Awareness & Envelope Requirements of the 2012 IECC

Commercial Workshop 1

MISSOURI DEPARTMENT OF NATURAL RESOURCES

RECOVERY.GOV

Introductions

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Code officials
Name
Municipality
Status of Commercial Codes

Overview

Project funded by the Missouri Department of Natural Resources (MDNR) with American Recovery and Reinvestment Act of 2009 (ARRA) funding.

4 Locations and Webinars:

- St. Louis (December 1st – 2nd)
- Springfield (December 5th – 6th)
- Kansas City (January 24th – 25th)
- Columbia (February 27th)

Objective of the Workshop: Work with municipalities and counties across the state to identify opportunities to adopt or enhance compliance with the 2009 or 2012 International Energy Conservation Code (IECC) at a local level.

Agenda

Topic	Approx. Time
Introduction	15 minutes
Best practices and lessons learned in Missouri	20 minutes
Compliance approaches	30 minutes
Envelope requirements	50 minutes
Summary	5 minutes
Total Time	**2 hours**

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Some Important Points

Overall

- Discussion-based

What can you expect?

- Can follow code citations in [ ]

Before we get started…

- Cell phones

Overview

- The IECC looks at energy consumption and cost savings in buildings
- Developed by The International Code Council® (ICC)
- Three year cycle for updates
- Example codes by the ICC
  - International Building Code®
  - International Residential Code®
  - International Fire Code®
  - International Mechanical Code®
  - International Property Maintenance Code®

Overview

Relationship between International Building Code (IBC) and IECC

IECC addresses only energy (commercial and residential)

IBC addresses all topics (structural, plumbing, energy, etc.)

IBC – Chapter 13 - Energy Efficiency

- Buildings shall be designed and constructed in accordance with the IECC

Overview

2012 IECC – Commercial Section

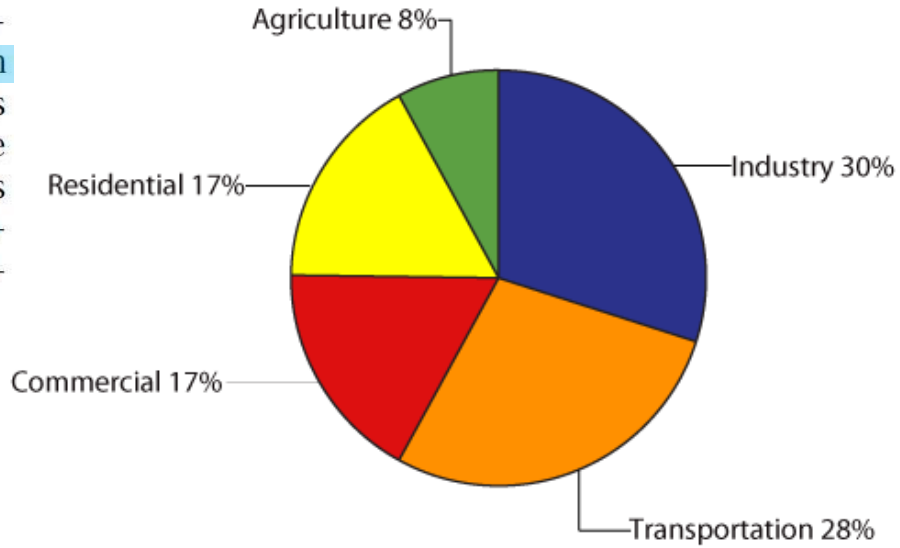
1. Administration
2. Definitions
3. General Requirements
4. Commercial Energy Efficiency
5. Referenced Standards

Overview

C101.3 Intent. This code shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

Greenhouse Gas Emissions by Sector

United States, 2004



Source: US EPA Inventory of Greenhouse Gas Emissions and Sinks, 2006.

Overview

Commercial provisions of the IECC attempts to regulate energy use:

- [C402] Building thermal envelope
- [C403] HVAC
- [C404] Service Water Heating
- [C405] Lighting

IECC does NOT regulate:

- Appliances (televisions, computers, refrigerator, etc.)
- Water consumption
  - Federally mandated items

Topic 1

Overview of Best Practices and Lessons Learned in Missouri

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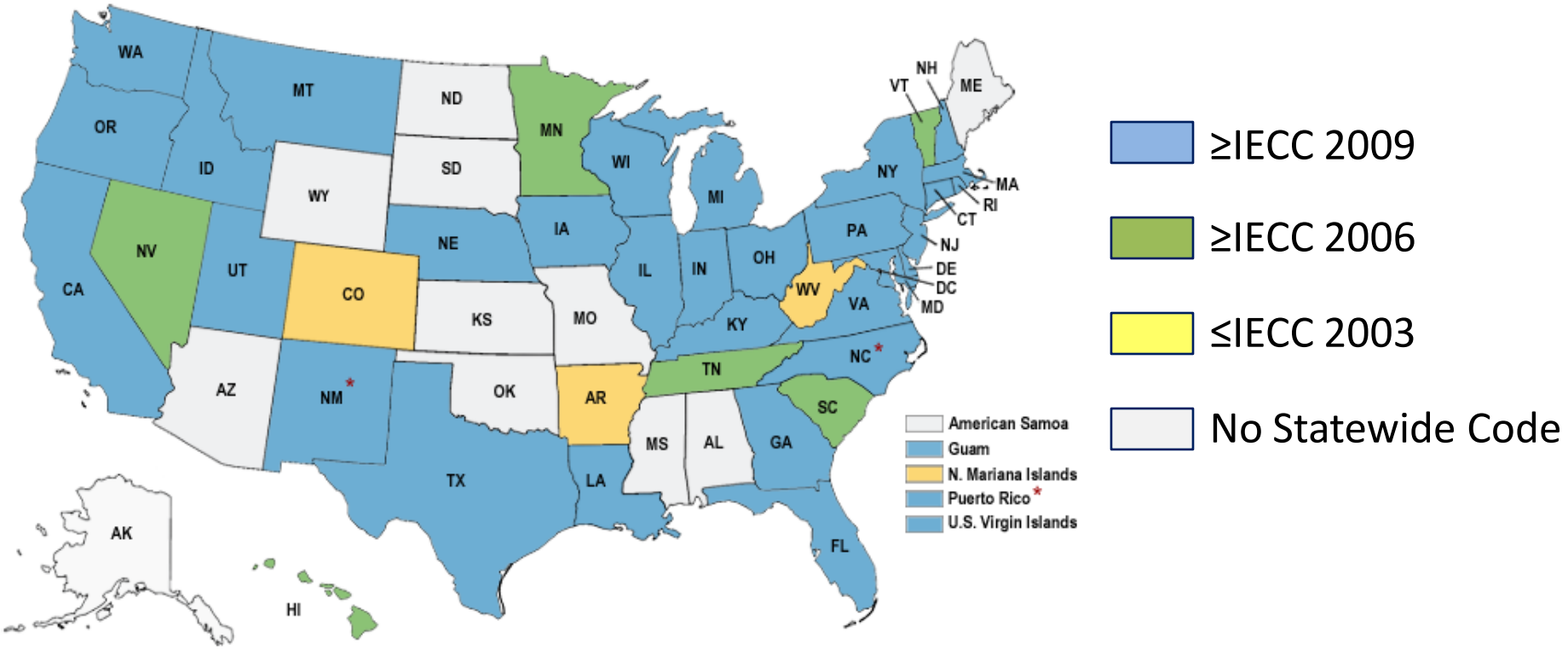
Commercial State Energy Code Status (*)



(*) as of November 1, 2011, DOE – Building Energy Codes Program

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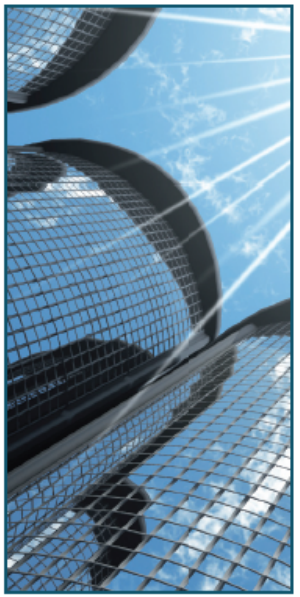
Missouri Facts

Missouri: A Patchwork of Codes

Due to its history of strong local government, **Missouri does not have a mandatory statewide energy code**, however all local jurisdictions except class III counties have the right to adopt an energy code. As expected, this system creates a sometimes confusing patchwork of different codes throughout the state.

