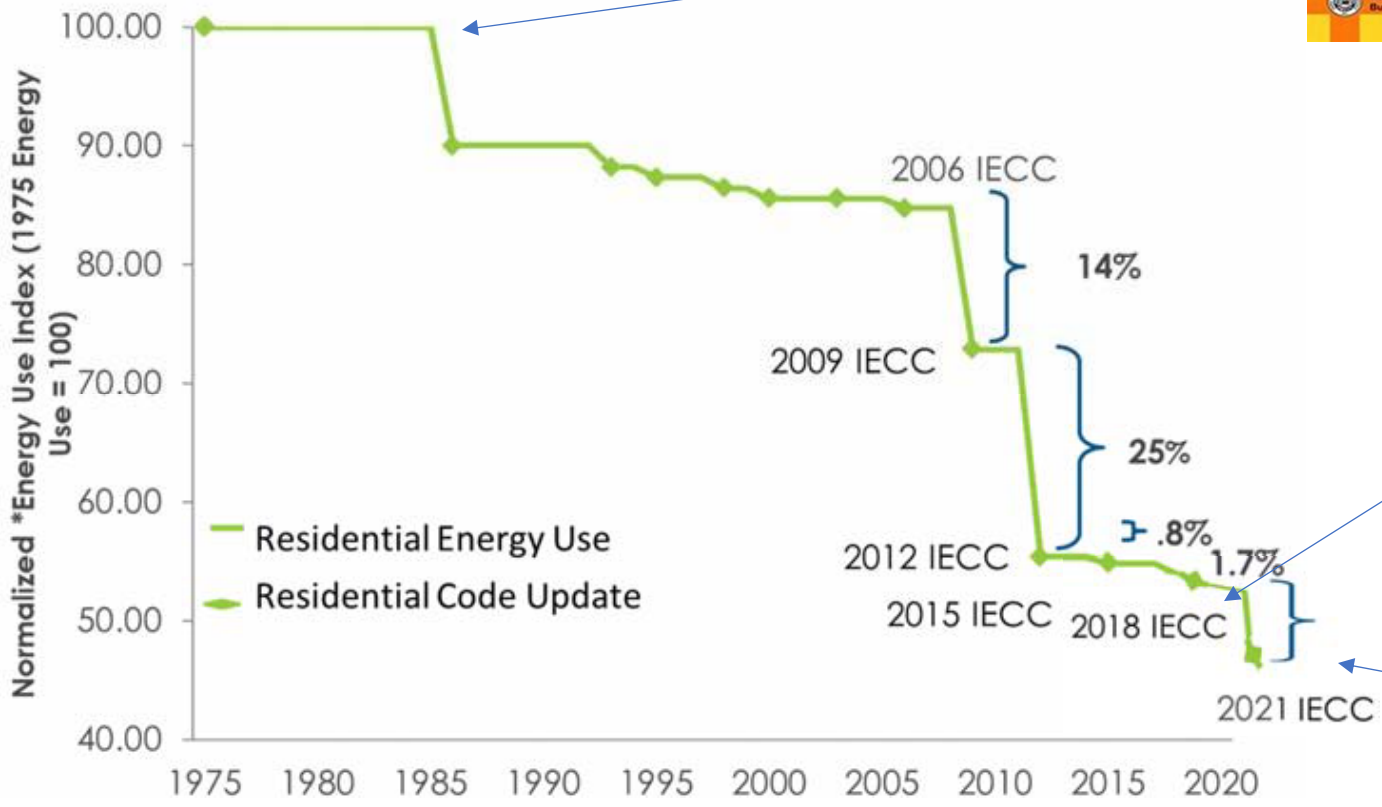
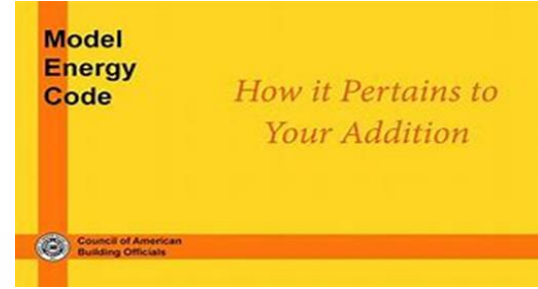
This interactive training will provide an overview of updates from the 2018 IECC to the 2021 IECC and a look beyond 2024 IECC.

-Residential and Commercial Basics

In this course you will:

1. Learn about the basic requirements of the 2018 IECC
2. Learn about the major changes to the 2021 IECC
3. Understand what is coming in the 2024 IECC and potential requirements
4. Understand the changes between the 2018 IECC and later versions of the energy code and how that will affect Building in Nebraska

Residential Energy Code Background



The Energy Code is Everywhere

- Unlike most other codes, the energy code directly impacts the work of many disparate building trades and systems, including:
 - Framing/Envelope
 - Plumbing
 - HVAC
 - Electric
 - Moisture management
 - Concrete
 - Caulking



Key Energy Code Components

- Insulation R-value (ceiling, wall, foundation)
- Insulation installation quality
- Continuous air barrier/sealing and testing
- Efficient windows
- Mechanical ventilation
- HVAC system sizing location detailing
- Envelope testing
- Efficient lighting & verification testing



2018 IECC / IRC Section 11

- **Basics:**
 - **Separates Commercial and Residential**
- **Remains +/- 15% above 2012 IECC**
- **Testing and verification.**
- **Promotes Innovation through Criteria; Energy Ratings Index (ERI) and 3 other alternative methods**



2021 IECC / IRC Section 11

Basics:

- Updated +/- 3% above 2018 IECC
- Testing and verification.
- Continues to Promote Innovation through Criteria; Energy Ratings Index (ERI) and 3 other alternative methods
- Biggest Changes:
 - R 60 attic Insulation
 - More focus on future electrification



IECC - Residential Provisions (All-Electric)

- **Chapter 1 – Scope and Application R101 SCOPE AND GENERAL REQUIREMENTS**

- **R101.3 Intent:**

Intent has been modified to include consideration of greenhouse gas emissions as well as both production and storage of energy.

- **R103 CONSTRUCTION DOCUMENTS**

- **R103.2.3 Solar-ready system**

Revisions to this section incorporate critical elements of solar readiness to be clearly identified on the construction documents. This code language has been migrated and amended from the 2021 IECC Appendix RB Solar-Ready Provisions.



Changes in IECC 2021



- **Administrative**
- R102: More Authority for Code Official to approve alternative material(s). (or not!)
- More definition for Code Officials Approval of Above Code Programs. (or not!)
- Information on Construction Documents must include: Energy Compliance Path and Air Sealing Details and Location of Air Barrier.

IECC - Residential Provisions (All-Electric) (Cont.)

