Nebraska's Commercial Energy Code: Building Envelope

Nebraska Energy Code Training Program

Instructor: Matt Belcher

June 15, 2022 9:00am – 10:30am CST

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Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box
- Webinar is being recorded – slides and recording will be sent to attendees
- CEU's will be available upon request (ICC, AIA)
  - Reporting information at the end of this presentation
- Email canderson@mwalliance.org with questions

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Today's Agenda

- The 2018 IECC
- Building Envelope Requirements
- Mechanical/Ventilation "Quick hit"
- Commissioning
- ASHRAE 90.1 2016 Option
- Existing Buildings
- Key Takeaways
- Q&A

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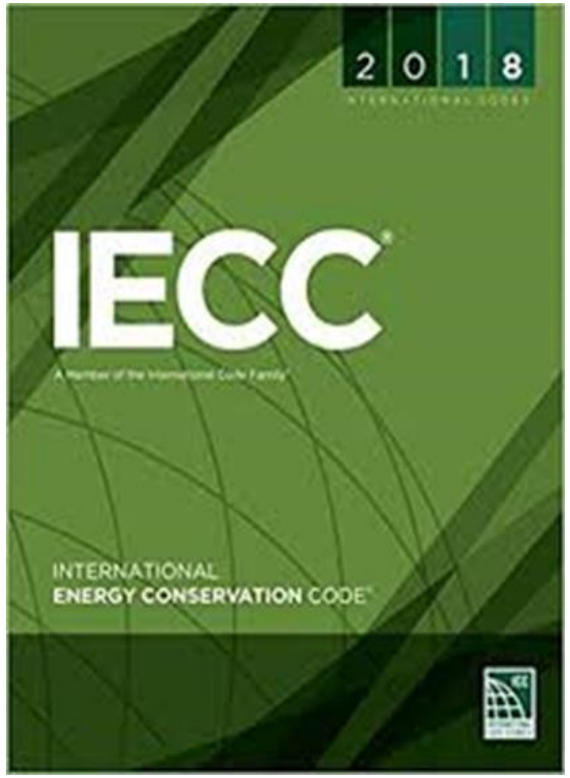
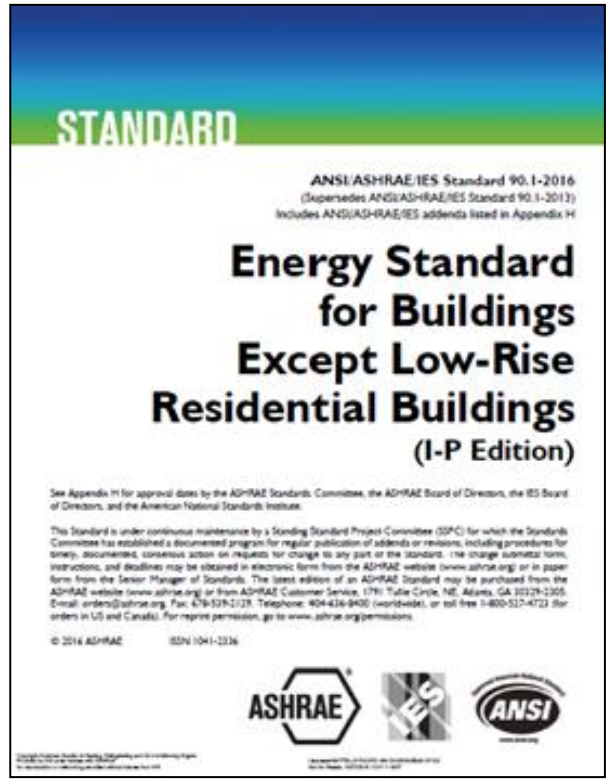
Two Commercial Compliance Options



We are going to discuss ASHRAE 90.1-2016 Envelope Requirements also.



The 2018 IECC

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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 commercial today

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Structure of Commercial 2018 IECC

- Ch. 1 Scope and Application / Administrative and Enforcement
- Ch. 2 Definitions
- Ch. 3 General Requirements
- Ch. 4 Commercial Energy Efficiency
- Ch. 5 Existing Buildings
- Ch. 6 Referenced Standards
- Index