Regardless of the system in place, the bottom line is that **many jurisdictions in Missouri still don't have an energy code**—meaning that many residents do not receive the benefits of energy-efficient construction.



(Building Codes Assistance Project)

Missouri Facts

Statewide Savings	**$318 million**	Annual energy savings by 2030.
	26 trillion	Btu of energy avoided annually by 2030.
	1.4 million	Metric tons of CO_2 prevented annually by 2030.[3]

By adopting and enforcing the 2009 IECC starting in 2011, Missouri municipalities and counties would **significantly improve the state's economy and environment** now and into the future.

(Building Codes Assistance Project)

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Best Practices Missouri

Kansas City incorporates energy codes into its broader sustainability effort:

1) The Environmental Management Commission advises the city on energy/environmental issues.
2) The Chamber of Commerce's Climate Protection Partnership brings together 180 businesses and institutions that support energy efficiency implementation.
3) The Sustainability Coordinator works regionally to promote efforts.
4) The *Climate Protection Plan includes energy codes as a policy tool.*
5) Kansas City joined with ten municipalities and the Mid-America Regional Council to create a regional energy strategy and promote the adoption of the 2012 IECC.

(Building Codes Assistance Project)

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Best Practices Missouri

Columbia created commissions to advise the city council on energy code issues:

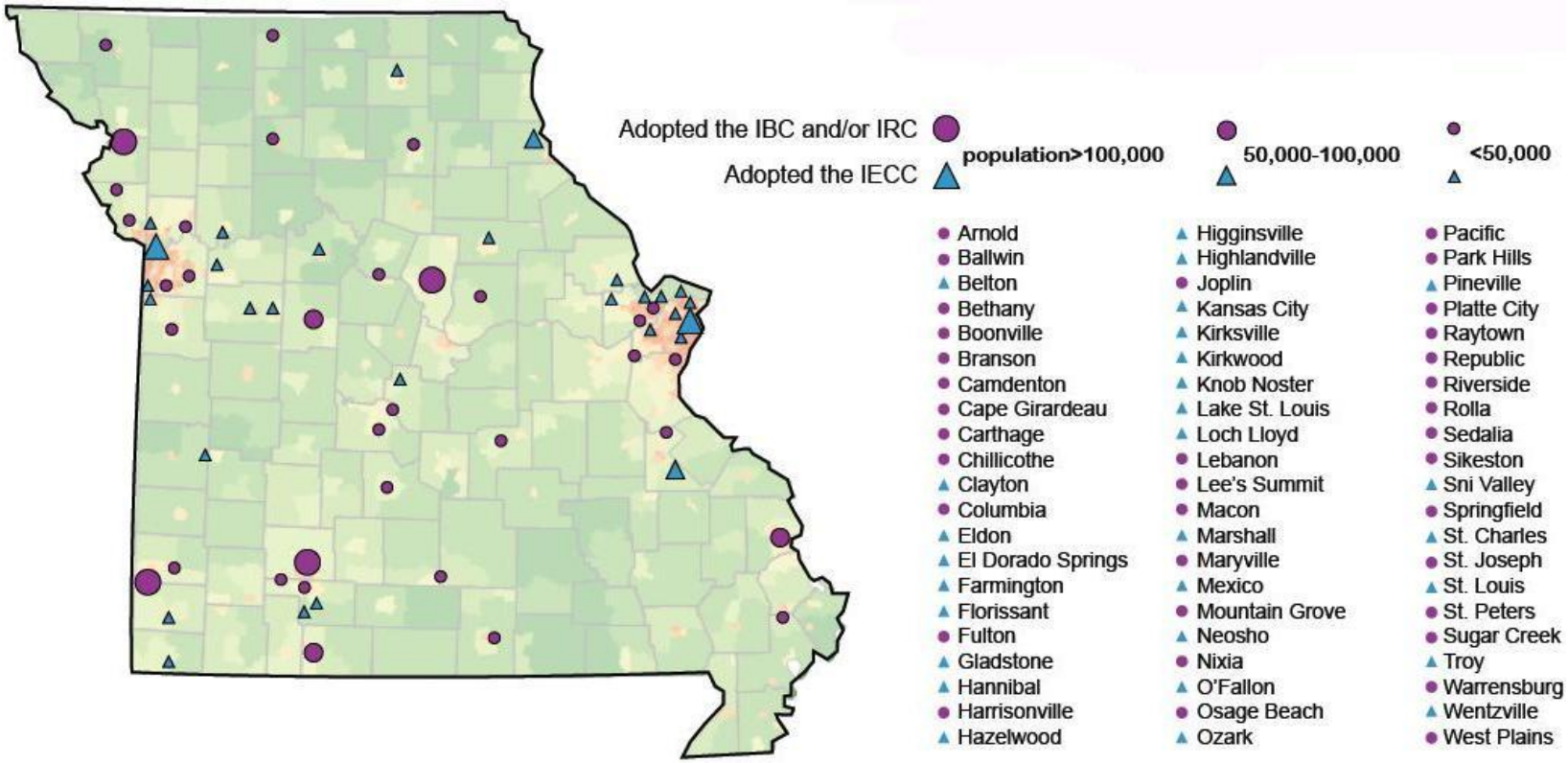
- The Building Construction Codes Commission (BCCC) reviews codes and provides a construction industry perspective.
- The Environment and Energy Commission adds input on the benefits of energy codes, stimulates public interest, and engages public/private agencies.

University City

- The University City Green Practices Committee provides input into energy code adoption efforts.

(Building Codes Assistance Project)

Local Jurisdiction – Adoption Status

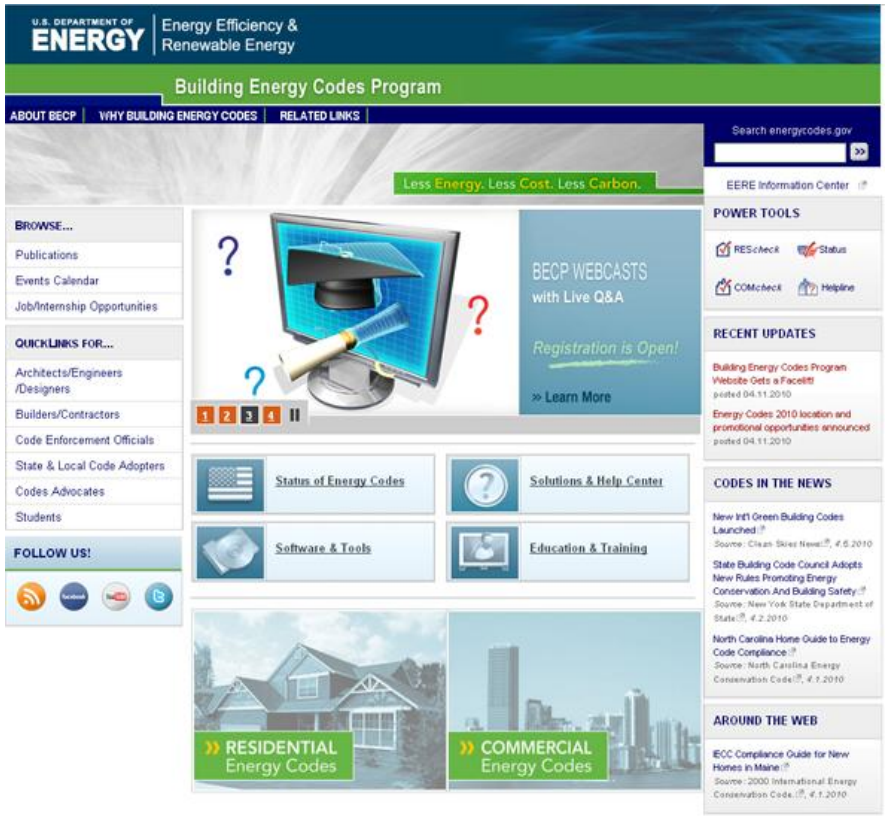


(Building Codes Assistance Project)

Promoting Awareness of IECC

www.energycodes.gov

- Foster uniformity and objectivity in measuring compliance rates
- Eliminate need for each state to develop its own procedures and tools
- Provide tools that states can adapt for their own preferred use
- Collect additional data and support related activities.