- **R105 INSPECTIONS**

- **R105.2.3 Plumbing rough-in inspection.**

Revisions to this section incorporate critical elements of solar readiness used for service water heating.

- **R105.2.5 Electrical rough-in inspection.**

Current 2021 IECC inspections do not require dedicated electrical inspections.

IECC - Residential Provisions (All-Electric) (Cont.)

- Chapter 4 – Residential Energy Efficiency
- R401 GENERAL
- R401.2 Application. Residential buildings shall be *all-electric buildings*.

The change in application requires that new construction be all-electric. Where a jurisdiction does not wish to require electrification of specific end uses but wants to advance electric buildings further than electric-readiness, exception language can be added.

R401.3 Certificate. *Where a solar-ready zone is provided, the certificate shall indicate the location, dimensions, and capacity reserved on the electrical service panel.*

IECC - Residential Provisions (All-Electric) (Cont.)

- **R403 SYSTEMS:**

- **R403.1.1 Thermostat Programmable thermostat**

Demand responsive controls for thermostats are added based on language from California Title 24 and integrated into the current requirement for thermostats.

- **R403.5.4 Demand responsive water heating.**

- **R404.4 Renewable energy infrastructure.**

By ensuring solar-ready zones, all-electric buildings will have the potential for an even greater impact on building decarbonization by contributing to the continued cleaning of the electricity supply.

IECC - Residential Provisions (All-Electric) (Cont.)

- **R408 ADDITIONAL EFFICIENCY PACKAGE OPTIONS.**

All electric buildings will not need language that relates to fossil fuel systems. This vestigial language has been removed to avoid confusion in implementation of this overlay and the sections have been renumbered.



IECC - Residential Provisions (Mixed-Fuel)

- **Chapter 1 – Scope and Application R101 SCOPE AND GENERAL REQUIREMENTS.**

Intent has been modified to include consideration of greenhouse gas emissions as well as both production and storage of energy.

- **R103 CONSTRUCTION DOCUMENTS**

- **R103.2 Information on construction documents.**

6. Mechanical and service water heating systems and equipment types, sizes, fuel sources and efficiencies.



IECC - Residential Provisions (Mixed-Fuel)

- **R103.2.3 Solar-ready system.**
- **R103.2.4 Electrification system.**

- **R105 INSPECTIONS**
- **R105.2.3 Plumbing rough-in inspection**

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. Where the solar-ready zone is installed for solar water heating, inspection shall verify pathways for routing of plumbing from solar-ready zone to service water heating system.

IECC - Residential Provisions (Mixed-Fuel)

- **Chapter 4 – Residential Energy Efficiency**

- **R401 GENERAL**

- For all-electric buildings
- For mixed-fuel buildings
- For buildings complying with the Energy Rating Index

- **R402 BUILDING THERMAL ENVELOPE**

Low energy buildings are currently exempt from thermal envelope requirements. This revision applies the same intention of low greenhouse gas impact that was given to low energy use impact when these building types were exempted.

IECC - Residential Provisions (Mixed-Fuel)

- **R404 ELECTRICAL POWER AND LIGHTING SYSTEMS**

- **R404.4.1 One- and two- family dwellings and townhouses.**

One- and two-family dwellings and townhouses shall comply with Sections R404.4.1.1 through R404.4.1.4.

Exceptions:

- 1. A building with a permanently installed on-site renewable energy system.
- 2. A building with a solar-ready zone area that is less than 600 square feet (55 m²) of roof area oriented between 110 degrees and 270 degrees of true north.
- 3. A building with a solar-ready zone area that is shaded for more than 70 percent of daylight hours annually.

IECC - Residential Provisions (Mixed-Fuel)

- **R404.4.1.2 Obstructions.** Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.
- **R404.4.1.3 Electrical service reserved space.** The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled “For Future Solar Electric.” The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.

IECC - Residential Provisions (Mixed-Fuel)

- **R404.4.1.4 Electrical interconnection.** An electrical junction box shall be installed within 24 inches (610 mm) of the main electrical service panel and shall be connected to a capped roof penetration sleeve or a location in the attic that is within 3 feet (914 mm) of the solar ready zone by one of the following:
 - 1. Minimum $\frac{3}{4}$ -inch nonflexible conduit
 - 2. Minimum #10 Metal copper 3-wire. Where the interconnection terminates in the attic, location shall be no less than 12" (35 mm) above ceiling insulation. Both ends of the interconnection shall be labeled "For Future Solar Electric".



IECC - Residential Provisions (Mixed-Fuel)

- **R404.5 Electric vehicle charging infrastructure.** Electric infrastructure for the current and future charging of electric vehicles shall be installed in accordance with this section. EV ready spaces are permitted to be counted toward meeting minimum parking requirements.



IECC - Residential Provisions (Mixed-Fuel)

- **R404.6.3 Combustion space heating.**
- A dedicated branch circuit in compliance with IRC Section E3702.11 based on heat pump space heating equipment sized in accordance with R403.7 and terminating within 3 feet (914 mm) of the location with no obstructions. Both ends of the branch circuit shall be labeled “For Future Heat Pump Space Heater.”



IECC - Residential Provisions (Mixed-Fuel)

- **R404.5 Electric vehicle charging infrastructure.** Electric infrastructure for the current and future charging of electric vehicles shall be installed in accordance with this section. EV ready spaces are permitted to be counted toward meeting minimum parking requirements.

EV Ready and EV Capable

- EV Chargers
 - Level 1 EVSE – Charging through 120V AC plug
 - Adds 2-5 miles of range per hour of charging
 - No special equipment, but does require dedicated branch circuit
 - Level 2 EVSE – Charging through 240 V AC plug
 - Adds 10-60 miles of range per hour of charging
 - Requires special charging equipment and dedicated electrical circuit of 20-100 amps
 - More expensive than Level 1
- EVs can also serve as a home battery in the future



Images: tesla.com; wsj.com

IECC - Residential Provisions (Mixed-Fuel)

- **R404.6.4 Combustion clothes drying.**

- A dedicated 240-volt branch circuit with a minimum capacity of 30 amps shall terminate within 6 feet (1829 mm) of natural gas clothes dryers and shall be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Clothes Drying” and be electrically isolated.

- **R404.6.5 Combustion cooking.**

A dedicated 240-Volt, 40A branch circuit shall terminate within 6 feet (1829 mm) of natural gas ranges, cooktops and ovens and be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Range” and be electrically isolated.