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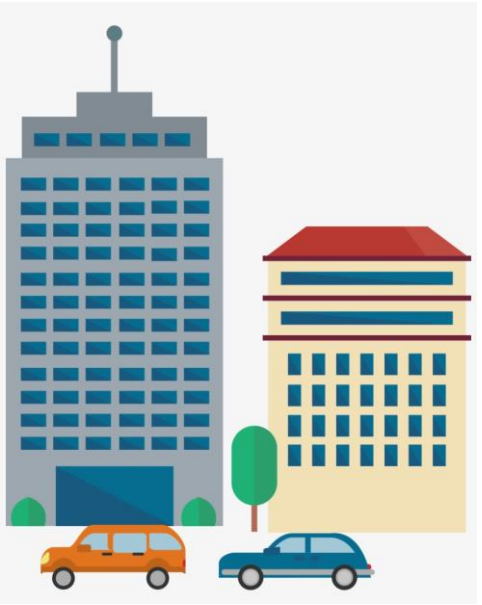
Commercial Buildings in the IECC

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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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

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

Additional Efficiency Package Options
Section C406

- <u>One</u> additional efficiency feature ***must*** be selected to comply with the IECC:
- C406.2 – Eff. HVAC Performance
- C406.3 – Reduced Lighting Power
- 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

More Efficient Lighting System

Onsite Renewables

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Building Envelope

Insulation, windows, doors, roof and floors

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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Mandatory Requirements

- Air Leakage
- Air barriers
- Fenestration air leakage
- Rooms Containing Fuel-burning Appliances
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weatherseals
- Vestibules
- Recessed lighting
- Commissioning

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Prescriptive Compliance: Insulation

Climate Zone 5													
	Roofs			Walls, above grade					Floors		Slab-on-grade floors		
	Insulation entirely above roof deck	Metal buildings[b]	Attic and other	Mass[g]	Metal building	Metal framed	Wood framed and other	Below grade wall[d]	Mass[e]	Joist/ framing	Unheated slabs	Heated slabs[h]	Opaque, non-swinging doors
All Other	R-30ci	R-19 + R-11 LS	R-38	R-11.4ci	R-13 + R-13ci	R-13 + R7.5ci	R-13 + R3.8ci or R-20	R-7.5ci	R-10ci	R-30	R-10 for 24" below	R-15 for 36" below + R-5 full slab	R-4.75
Group R	R-30ci	R-19 + R-11 LS	R-49	R-13.3ci	R-13 + R-13ci	R-13 + R7.5ci	R-13 + R-7.5ci or R-20 + R3.8ci	R-7.5ci	R-12.5ci	R-30	R-10 for 24" below	R-15 for 36" below + R-5 full slab	R-4.75

ci – Continuous insulation
LS – Linear system
See Table C402.1.3 for other footnotes

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Prescriptive Compliance: Fenestration

Climate Zone 5		
Vertical Fenestration		
U-Factor		
Fixed Fenestration	0.38	
Operable Fenestration	0.45	
Entrance Doors	0.77	
SHGC		
Orientation	SEW	N
PF < 0.2	0.38	0.51
0.2 ≤ PF < 0.5	0.46	0.56
PF ≥ 0.5	0.61	0.61
Skylights		
U-Factor	0.50	
SHGC	0.40	

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Vertical Fenestration Requirement
Section C402.4.1 – Prescriptive (Max area)

- Percentage of Vertical Fenestration Area to Gross Wall Area
- Allowed up to 30% maximum of above grade wall
- In Climate Zones 1-6, up to 40% maximum of above grade wall with daylighting controls
- Total fenestration area (includes frame and glazing)
- Does not include opaque door area

Image: socalbudgetwindows.com

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Skylight Minimum Fenestration Area
Section C402.4.1 Prescriptive

- Limited to ≤ 3% of Roof Area
- Up to 6% allowed if automatic daylighting controls installed in toplit zones

Image: Velux.com

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Fenestration Product Rating

Section C303.1.3

- Install fenestration product rating in accordance to NFRC 100 (Windows, Doors, Skylights)
- Fenestration must be labeled and certified by the manufacturer
- Non-NFRC 100 rated fenestration
- Default Glazed Fenestration U-factor Table C303.1.3(1)
- Difficult to meet requirements using default U-factors

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Fenestration SHGC Requirements

The Effect of Overhangs on Fenestration SHGC:

- Overhangs allow a higher SHGC product to be installed
- Projection factor must be calculated
- Evaluate separately when different windows or glass doors have different PFs