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Promoting Awareness of IECC

Resource Inventory

- Compilation of resources
- Living document

Residential/ Commercial	Residential/Commercial 2009 IECC	Guide	2009 IECC with commentary	Basic Energy Code definitions from the 2009 IECC with short commentary. Purchase available at this link.	http://www.iccsafe.org/Store/Pages/Product.aspx?id=3810S09
Residential/ Commercial	REScheck and COMcheck	Presentation	Building Energy Codes Online Training	This website provides links to a variety of courses, including information about REScheck, the requirements of the 2009 IECC, etc.	http://www.energycodes.gov/moodle/
Residential/ Commercial	REScheck and COMcheck	Presentation	2009 IECC, RES*check* and COMcheck	IECC, RES*check* and COM*check* presentation developed by U.S. DOE.	http://www.energycodes.gov/training/pdfs/2009_iecc_reschec k_comcheck.pdf
Residential	Additions and Renovations and the 2009 IECC	Transcript	Residential Requirements of the 2009 IECC	Transcript for a presentation given by the U.S. DOE on the residential requirements of the 2009 IECC (pg. 7 is relevant to additions and renovations).	http://www.energycodes.gov/training/pdfs/2009_iecc_resident ial_transcript.pdf
Residential	REScheck	Compliance Report	RES*check* Compliance Report	Sample RES*check* compliance report with sample energy efficiency certificate on pg 5.	http://kwhdesign.net/site/Permit_&_Construction_Documents _files/REScheck.pdf
Residential	Compliance	Frequently-Asked Questions	Frequently-Asked Questions - Module 3 provided by ICC	Frequently-asked questions around the residential energy code; includes answers to questions about the 2009 IECC and roofs, wood-burning fireplaces, windows, thermal envelopes, etc.	http://media.iccsafe.org/geo/docs/FAQ_Module-3.pdf
Residential/ Commercial	General Code Information	Fact Sheet	Policy Maker Fact Sheet, Building Energy Code Compliance; October 2010	One-page tool that provides answers to questions such as: (1) What are energy codes? (2) What are the benefits of building energy codes? (3) What can policy makers do to enhance code compliance and enforcement?	www.imt.org/files/PolicymakerFactsheet-EnergyCodeCompliance.pdf
Residential/ Commercial	Mechanical	Article	Bigger is not always better with HVAC systems	Article describes why sizing appropriately is of importance, links to article regarding how to size equipment correctly, and to diagrams outlining the mechanical systems covered by the IECC	http://resourcecenter.pnl.gov/cocoon/morf/ResourceCenter/art icle//136
Residential/ Commercial	Mechanical	Articles, web tools, photos, presentations	Building Codes Energy Resource Center	Numerous sources for information regarding HVAC systems and the IECC. Use "browse topic" drop down menu at upper right to choose "mechanical."	http://resourcecenter.pnl.gov/cocoon/morf/ResourceCenter

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Promoting Awareness of IECC

Resource Inventory

- Central location
- Sort-able
- Variety of resources
  - Presentations
  - Pamphlets
  - Factsheets
  - Articles
  - Guides
  - Websites
  - Reports
  - Frequently-asked questions

Sources

- U.S. Department of Energy
- International Code Council
- Other states and municipalities

Promoting Awareness of IECC

Resource Inventory

Topics:

- Code requirements
- RES*check* and COM*check*
- Additions/renovations
- Duct pressure testing
- Mechanical systems
- Inspections
- Incentives available

Interpretation questions

- Website: http://www.iccsafe.org/cs/Pages/opinions.aspx
- Phone: 1-888-ICC-SAFE (422-7233) - ext. 338077

US Department of Energy

- Website: http://www.energycodes.gov/help/

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Topic 1 Summary

- Current implementation
- Best practices
- Promoting awareness

Topic 2

Commercial Compliance Approaches and their Corresponding Tools

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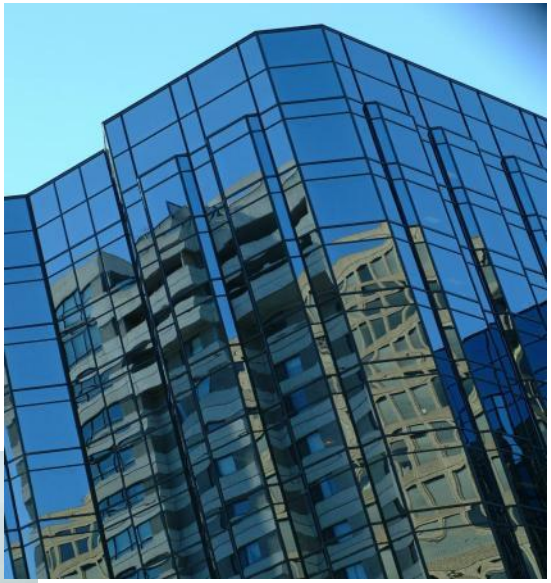
Compliance with the Commercial Provisions [C101.2]

All Buildings Other Than:

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



Applicability [C101.4]

Applicability

- New construction
- Modifications
  - can comply alone or in combination with existing building
- Mixed occupancy buildings

Applicability [C101.4]

Exemptions

- Existing buildings
- Historic buildings
- Peak design rate of energy usage < 1 Watt/ft^2 (building envelope requirements)

Exempted Alterations

- Eight exceptions for alterations

Applicability [C101.4]

8 Exceptions

1. Storm windows installed over (E) window.
2. Glass only replacements in an (E) window.
3. (E) cavities are filled with insulation.
4. (E) cavity is not exposed.
5. Reroofing for roofs where neither the sheathing nor the insulation is exposed.
6. Replacement of (E) doors that separate conditioned space from the exterior shall not require the installation of a vestibule or revolving door.
7. Alterations that replace less than 50% of the luminaires in a space.
8. Alterations that replace only the bulb and ballast w/in the (E) luminaires in a space.

The IECC "is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances."

Commercial Compliance Options [C401.2]

Option 1 - Reference Document
- **ASHRAE 90.1-2010**

Option 2 - Prescriptive
- C402 - Envelope
- C403 - Mechanical
- C404 - Service Water Heating
- C405 - Lighting
- C406 - Additional Efficiency Package
  - C406.2 - HVAC Performance
  - C406.3 - Lighting Systems
  - C406.4 - On-site Renewable Energy

Option 3 - Performance
- C407 - Total Building Performance

AND

Mandatory Provisions:
- C402.4 - Air Leakage
- C403.2 - Mechanical Systems
- C404 - SWH
- C405.2,3,4,6,7 - Lighting

AND
- Building energy cost to be ≤ 85% of the standard reference design building

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Commercial Compliance Options [C401.2]

ASHRAE 90.1-2010

Prescriptive Option

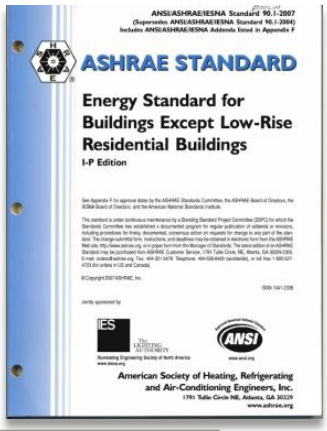
- Section 5 - Envelope
- Section 6 - Mechanical
- Section 7 - SWH
- Section 8 - Power
- Section 9 - Lighting
- Section 10 - Other Equipment