IECC and IMC

- Whole-house mechanical ventilation required by energy code
- Ventilation rate and equipment requirements in the International Mechanical Code (IMC)



HVAC Design and Loads

Oversized systems:

- Less comfort
- Less efficient
- Poorly handles moisture
- Premature equipment failure

Right-sized systems:

- Better operating efficiencies
- Greater comfort
- Healthier indoor environments
- Better moisture control

HVAC Design and Loads



- Properly designed HVAC systems rely on scientific criteria and a systematic method to match the loads required for health and comfort:
 - *ACCA Manual J – Residential Load Calculation*
 - *ACCA Manual S – Residential Equipment Selection*
 - *ACCA Manual D – Residential Duct Systems*
- Reports should be submitted with permit application



HVAC Load Calculations

Section C403.1.1 (Mandatory)

Heating and cooling load sizing calculations required:

- ASHRAE/ACCA Standard 183
 - OR -
- Other approved computation procedures – defined in Chapter 3
 - Interior design conditions specified by Section C302
 - $\leq 72^{\circ}\text{F}$ for heating load
 - $\geq 75^{\circ}\text{F}$ for cooling load
- Loads reduced from energy recovery systems utilized in the HVAC system shall be accounted for in accordance with the ASHRAE HVAC Systems and Equipment Handbook



Ventilation

Section C403.2.2 (Mandatory)

- Natural and mechanical ventilation to be provided in accordance with Chapter 4 of the IMC
- If mechanical: system to provide the capability to reduce outdoor air supply to minimum required by IMC Chapter 4

Air Sealing, Testing & Ventilation | R402.4

- **2009 IECC** Requirement: 7 ACH50 (testing optional)
 - Mechanical Ventilation not required
- **2015 IECC** Requirement: 5 ACH50 (testing Required)
- **2018 IECC** Requirement: 3 ACH50 (testing required)
 - Mechanical ventilation required and is critical!
 - Exhaust, Supply or Balanced Ventilation
 - As simple as a continuous bath fan
- ✓ **2021 IECC** Requirement: 3 ACH50 (No Real Change)

Ventilation and Air Sealing

- Both natural and mechanical ventilation provide fresh air that can dilute and remove indoor pollutant levels
- Per the IMC/IRC, mechanical ventilation is required when homes are <5 ACH 50
 - Need to do a blower door test to determine leakage rate
 - **Liability concerns when not performed**
- A blower door test measures a building's existing air leakage
- Can not design a code compliant system without knowing air leakage



Courtesy of AC Tool Supply, Inc.

Biggest Changes in IECC 2021

- Redrawn Climate Zones (No Change in NE)
- Improved Window U-factors & Wall and Ceiling R-values
- Attic pull-down stairs – R-13 okay for CZ1-4
- Floor insulation – 3 options
- Basement option details
- Sunrooms and heated garage separation
- Ducts Testing on all systems
- Ducts inside, < 8% Total Leakage
- Ducts outside, < 4% Total Leakage
- Verified fan (kitchen, bath, whole house) airflow
- All efficient lighting and controls (100%)
- Must choose your Additional Efficiency Package



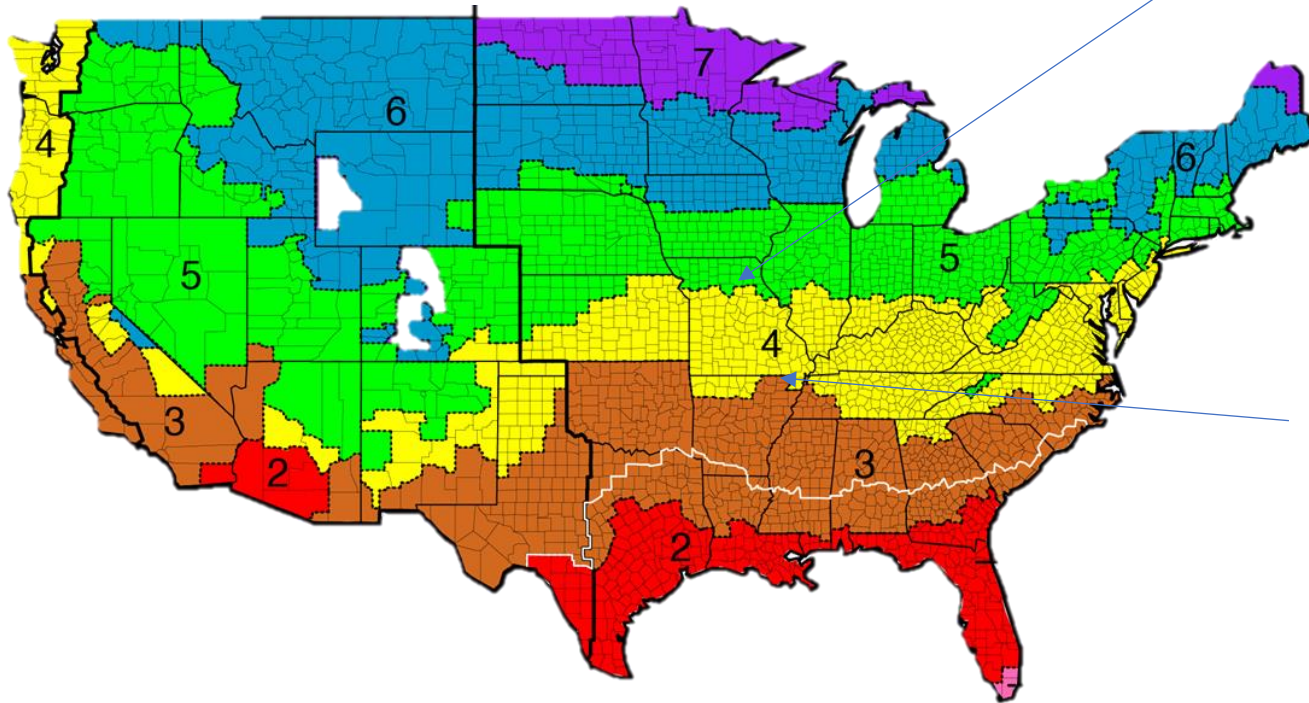
Changes in IECC 2021

- **Definitions Added/Modified:**
 - *Lighting Definition Modification*
 - Information Technology Equipment (ITE)
 - Internal Curtain System
 - *On-Site Renewable Energy*
 - *Renewable Energy Resources*
 - *Testing Unit Enclosure Area*
 - *Thermal Distribution Efficiency (TDE)*
 - *Vegetative Roof*
 - *Visible Transmittance*



Climate Zones '21

- Buchanan, Caldwell, Chariton, Clinton, are now CZ 4A (Mo)



- Dunklin & Pemiscot, are now CZ 3A (Mo)

2021 IECC

One prescriptive “answer” for how to build per climate zone
(now CZ: 3, 4, 5)

- Buchanon, Caldwell, Chariton, Clinton, are now CZ 4A
- Dunklin & Pemiscot, are now CZ 3A



TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT^a

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

402.1.2 is similar table for U-factors (get U-values from RESCheck)

Insulation Requirements

- **402.2.1 - Ceilings with Attics**
- R-49 (CZ3) and R-60 (CZ4-5)
- is prescriptive requirement
- Rulers required every 300 s.f.