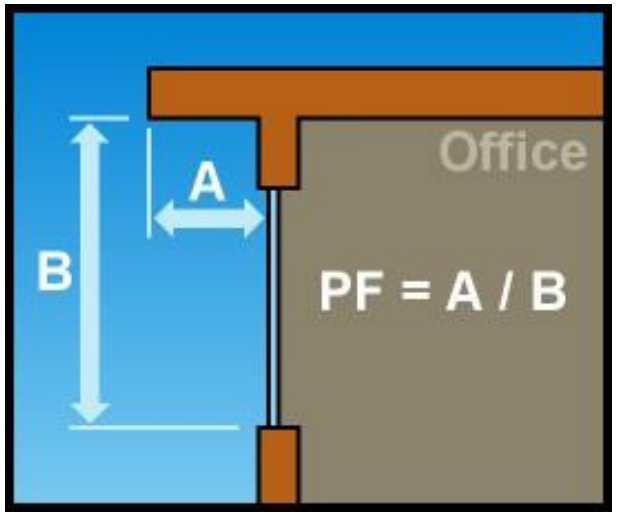

Image: energycode.pnl.gov

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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

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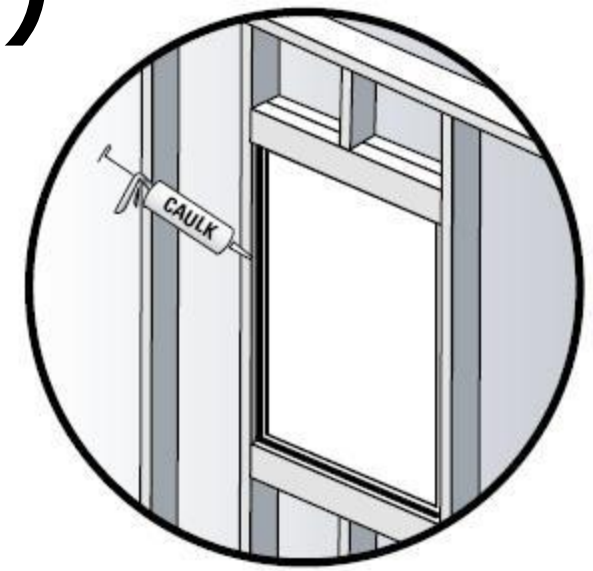
Air Barrier Construction
Section C402.5.1.1 (Mandatory)

- Air barrier placement allowed:
  - Inside of building envelope
  - Outside of building envelope
  - Located within assemblies composing envelope

    OR

  - Any combination thereof



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- Must be continuous for all assemblies and joints that are part of the thermal envelope

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Rooms Containing Fuel-burning Appliances
Section C402.5.3 (Mandatory)

- Appliances and combustion air openings to be located outside the building thermal envelope or enclosed in a room isolated from inside the thermal envelope in **Climate Zones 3-8**, one of the following to comply:
  - Rooms to be sealed and insulated per envelope requirements
  - Doors into the rooms fully gasketed
  - Water lines and ducts insulated
  - Combustion air ducts that pass through conditioned space, insulated to ≥ R-8

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Vestibules
Section C402.5.7 (Mandatory)

- Required to reduce infiltration into spaces
- Required on entrance doors leading into spaces ≥ 3,000 ft^2
- Doors must have self-closing devices
- **Exceptions:**
  - Buildings in Climate Zones 1 and 2
  - Doors from a sleeping unit or dwelling unit
  - Revolving doors
  - Doors that have an air curtain meeting requirements