Performance Option

- Section 11 - Total Building Performance

AND

Mandatory Provisions of each of the prescriptive sections



Comparison of 2012 IECC and ASHRAE 90.1-2010

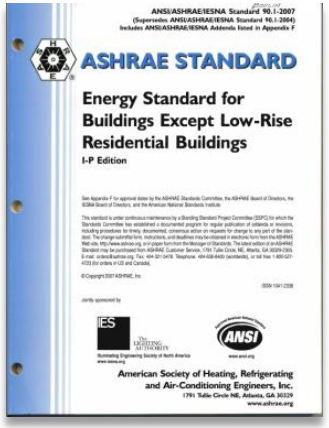
- New version every three years with more stringent requirements

2012 IECC

- Developed by the *International Code Council (ICC)*

ASHRAE 90.1-2010

- Developed by *American Society for Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)*
- ASHRAE 90.1 is a referenced standard in IECC

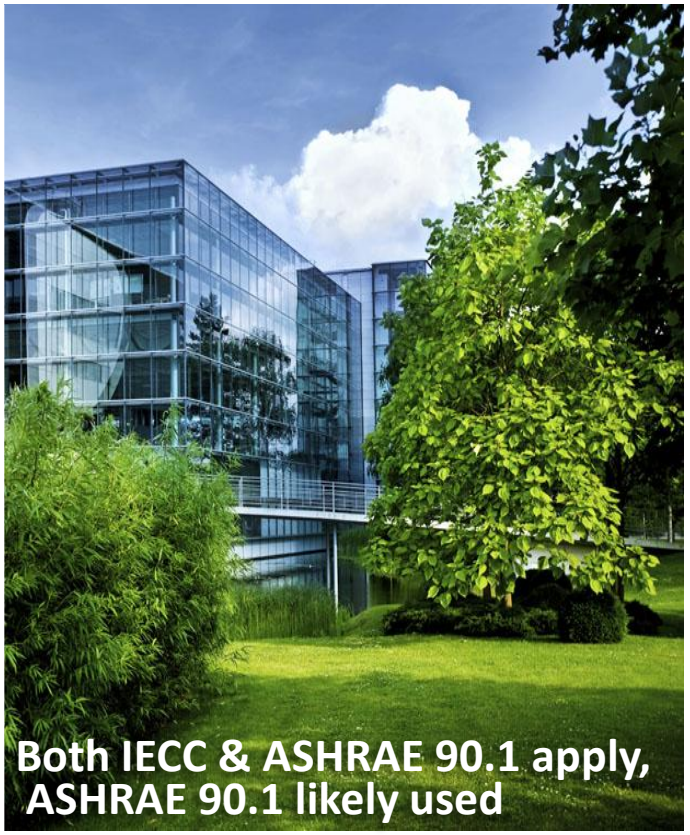


Commercial Compliance Options [C401.2]

Relationship between ASHRAE and IECC

- Prescriptive and performance paths are very similar
  - Envelope requirements are at times slightly different
  - ASHRAE has separate envelope requirements for semi-heated spaces
  - IECC allows for 30% WWR (40% with daylighting) where as ASHRAE allows 40%
  - Definitions slightly different: below grade wall, residential, etc.
  - Controls, exceptions, inspections, and commissioning

Commercial Compliance Options [C401.2]



Total Building Performance Approach [C407]

Greater Flexibility

- Detailed picture of overall building
- Baseline analysis and comparison
- Renewable energy
- Passive solar design

Total Building Performance Approach [C407]

Samples of performance software available are listed in the

- Building Energy Software Tools Directory, http://apps1.eere.energy.gov/buildings/tools_directory/

eQuest is a software that can do an energy analysis

- http://doe2.com/equest/

COMcheck

No-cost, easy-to-use software that will demonstrate compliance with IECC
www.energycodes.gov/software.stm

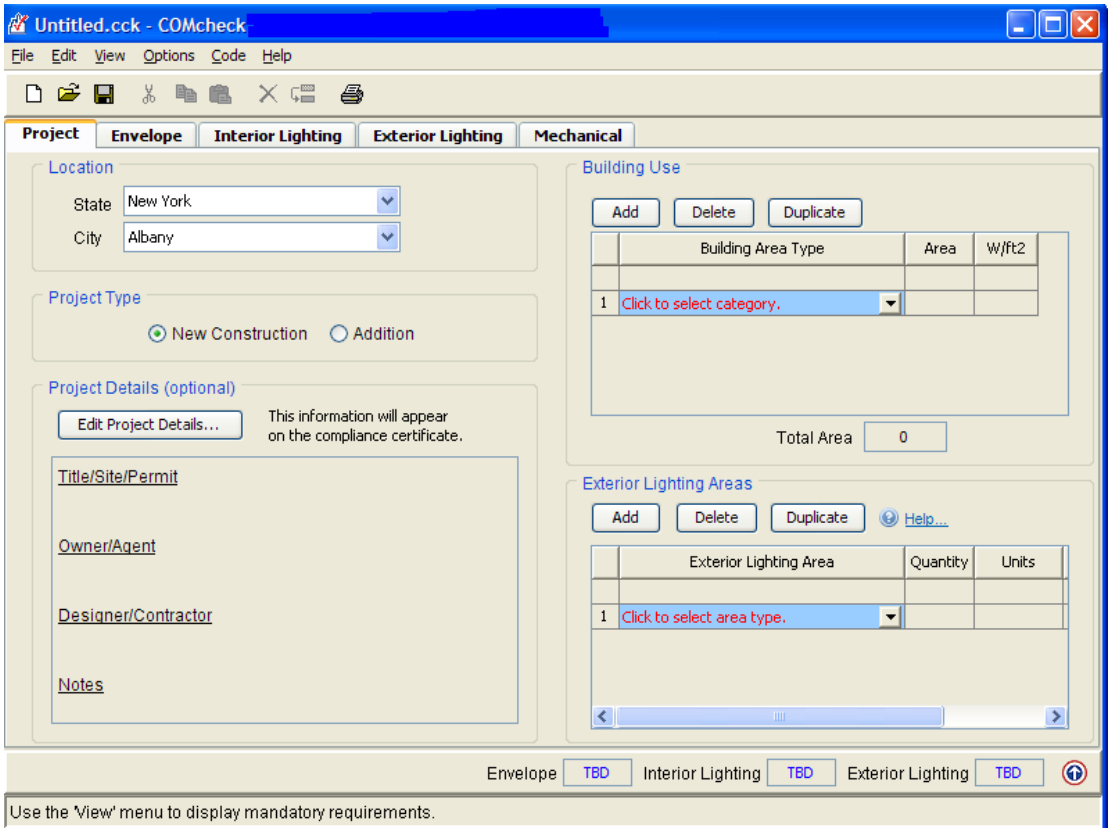
COMcheck™

COMcheck is to have 2012 capability by end of March

COMcheck

- Basic information about the builder and project
- Area take-offs for exterior walls, fenestration, roof/ceiling, basement walls, floors, etc.
- Insulation R-values, fenestration U-factors, etc.
- Lighting fixture details
- Heating and cooling system details
- Service water heating details