Nebraska's Energy Code: Commercial Energy Code Basics Designing and Constructing to 2018/2021 IECC & *Beyond!*



Biggest Changes in IECC 2021

- Redrawn Climate Zones (6 CZ's in MO) Nebraska unaffected
- ASHRAE 90.1 2019 = Alternate Path
- Improved Window U-factors & Wall and Ceiling R-values
- Updated Mechanical/Lighting requirements
- Controls!
- Must choose your Additional Efficiency Package
- Increased Alternative Methods
- ComCheck
- More Focus on Commissioning



Changes in IECC 2021



- **Administrative**
- C102: More Authority for Code Official to approve alternative material(s). (or not!)
- More definition for Code Officials Approval of Above Code Programs. (or not!)
- Information on Construction Documents must include: Energy Compliance Path and Air Sealing Details and Location of Air Barrier.



Changes in IECC 2021

- **Definitions Added/Modified:**

- BioGas
- *Biomass*
- *Data Center/Computer Room*
- Direct Digital Control (DDC)
- Enthalpy Recovery Ratio
- Fans: Many Additions and Changes (Energy/Power, Number, etc.)
 - Large Diameter Fans
- Fault Detection and Diagnostics (FDD) System

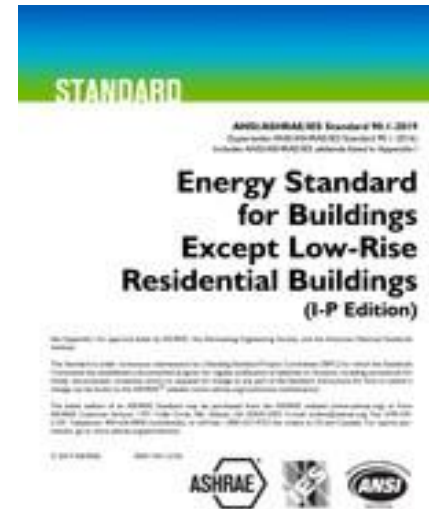
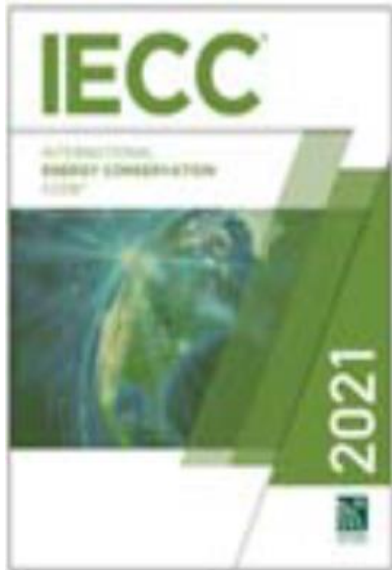


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 - *Thermal Distribution Efficiency (TDE)*
 - *Vegetative Roof*
 - *Visible Transmittance*



Two Commercial Compliance Options (new in 2018 = 90.1 2016)



ASHRAE 90.1-
2019

Alternative
Method to IECC

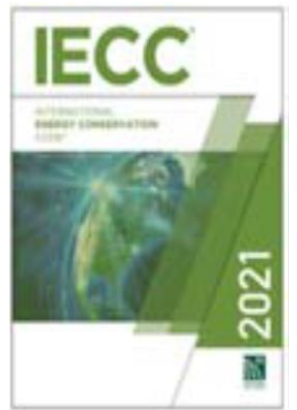
C401

Thermal Envelope Certificate Required

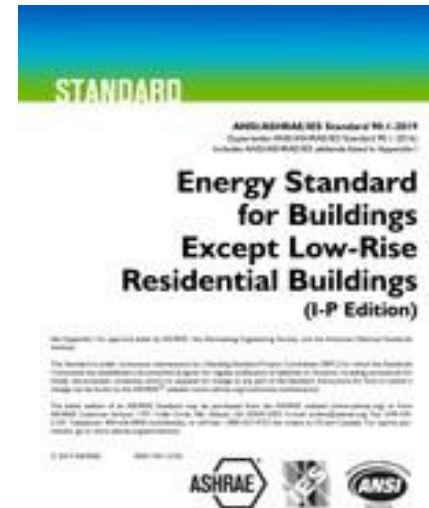
- Completed by an *Approved Party*
- Posted on a wall in the space where space conditioning equipment is located
- Shows R-Values, U-Values, Envelope Leakage Test Results, Etc.

In Addition:

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



Two Commercial Compliance Options (new in 2018 = 90.1 2016)

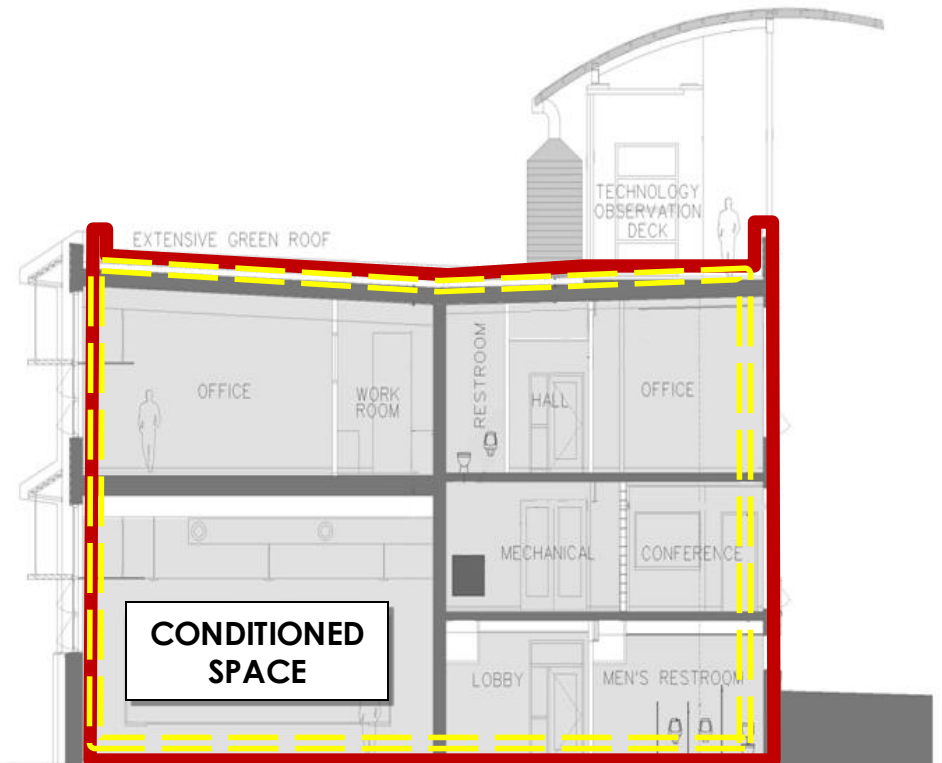


ASHRAE 90.1-
2019

Alternative
Method to IECC

C402 What is the Building Thermal Envelope?