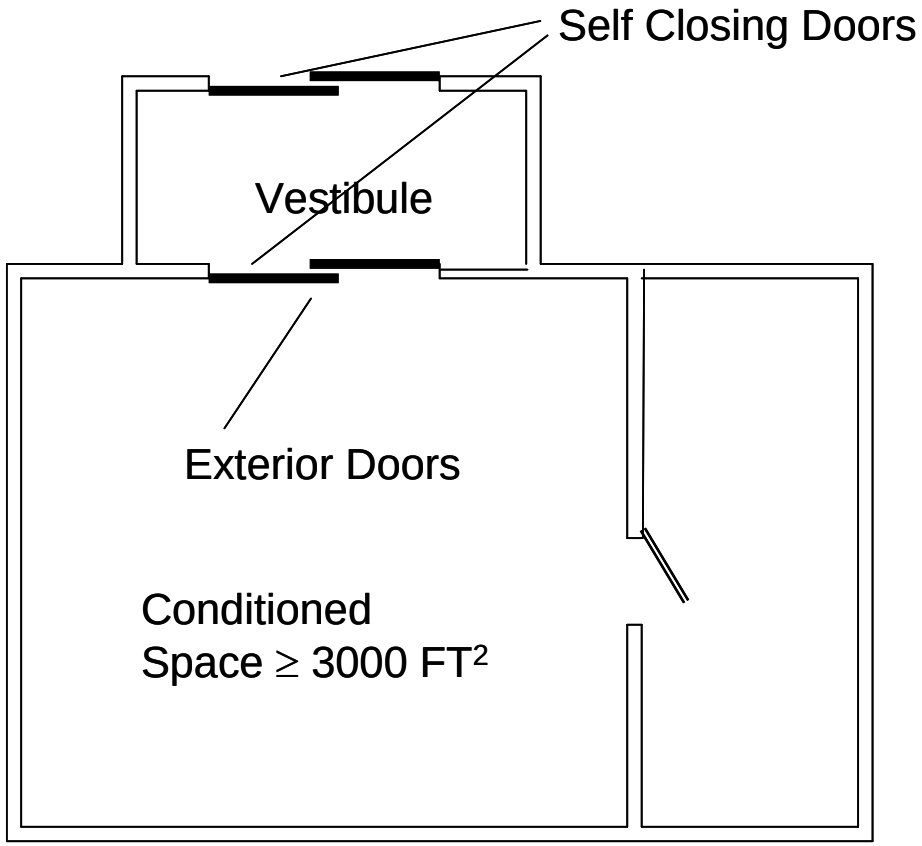

Image: U.S. Dept of Energy

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ASHRAE 90.1 2016 Overview

- Applies to:
  - New, and new portions of, *buildings* and their *systems*
  - New *systems* and *equipment* in *existing buildings*, and
- Does not apply to:
  - Single-family houses, low-rise multi-family ≤ 3 stories above *grade*, manufactured houses (mobile or modular)
  - *Buildings* that use neither electricity nor *fossil* fuel
- Does not circumvent any safety, health, or environmental requirements

graphic: dreamstime.com

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Mechanical Systems

Section C403 Reorganization

- For 2018 IECC, there was a major reorganization of the mechanical section (C403)
- Rather than separate mandatory (C403.2) and prescriptive requirements by section group:
  - Similar requirements were brought together
  - Mandatory requirements were indicated (Mandatory) for each section. Sections without the "Mandatory" designation are prescriptive.
- As a result, familiar section numbers have likely changed
- **See individual sections for exceptions**

Mechanical sections:

C403.1: General (Loads)

C403.2: System Design

C403.3: Equipment Efficiencies & Specs

C403.4: HVAC Controls

C403.5: Economizers

C403.6: Multi-zone/VAV

C403.7: Vent & Exhaust

C403.8: Fan Eff. & Controls

C403.9: Heat Rejection

C403.10: Refrigeration

C403.11: Construction

C403.12: Outside Bldg.

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Zone Isolation
Section C403.2.1 (Mandatory)

- Divided into isolation areas:
  - HVAC systems serving zones > 25,000 ft^2 in floor area OR
  - Span > one floor and are designed to operate or be occupied non-simultaneously

- Isolation areas controlled independently by a device meeting C403.4.2.2

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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
        - ≤ 72°F for heating load
        - ≥ 75°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

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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

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Equipment and System Sizing
Section C403.3.1 (Mandatory)

- Output capacity of heating and cooling equipment only SHALL NOT be greater than calculated loads

- Select the system which serves the greater load – heating or cooling

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Questions so far?

Put questions/comments in the chat!

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

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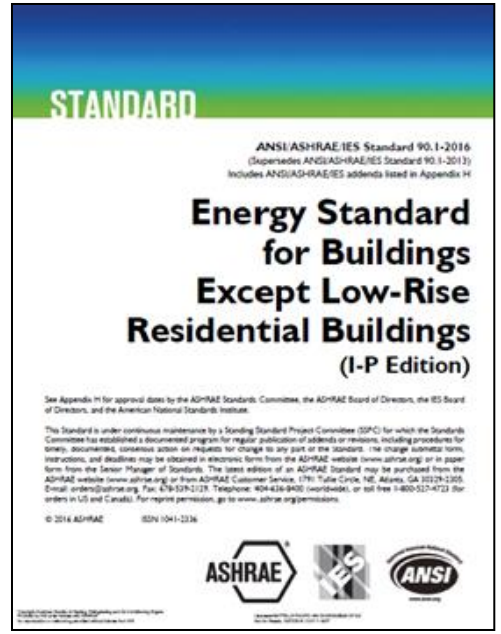
Structure of Standard 90.1-2016

1. Purpose
2. Scope
3. Definitions, Abbreviations, and Acronyms
4. Administration and Enforcement
5. **Building Envelope**
6. **Heating, Ventilating, and Air Conditioning**
7. Service Water Heating
8. Power
9. **Lighting**
10. Other Equipment
11. Energy Cost Budget Method
12. Normative References

Normative Appendices A-H

Appendix G – is a new compliance path!