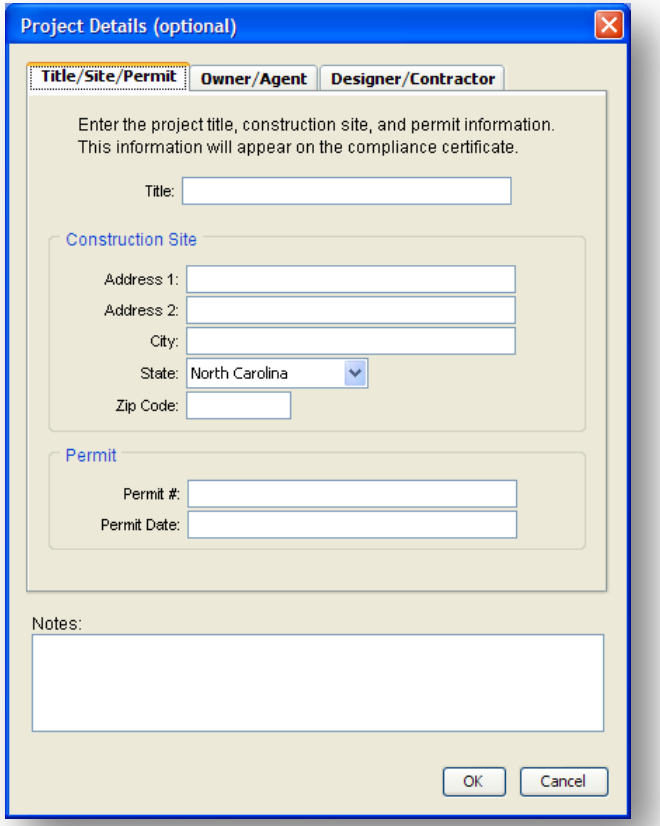
COMcheck


Untitled.cck - COMcheck
File Edit View Options Code Help
Project
Envelope
Interior Lighting
Exterior Lighting
Mechanical
Location
State New York
City Albany
Project Type
New Construction
Addition
Project Details (optional)
Edit Project Details...
This information will appear on the compliance certificate.
Title/Site/Permit
Owner/Agent
Designer/Contractor
Notes
Building Use
Add
Delete
Duplicate
Building Area Type
Area
W/ft2
1
Click to select category.
Total Area
0
Exterior Lighting Areas
Add
Delete
Duplicate
Help...
Exterior Lighting Area
Quantity
Units
1
Click to select area type.
Envelope
TBD
Interior Lighting
TBD
Exterior Lighting
TBD
Use the 'View' menu to display mandatory requirements.

COMcheck

Project Information

- Project location
- Project type
- Project details for report (optional)
- Title/Site/Permit
- Owner/Agent
- Designer/Contractor
- Notes



COMcheck – Envelope

Envelope Information

- Floor, walls, windows, doors, roofs, and skylights

Garden Center.cck - COMcheck 3.9.0 Code: 2009 IECC

File Edit View Options Code Help

Project | Envelope | Interior Lighting | Exterior Lighting | Mechanical

Roof | Skylight | Ext. Wall | Window | Door | Basement | Floor

	Component	Post-Alteration Assembly	Concrete Density	Construction Details	Alteration Details	Cavity Insulation R-Value	Continuous Insulation R-Value	Proposed U-Factor	Proposed SHGC	Projection Factor	Maximum U-Factor	Maximum SHGC
	Building											
1	Roof 1	Metal Building, Standing ...			Compliance required	19.0	12.56	0.036			0.055	
2	Exterior Wall 1	Solid Concrete:8" Thickness	Light W...	Furring: W...	Compliance required	15.0	0.0	0.066			0.090	
3	Window 1	Wood Frame:Double Pan...		Glazing: Cl...	Compliance required			0.320	0.34	0.00	0.350	0.40
4	Door 1	Insulated Metal		Swinging	No exemptions available			0.400			0.700	
5	Floor 1	Slab-On-Grade:Unheated			No exemptions available		10.0				0.730	

COMcheck – Envelope Results

COMcheck Software Version 3.9.0

Envelope Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Example

Construction Site:	Owner/Agent:	Designer/Contractor:
MT		

Section 2: General Information

Building Location (for weather data):	**Jefferson City, Missouri**
Climate Zone:	**4a**
Building Type for Envelope Requirements:	**Non-Residential**
Vertical Glazing / Wall Area Pct.:	**8%**
Skylight Glazing / Roof Area Pct.:	**2%**

Activity Type(s)	Floor Area
Office	1000
Retail	5000
Workshop	2700

Section 3: Requirements Checklist

Envelope PASSES: Design 2% better than code.

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Roof 1: Non-Wood Joist/Rafter/Truss	6112	40.0	0.0	0.033	0.027
Skylight 1: Metal Frame, Double Pane, Tinted, SHGC 0.80	112	---	---	0.500	0.600
Exterior Wall 1: Solid Concrete:8" Thickness,Medium Density , Furring: Metal	6000	11.0	10.0	0.063	0.104
Door 1: Glass (> 50% glazing):Nonmetal Frame, Entrance Door,	42	---	---	0.500	0.400

COMcheck – Interior Lighting

Lighting Information

- Input fixtures
- Identify exemptions and allowances (if applicable)
- Proposed wattage ≤ allowed wattage

	Component	Fixture ID	Fixture Description	Lamp Description/ Wattage Per Lamp	Ballast	Lamps Per Fixture	Number of Fixtures	Fixture Wattage
	Building	Allowed wattage = 17320 Proposed wattage = 12478						
1	Office (4520 sq.ft.)	Allowed wattage = 6780 Proposed wattage = 1976						
2	Incandescent 1	G	Recessed wall washer	Incandescent 150W		1	2	150
3	Incandescent 2	H	Accent track lighting	Incandescent 50W		1	5	50
4	Compact Fluorescent 1	F	Down light, twin tube	Twin Tube 18W	Magnetic	2	31	46
5	Convention, Conference or M	Allowed wattage = 630 Proposed wattage = 3900						
6	T8 / T12 Fluorescent 5	E	8 ft. Industrial, penda...	96" T8 75W	Electronic	2	30	130

COMcheck – Interior Lighting Results

COMcheck Software Version 3.9.0

Interior Lighting Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Example
Construction Site: MT
Owner/Agent:
Designer/Contractor:

Section 2: Interior Lighting and Power Calculation

A Area Category	B Floor Area (ft2)	C Allowed Watts / ft2	D Allowed Watts (B x C)
Office	1000	1	1000
Retail	5000	1.5	7500
Workshop	2700	1.4	3780
		Total Allowed Watts =	12280

Section 3: Interior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
Office (1000 sq.ft.)				
T8 / T12 Fluorescent 1: A: 2x4 Troffer, parabolic louver / 48" T8 32W / Electronic	3	10	95	950
Compact Fluorescent 1: F: Down light, twin tube / Twin Tube 18W / Magnetic	2	10	46	460
Retail (5000 sq.ft.)				
T8 / T12 Fluorescent 3: C: 4 ft. Wall mout, wrap-around / 48" T8 32W / Electronic	2	50	65	3250
HID 2: J: Low bay, pendant mount / High-Pressure Sodium 150W / Magnetic	1	10	190	1900
Workshop (2700 sq.ft.)				
T8 / T12 Fluorescent 5: E: 8 ft. Industrial, pendant mount / 96" T8 75W / Electronic	2	30	130	3900

COMcheck – Exterior Lighting

Lighting Information

- Input fixtures
- Identify exemptions and allowances (if applicable)
- Tradable vs non-tradable
- Proposed wattage ≤ allowed wattage

Exterior Lighting Areas

Add | Delete | Duplicate | Help...