- These assemblies can comprise the building thermal envelope if they **separate conditioned from unconditioned space or outside air**
 - Roof/Ceiling Assembly
 - Wall Assembly
 - Vertical Fenestration and Skylight
 - Floor Assembly
 - Slab Edge
 - Below-Grade Wall Assembly



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

Space Conditioning Categories

Separate envelope component requirements apply to three types of conditioned spaces

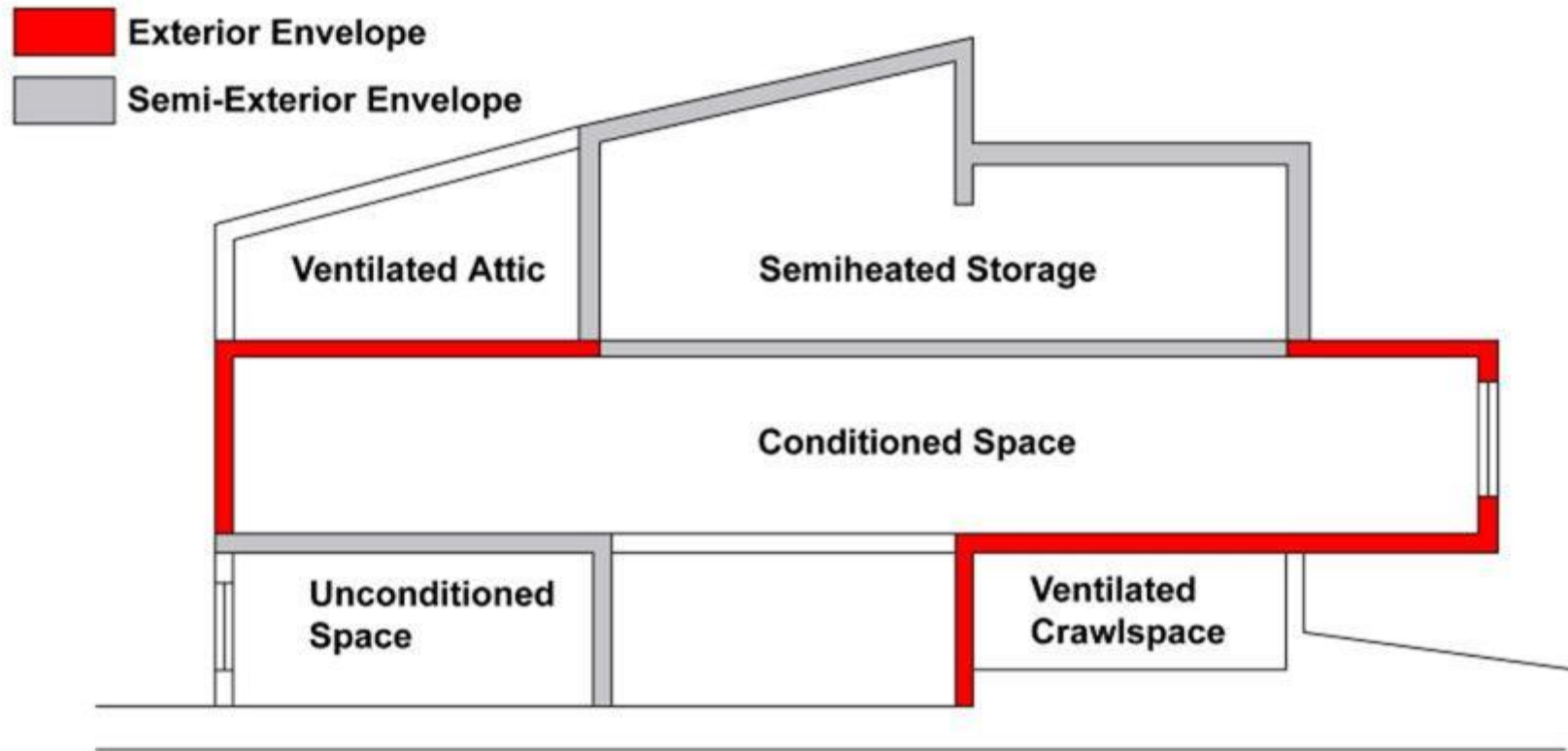
- 90.1: *Nonresidential* – IECC: “All other”
- 90.1: *Residential* – IECC: “Group R”
- 90.1: *Semiheated* – spaces are heated, but not to comfort levels, and not cooled.
(Only if approved by the building official - Uncommon)

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·ft² 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