Some of the Key Changes

- ✓Major format changes
- ✓New climate maps
- ✓New performance-based compliance path
- ✓Significant energy savings
- ✓Increased HVAC equipment efficiency
- ✓Requirements for replacement equipment

For this presentation, text in red indicates a new requirement in ASHRAE 90.1-2016

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Compliance Paths

Building System

- Envelope
- HVAC
- SWH
- Power
- Lighting
- Other

Mandatory Provisions

Must be met for all compliance options

Compliance Options

- Prescriptive Option
- Trade Off Option (only envelope)
- Energy Cost Budget
- **Performance Rating Method**

Energy Code Compliance

New Compliance Path – Appendix G

Appendix G (Performance Rating Method) uses a stable baseline approach with set efficiency levels

- Values are not updated with each new edition of the code
- Proposed energy performance needs to exceed baseline by an amount commensurate with the efficiency of the code year being evaluated.

Appendix G credit is available for strategies not credited in ECB

- Optimized window area and orientation
- More efficient HVAC and SWH equipment
- Right sizing HVAC equipment
- Efficient use of thermal mass

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Section 5: Building Envelope

There have been a *lot* of changes, but we are just going to hit some highlights

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Some Key Changes

- Comprehensive update to the fenestration prescriptive requirements in Tables 5-5-0 through 5-5-8
- Orientation requirements for vertical fenestration were tightened
- SHGC credit for shading by permanent projections was modified to correct how it addressed north-facing fenestration
- Whole building air leakage testing added as an option
- Thresholds for conditioned space were lowered

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Space Conditioning Categories & Basis -5.1.2

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 below
  - 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

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Air Leakage &Continuous Air Barrier -5.4.3.1

- Continuous Air Barrier Required
- Three Compliance Options
  - **Whole building testing (blower door)**
  - Materials testing
  - Assemblies of materials testing

Image: energyconservatory.com

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Existing Buildings

Existing Buildings
Section C503 - Alterations

- Code applies to any new construction
  - Additions or new work in existing structures
- Unaltered portion(s) may not need to comply
- When complying via ASHRAE 90.1-2016, alterations do not need to comply with C402-C405
- Where existing building exceeds fenestration area limitations of Section C402.4.1 prior to alteration, building is exempt from C402.4.1 provided there is no increase in fenestration area

Image: montgomerycountymd.gov

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Existing Buildings
Section C503 - Alterations

- Heating and Cooling
  - New HVAC systems and duct systems that are part of the alteration to comply with Section C403
- Service hot water systems
  - New SWH systems that are part of the alteration to comply with C404
- Lighting Systems
  - New Lighting systems that are part of the alteration to comply with C405
    - **Exception** – alteration that replace <10% of the luminaires in a space provided such alteration does not increase the installed interior lighting power

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Change of Occupancy or Use
Section C505.1

- Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code
- Where the use in a space changes from one to another in Tables C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section 405

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Existing Buildings - Lighting Power and Systems Section *C502.2.6*

New lighting systems installed as part of an addition to comply with C405

- Total interior lighting power to comply C405.3.2
  - Stand alone addition
  - Addition + existing building as a single building
- Total exterior lighting power to comply C405.4.2
  - Stand alone addition
  - Addition + existing building as a single building
- Repairs – C504.2
  - Repairs exempt where only the bulb, ballast or both within the existing luminaires in a space are replaced, provided that the replacement does not increase the installed interior lighting power

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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

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Resources

90.1-2016 Overview:
energy.gov/eere/buildings/articles/new-energy-code-commercial-buildings-standard-901-2016

DOE Presentation:
energycodes.gov/resource-center/training-courses/ansiashraeies-standard-901-2016

Performance Rating Method Reference Manual:
pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

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Questions?

Continuing Education

Participants of this training are eligible for continuing education credits through ICC and AIA. Certificates will be sent out following the training. Contact canderson@mwalliance.org for questions.

International Code Council

- Course ID: 29122
- CEUs: 0.2

AIA

- Course Number: NECOM01
- CEUs: 2LU | HSW
- Please email your AIA number to canderson@mwalliance.org

Thank you!

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