	Exterior Lighting Area	Quantity	Units	W/Unit	Tradable
1	Drive-up window	2	window(s)	400	No
2	Main entry/exit	4	ft of door ...	30	Yes
3	Parking area(s)	15000	ft2	0.15	Yes
4	Walkway < 10 feet wide	100	ft of walk...	1.0	Yes

COMcheck – Exterior Lighting Results

COMcheck Software Version 3.9.0

Exterior Lighting Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Example
Exterior Lighting Zone: **4 (High activity metropolitan commercial district)**

Construction Site: MT | Owner/Agent: | Designer/Contractor:

Section 2: Exterior Lighting Area/Surface Power Calculation

A Exterior Area/Surface	B Quantity	C Allowed Watts / Unit	D Tradable Wattage	E Allowed Watts (B x C)	F Proposed Watts
Parking area	20000 ft2	0.13	Yes	2600	2200
			Total Tradable Watts* =	2600	2200
			Total Allowed Watts =	2600	
			Total Allowed Supplemental Watts** =	1300	

* Wattage tradeoffs are only allowed between tradable areas/surfaces.
** A supplemental allowance equal to 1300 watts may be applied toward compliance of both non-tradable and tradable areas/surface

Section 3: Exterior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
Parking area (20000 ft2): Tradable Wattage				
Halogen 1: Halogen 55W	1	40	55	2200
			Total Tradable Proposed Watts =	2200

COMcheck – Mechanical Equipment

Works differently than Envelope and Lighting

Enter characteristics of:

- HVAC system
- Plant
- Water heating

Generates a customized list of requirements

COMcheck – Mechanical Report

COMcheck Software Version 3.9.0

Mechanical Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Example

Construction Site: MT

Owner/Agent:

Designer/Contractor:

Section 2: General Information

Building Location (for weather data): **Jefferson City, Missouri**
Climate Zone: **4a**

Section 3: Mechanical Systems List

Quantity	System Type & Description
2	RT-2 & RT-3 - Pkg. gas/elec. (Single Zone) : Heating: 1 each - Central Furnace, Gas, Capacity = 150 kBtu/h, Efficiency = 85.00% Et Cooling: 1 each - Field-Assembled DX System, Capacity = 113 kBtu/h, Efficiency = 12.00 EER, Air-Cooled Condenser, Air Economizer
1	CU-1 - Condensing unit (Single Zone) : Cooling: 1 each - Field-Assembled DX System, Capacity = 113 kBtu/h, Efficiency = 12.00 EER, Air-Cooled Condenser, Air Economizer
1	UH-1 - Gas unit heater (Unknown) : Heating: 1 each - Unit Heater, Gas, Capacity = 150 kBtu/h, Efficiency = 85.00% Ec
1	F-1 - Gas furnace (Single Zone) : Heating: 1 each - Central Furnace, Gas, Capacity = 150 kBtu/h, Efficiency = 85.00% Et

Section 4: Requirements Checklist

Requirements Specific To: RT-2 & RT-3 - Pkg. gas/elec. :

COMcheck – Help

COMcheck – Educational Oppurtunities

- COM*check* 101
- COM*check* 201
- Case studies

www.energycodes.gov

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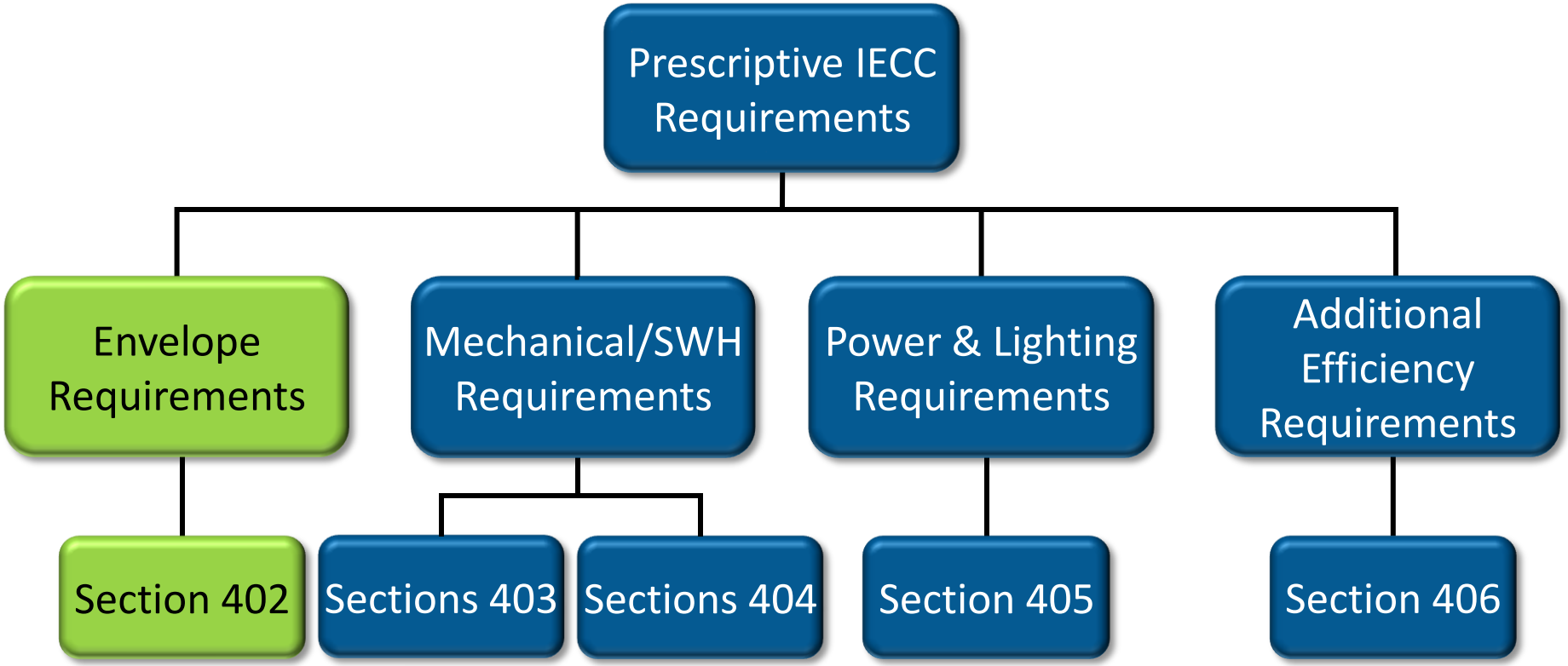
Topic 2 Summary

- Applicability
- 2012 IECC Compliance Options
  - Prescriptive
  - Performance
  - ASHRAE 90.1-2010 (Prescriptive or Performance)
- COM*check*

Topic 3

Envelope requirements of the 2012 IECC

2012 IECC Compliance



Envelope Requirements [C402]

Insulation and Fenestration

- Roof
- Above grade wall
- Below grade wall
- Floor
- Slab-on-grade
- Windows, skylights, doors