Semi-Exterior Envelope



**IECC does not have a definition for semiheated*

Compliance Options

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

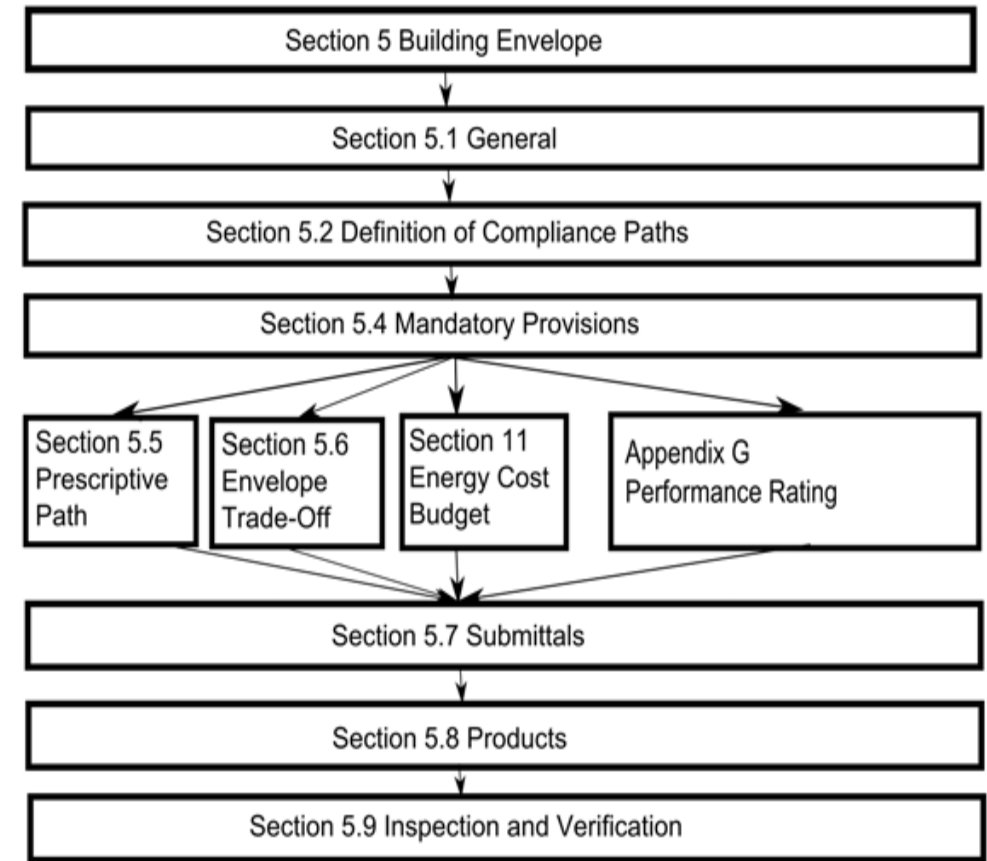


TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD^a



CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs														
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci
Metal buildings ^b	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-60	R-60
Walls, above grade														
Mass ^f	R-5.7ci ^c	R-5.7ci ^c	R-5.7ci ^c	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci
Metal building	R-13 + R-6.5ci	R-13 + R-6.5ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-17ci	R-13 + R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-10ci	R-13 + R-10ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-15.6ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci
Walls, below grade														
Below-grade wall ^d	NR	NR	NR	NR	NR	NR	R-7.5ci	R-10ci	R-7.5ci	R-10ci	R-10ci	R-15ci	R-15ci	R-15ci
Floors														
Mass ^e	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-14.6ci	R-16.7ci	R-14.6ci	R-16.7ci	R-16.7ci	R-16.7ci	R-20.9ci	R-20.9ci
Joist/framing	R-13	R-13	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38	R-38	R-38
Slab-on-grade floors														
Unheated slabs	NR	NR	NR	NR	NR	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-20 for 24" below	R-20 for 24" below	R-20 for 48" below	R-20 for 24" below	R-20 for 48" below
Heated slabs ^g	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-10 for 24" below + R-5 full slab	R-10 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab

TABLE C402.1.4 OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD^{a, b}



CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass ^f	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other ^c	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall ^c	C-1.140 ^e	C-1.140 ^e	C-1.140 ^e	C-1.140 ^e	C-1.140 ^e	C-1.140 ^e	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass ^d	U-0.322 ^e	U-0.322 ^e	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066 ^e	U-0.066 ^e	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73 ^e	F-0.73 ^e	F-0.73 ^e	F-0.73 ^e	F-0.73 ^e	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door ^g	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing ^h	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31



IECC fenestration requirements

TABLE C402.4 BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
Vertical fenestration																
U-factor																
Fixed fenestration	0.50		0.45		0.42		0.36		0.36		0.34		0.29		0.26	
Operable fenestration	0.62		0.60		0.54		0.45		0.45		0.42		0.36		0.32	
Entrance doors	0.83		0.77		0.68		0.63		0.63		0.63		0.63		0.63	
SHGC																
	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable
PF < 0.2	0.23	0.21	0.25	0.23	0.25	0.23	0.36	0.33	0.38	0.33	0.38	0.34	0.40	0.36	0.40	0.36
0.2 ≤ PF < 0.5	0.28	0.25	0.30	0.28	0.30	0.28	0.43	0.40	0.46	0.40	0.46	0.41	0.48	0.43	0.48	0.43
PF ≥ 0.5	0.37	0.34	0.40	0.37	0.40	0.37	0.58	0.53	0.61	0.53	0.61	0.54	0.64	0.58	0.64	0.58
Skylights																
U-factor	0.70		0.65		0.55		0.50		0.50		0.50		0.44		0.41	
SHGC	0.30		0.30		0.30		0.40		0.40		0.40		NR		NR	

NR = No Requirement. PF = Projection Factor.

Ashrae 90.1-2019 envelope requirements Climate Zone 4



Table 5.5-4 Building Envelope Requirements for Climate Zone 4 (A,B,C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
<i>Insulation entirely above deck</i>	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.093	R-10 c.i.
<i>Metal building^a</i>	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.082	R-19
<i>Attic and other</i>	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
<i>Walls, above Grade</i>						
<i>Mass</i>	U-0.104	R-9.5 c.i.	U-0.090	R-11.4 c.i.	U-0.580	NR
<i>Metal building</i>	U-0.060	R-0 + R-15.8 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.162	R-13
<i>Steel-framed</i>	U-0.064	R-13 + R-7.5 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13
<i>Wood-framed and other</i>	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.089	R-13
<i>Wall, below Grade</i>						
<i>Below-grade wall</i>	C-0.119	R-7.5 c.i.	C-0.092	R-10 c.i.	C-1.140	NR
<i>Floors</i>						
<i>Mass</i>	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 c.i.
<i>Steel joist</i>	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19
<i>Wood-framed and other</i>	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
<i>Slab-on-Grade Floors</i>						
<i>Unheated</i>	F-0.520	R-15 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
<i>Heated</i>	F-0.843	R-20 for 24 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
<i>Opaque Doors</i>						
<i>Swinging</i>	U-0.370		U-0.370		U-0.370	
<i>Nonswinging</i>	U-0.310		U-0.310		U-0.360	

ASHRAE 90.1-2019 Envelope requirements

Climate Zone 5



Table 5.5-4 Building Envelope Requirements for Climate Zone 4 (A,B,C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
<i>Insulation entirely above deck</i>	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.093	R-10 c.i.
<i>Metal building^a</i>	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.082	R-19
<i>Attic and other</i>	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
<i>Walls, above Grade</i>						
<i>Mass</i>	U-0.104	R-9.5 c.i.	U-0.090	R-11.4 c.i.	U-0.580	NR
<i>Metal building</i>	U-0.060	R-0 + R-15.8 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.162	R-13
<i>Steel-framed</i>	U-0.064	R-13 + R-7.5 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13
<i>Wood-framed and other</i>	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.089	R-13
<i>Wall, below Grade</i>						
<i>Below-grade wall</i>	C-0.119	R-7.5 c.i.	C-0.092	R-10 c.i.	C-1.140	NR
<i>Floors</i>						
<i>Mass</i>	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 c.i.
<i>Steel joist</i>	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19
<i>Wood-framed and other</i>	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
<i>Slab-on-Grade Floors</i>						
<i>Unheated</i>	F-0.520	R-15 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
<i>Heated</i>	F-0.843	R-20 for 24 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
<i>Opaque Doors</i>						
<i>Swinging</i>	U-0.370		U-0.370		U-0.370	
<i>Nonswinging</i>	U-0.310		U-0.310		U-0.360	

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

Verifying an Energy Efficient Building Envelope (Reduced Air Infiltration)

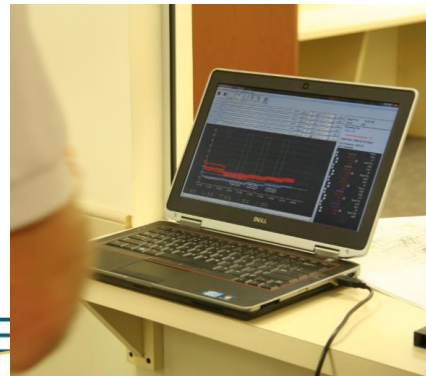
Blower Door Testing – Designated by IECC C406.9

- Prove Air Sealing
- Envelope Integrity

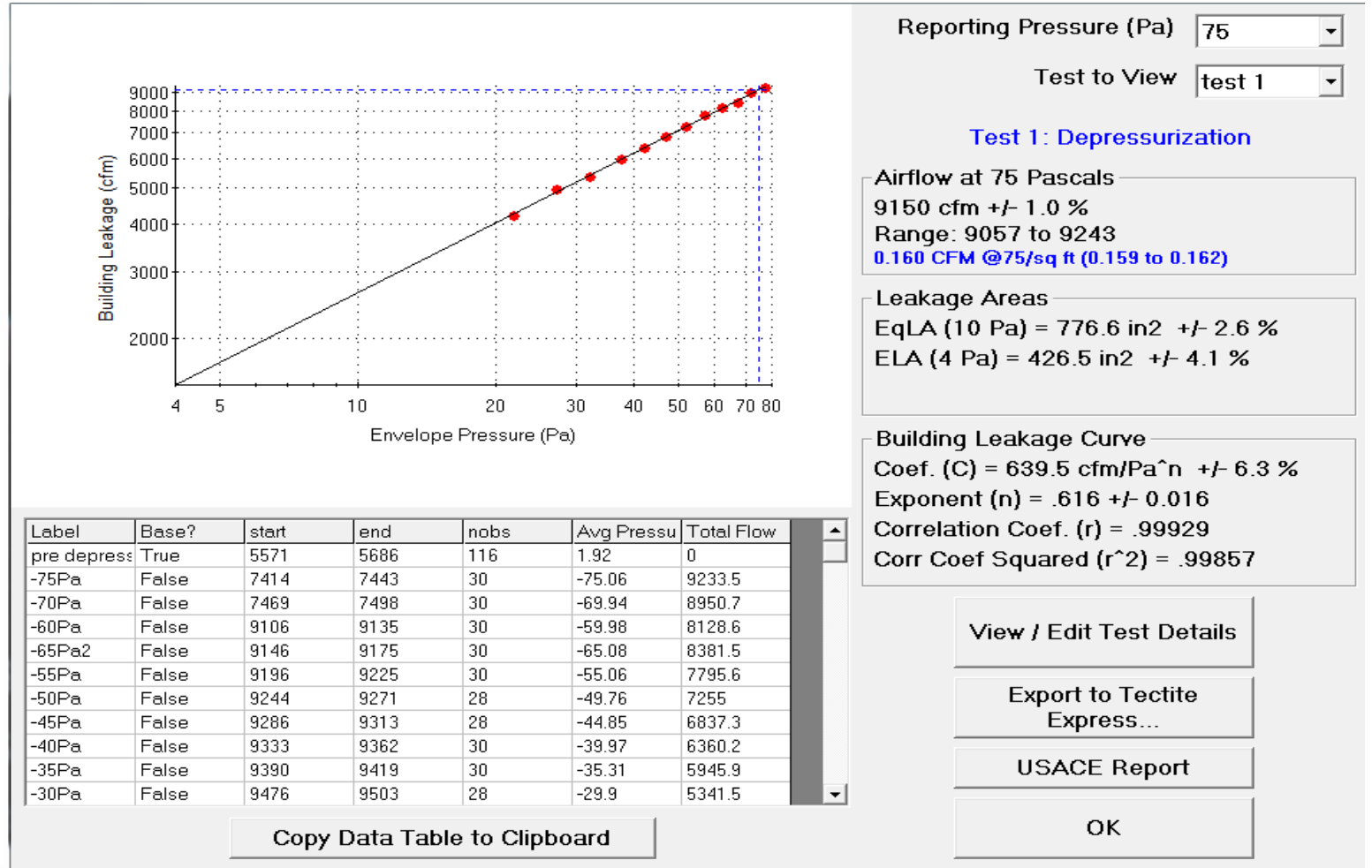
C402.5 Air leakage—thermal envelope (Mandatory). The *thermal envelope* of buildings shall comply with Sections C402.5.1 through C402.5.8, or the building *thermal envelope* shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft² (0.2 L/s · m²). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

Note: ASTM E1827 1-2 Fan Testing

$$ELR_{75} = \frac{CFM_{75}}{\text{shell area}}$$
$$ELR_{75} \leq 0.40$$



Multi-blower door – envelope leakage test ASTM E779 (Multiple fans)