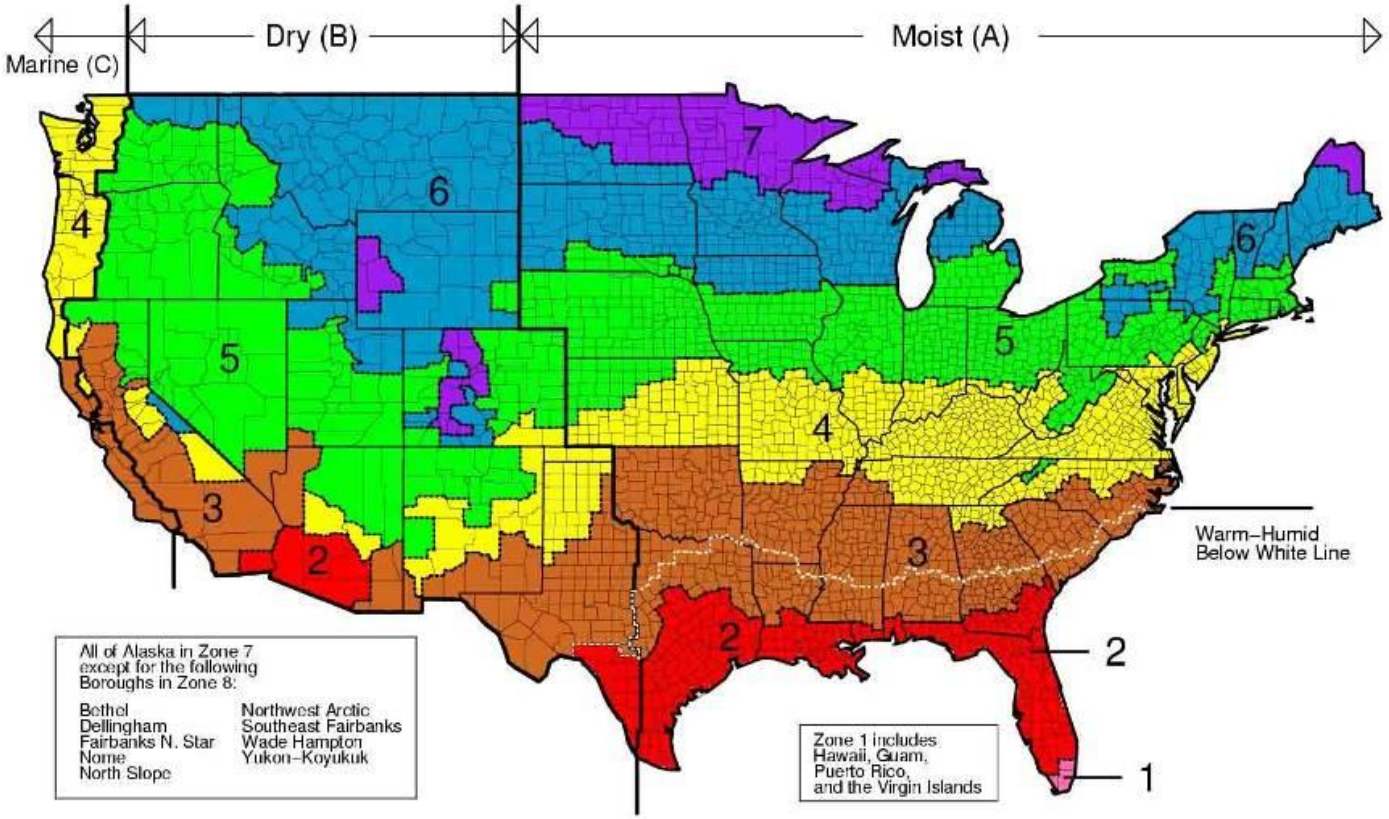
Air Leakage

- Air barriers
- Penetrations/openings/shafts
- Fenestration
- Loading docks
- Vestibules
- Recessed lighting

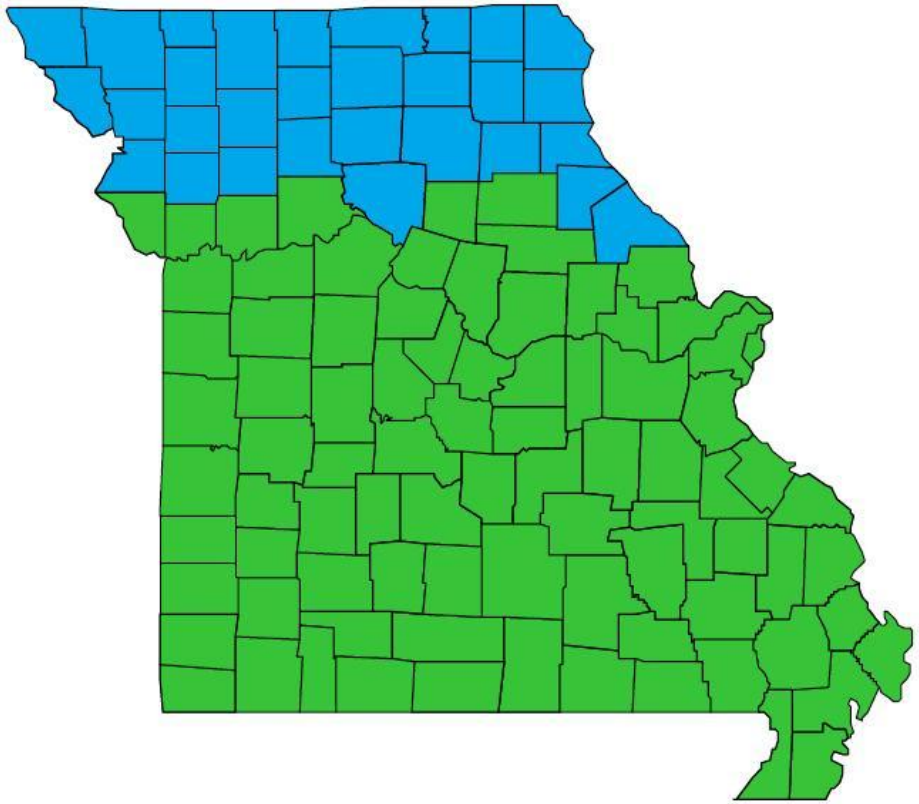
BUILDING THERMAL ENVELOPE. The basement walls, exterior walls, floor, roof, and any other building element that enclose *conditioned space*. This boundary also includes the boundary between *conditioned space* and any exempt or unconditioned space.

MISSOURI DEPARTMENT OF NATURAL RESOURCES

Climate Zones [C301]



Climate Zones [C301]



Prescriptive Approach Compliance [Table C402.1.2]

TABLE C402.1.2
OPAQUE THERMAL ENVELOPE ASSEMBLY REQUIREMENTS[a]

CLIMATE ZONE	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 deck	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.044	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-0.031	U-0.029	U-0.029	U-0.029	U-0.029
Attic and other	U-0.027	U-0.027	U-0.027	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-0.021
Walls, Above Grade																
Mass	U-0.142	U-0.142	U-0.142	U-0.123	U-0.110	U-0.104	U-0.104	U-0.090	U-0.078	U-0.078	U-0.078	U-0.071	U-0.061	U-0.061	U-0.061	U-0.061
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.039	U-0.052	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-0.064	U-0.064	U-0.064	U-0.057	U-0.064	U-0.052	U-0.045	U-0.045
Wood framed and other	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-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.036	U-0.036
Walls, Below Grade																
Below-grade wall[b]	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-0.119	C-0.119	C-0.119	C-0.119	C-0.119	C-0.119	C-0.092	C-0.092	C-0.092	C-0.092
Floors																
Mass	U-0.322	U-0.322	U-0.107	U-0.087	U-0.076	U-0.076	U-0.076	U-0.074	U-0.074	U-0.064	U-0.064	U-0.057	U-0.055	U-0.051	U-0.055	U-0.051
Joist/framing	U-0.066	U-0.066	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-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033
Slab-on-Grade Floors																
Unheated slabs	F-0.73	F-0.73	F-0.73	F-0.73	F-0.73	F-0.73	F-0.54	F-0.54	F-0.54	F-0.54	F-0.54	F-0.52	F-0.40	F-0.40	F-0.40	F-0.40
Heated slabs	F-0.70	F-0.70	F-0.70	F-0.70	F-0.70	F-0.70	F-0.65	F-0.65	F-0.58	F-0.58	F-0.58	F-0.58	F-0.55	F-0.55	F-0.55	F-0.55

MISSOURI DEPARTMENT OF NATURAL RESOURCES

Prescriptive Approach Compliance [Table C402.2]

TABLE C402.2
OPAQUE THERMAL ENVELOPE REQUIREMENTS[a]

CLIMATE ZONE	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 deck	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings (with R-5 thermal blocks)[a, b]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 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-25 + R-11 LS	R-30 + R-11 LS	R-30 + 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-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-49
Walls, Above Grade																
Mass	R-5.7ci	R-5.7ci	R-5.7ci	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	R-25ci	R-25ci
Metal building	R-13+ R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13+ R-19.5ci	R-13 + R-13ci	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-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-15.6ci	R-13 + R-7.5ci	R-13+ R17.5ci
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-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-15.6ci or R-20 + R-10ci	R-13 + R-15.6ci or R-20 + R-10ci
Walls, Below Grade																
Below-grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-10ci	R-10ci	R-12.5ci
Floors																
Mass	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-12.5ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing	NR	NR	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30[e]	R-30[e]	R-30[e]	R-30[e]
Slab-on-Grade Floors																
Unheated slabs	NR	NR	NR	NR	NR	NR	R-10 for 24″ below	R-10 for 24″ below	R-10 for 24″ below	R-10 for 24″ below	R-10 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-20 for 24″ below
Heated slabs[d]	R-7.5 for 12″ below	R-7.5 for 12″ below	R-7.5 for 12″ below	R-7.5 for 12″ below	R-10 for 24″ below	R-10 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 36″ below	R-15 for 36″ below	R-15 for 36″ below	R-20 for 48″ below	R-20 for 24″ below	R-20 for 48″ below	R-20 for 48″ below	R-20 for 48″ below
Opaque Doors																
Swinging	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Roll-up or sliding	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75