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

Benefits of Commissioning



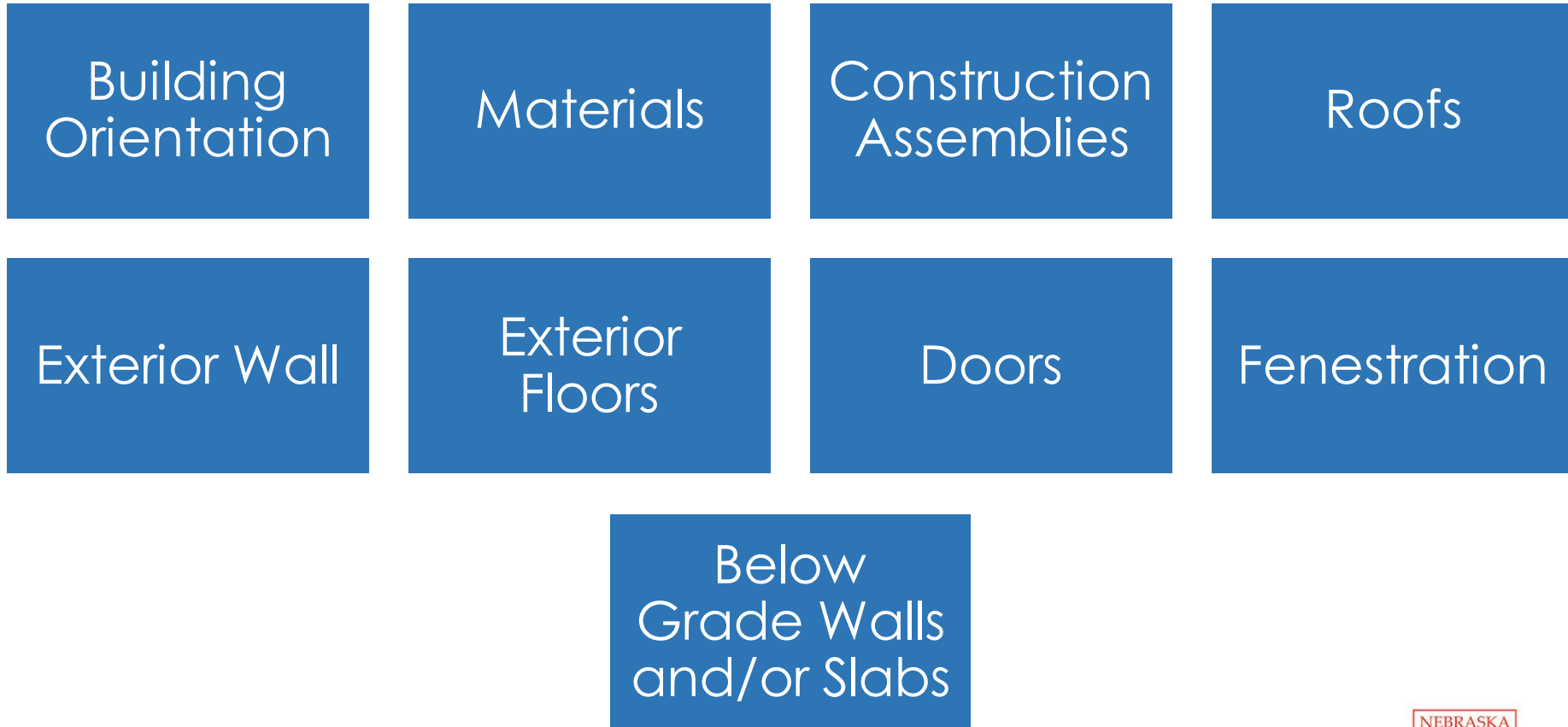


Functional Testing of Lighting Controls

Section C408.3.1

- Prior to passing final inspection, registered design professional to provide evidence that lighting control systems:
 - have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working order per construction documents and manufacturer's installation instructions

Commissioning: Building Envelope Data Points



Existing Buildings - Scope

Chapter 5

- Applies to alterations, repairs, additions, and change of occupancy (C501.1)
- Additions must comply with code without requiring unaltered portions to comply (C502.1)
 - Specific requirements for new vertical fenestration and skylights (C502.2.1 and C502.2.2)
- Alterations shall not make building less conforming (C503.1)



Image: MontgomeryCountyMD.gov

Key Takeaways

- 2018/2021 IECC has new requirements for:
 - Air sealing
 - Duct sealing
 - U-Factor
 - R-Values
 - Performance Testing
- Controlling moisture is critical. *Always has been, Always will be!*
 - Proper air sealing is key
 - Right-sizing HVAC is required
 - Mechanical ventilation must be installed and takes on new importance

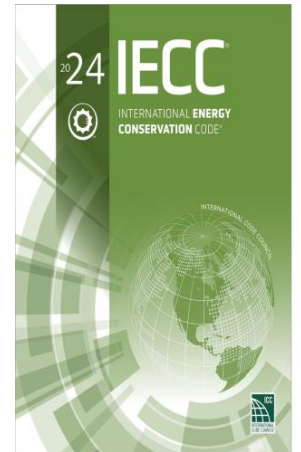
Looking Ahead:



- IECC changes to The National Energy Standard as of 2024.
- Uses 2021 IECC as a baseline.
- Introduces Carbon Impact into the conversation.
- On a trajectory for Net Zero Energy as of 2030.

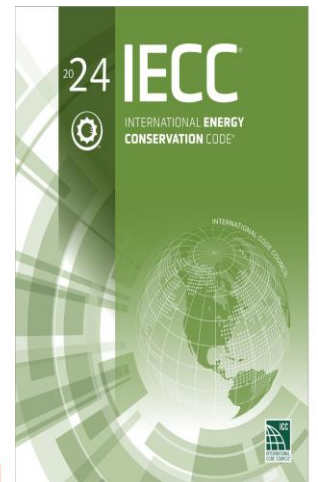
2024 National Energy Standard

- In Process since November '21
- Use '21 Energy Code as Basis and Improvements from there.
- Many more stakeholders than IECC Development
- Glide slope to Net Zero by 2030
- Expanded Appendices
- Carbon Impact/Credits



2024 National Energy Standard (Cont.)

- More focus on Electrification
- Tables for Envelope and Fenestrations (402/403) updated
- More reliance of high performance
- More focus on testing/verification
- More intent to move appendices items forward in 2027 & 2030 versions





2024 Energy Standard

- Many of these “advanced” technologies and practices have actually been in use for a number of years.
- As newer technologies and components come along, they are easier to incorporate
- They all require the “basics” to be done properly!
- They are all systems part of a larger system!





Key Takeaways

- 2024 Energy Standard has new requirements for:
 - Electrification
 - EV Charging
 - Solar
 - Grid Interaction
 - Carbon
- Using & Understanding Guides and formulas is *critical*
 - Good Design!!!
 - Proper envelope construction is key
 - Right-sizing HVAC is required
 - Documenting construction and certification



Key Takeaways Continued

- Many of these “advanced” technologies and practices have actually been in use for a number of years.
- As newer technologies and components come along, they are easier to incorporate
- They all require the “basics” to be done properly!
- They are all systems part of a larger system!



MEEA YouTube Videos

Commercial Air Infiltration

- <https://www.youtube.com/watch?v=as6l1xEMJes>

Commercial Lighting and HVAC

- <https://www.youtube.com/watch?v=FroYByTpu7U>



Upcoming Events:

Major Announcement!!!

Coming in April! “Tour de Nebraska”

4/9: Nebraska Collaborative Meeting – **NDEE Lincoln**

4/10 Tour of New Medical Facilities Construction **Univ of Nebraska-Kearney**

4/11 Scottsbluff Nebraska (**Gering Civic Center, Gering Ne**)
AM Residential Codes Overview
PM Commercial Codes Overview

2024 Tour de Nebraska! It's like “Door-Dash Code Training”!





Thank you!

Matt Belcher, Verdatek Solutions

matt@verda-solutions.com

Cell: (314) 749-4189

John Gossman, MEEA

jgossman@mwalliance.org