MISSOURI DEPARTMENT OF NATURAL RESOURCES

Roof Assembly [C402.2.1]

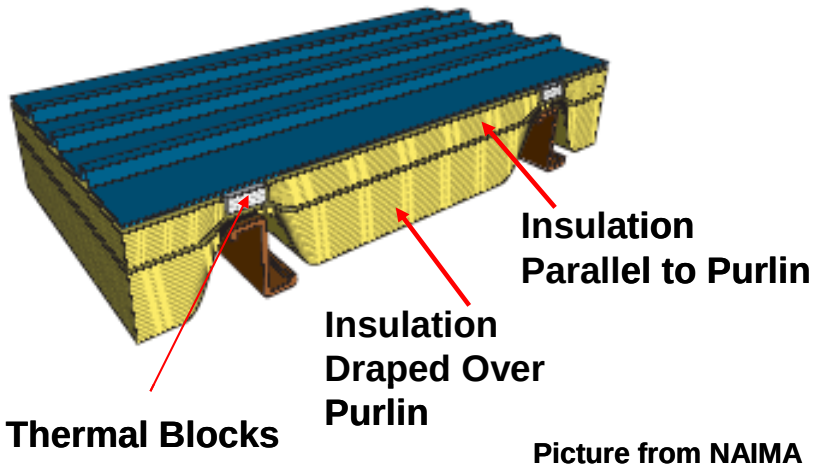
ROOFS				
Climate Zone	4		5	
	All Other	Group R	All Other	Group R
Insulation entirely above deck	R-25ci	R-25ci	R-25ci	R-25ci
Metal buildings (with R-5 thermal blocks)	R-19+R-11 LS	R-19+R-11 LS	R-19+R-11 LS	R-19+R-11 LS
Attic and other	R-38	R-38	R-38	R-49

- ci - continuous insulation
- LS – liner system – a continuous membrane installed below the purlins and uninterrupted by framing members and uncompressed, unfaced insulation rests on top of the membrane between the purlins

Roof Assembly [C402.2.1]

- Continuous insulation above roof deck
- Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered

Roof Assembly [C402.2.1]



Picture from NAIMA

R-5 thermal blocks required on all metal buildings or must use U-factor Compliance Method

Two layers of insulation required

- CZ 1-5: R-19+R-11 LS

Above Grade Walls [C402.2.3]

WALLS, ABOVE GRADE				
Climate Zone	4		5	
	All Other	Group R	All Other	Group R
Mass	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci
Metal building	R-13+R-13 ci	R-13+R-13 ci	R-13+R-13 ci	R-13+R-13 ci
Metal Framed	R-13+7.5ci	R-13+7.5ci	R-13+7.5ci	R-13+7.5ci
Wood Framed & 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-7.5ci or R-20+R-3.8ci

- ci - continuous insulation
- Above grade wall is defined as a wall completely above grade or walls that are more than 15% above grade

Above Grade Walls [C402.2.3] - Mass Walls

- Walls weighing at least 35 lbs/ft^2 of wall surface area
  OR
- 25 lbs/ft^2 of wall surface area if material weight is ≤ 120 lb/ft^3

Above Grade Walls [C402.2.3] - Wood/Metal Frame and Other

- Cavity insulation or cavity plus continuous (ci)
- Continuous insulation not broken up by framing members e.g., rigid board insulation

Photo courtesy of Dow Building Solutions

Below Grade Walls [C402.2.4]

WALLS, BELOW GRADE				
Climate Zone	4		5	
	All Other	Group R	All Other	Group R
Below grade wall	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci

What is a below grade wall?

- Basement or first-story walls ≥ 85% below grade
- Insulation must extend down 10 ft from the outside finished grade level or to the level of the floor, whichever is less
- Below grade walls must meet exterior insulation requirements for heated slabs if the below grade slab is heated*(footnoted to Tables C401.2.2 and C402.2)*

Floors [C402.2.5]

FLOORS				
Climate Zone	4		5	
	All Other	Group R	All Other	Group R
Mass	R-10ci	R-10.4ci	R-10ci	R-12.5ci
Joist/Framing	R-30	R-30	R-30	R-30

Floors [C402.2.5]

Joist/Framing (Steel/Wood)

- Insulation installed between framing

Mass Floors

- Materials weighing (of floor surface area) 35 lbs/ft2, **OR**
- 25 lbs/ft2 if material weight is ≤ 12 lbs/ft3
- Insulation installed continuously

Slab on grade [C402.2.6]

SLAB-ON-GRADE FLOORS				
Climate Zone	4		5	
	All Other	Group R	All Other	Group R
Unheated Slabs	R-10 for 24 in. below	R-10 for 24 in. below	R-10 for 24 in. below	R-10 for 24 in. below
Heated Slabs	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 36 in. below	R-15 for 36 in. below

Opaque Doors [C402.2.7]

OPAQUE DOORS				
Climate Zone	4		5	
	All Other	Group R	All Other	Group R
Swinging	U-0.61	U-0.61	U-0.37	U-0.37
Roll-Up or Sliding	R-4.75	R-4.75	R-4.75	R-4.75

Opaque Doors [C402.2.7]

Doors having < 50% glass area

Swinging doors

- Meet U-factor requirement

Roll-up or sliding doors

- R-4.75

Insulation of Radiant Heating Systems [C402.2.8]

Thermally effective systems – direct heat transfer to interior spaces

- Radiant panels to be insulated with a minimum of R-3.5

Maximum Fenestration Area [C402.3.1]

Percentage of vertical fenestration area to gross wall area

- Limited to 30% maximum of above grade wall
- Up to 40% by meeting automatic daylighting requirements

Maximum Fenestration Area [C402.3.1]

Percentage of skylight area to roof area

- Limited to 3% of Roof Area
- Up to 5% if automatic daylighting controls are installed in daylight zones under skylights

Minimum Skylight Fenestration Area [C402.3.2]

Select enclosed spaces > 10,000 ft^2 directly under a roof with ceiling heights > 15 ft require a total daylight zone under skylights to not be <½ the floor area and to provide a minimum skylight area to daylight zone of either

- Minimum of 3% of roof area with a skylight VT at least 0.40 **OR**
- Provide a minimum skylight effective aperture of at least 1%

Exceptions

- Spaces with LPDs < 0.5 W/ft^2
- Documented shaded spaces
- Daylight area under rooftop monitors is > 50% of floor area

Photo courtesy of Ken Baker, K energy

Haze Factor [C402.3.2.2]

Skylights in certain space types to have a glazing material or diffuser with a measured haze factor > 90% per ASTM D 1003

Office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store, and distribution/sorting area

Exception

Skylights designed to exclude direct sunlight entering the occupied space by use of fixed or automated baffles, or the geometry of skylight and light well

Fenestration U-Factor [C402.3.3]

Table C402.3 requirements by these categories:

- Fixed fenestration
- Operable fenestration
- Entrance doors

Fenestration [Table C402.3]

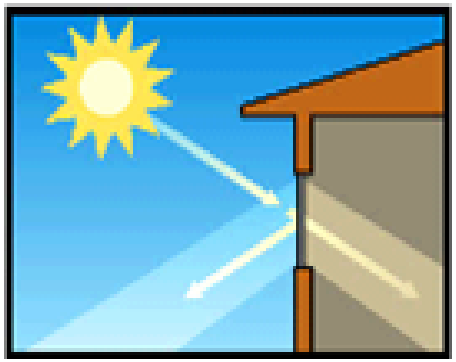
TABLE C402.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration								
***U*-factor**								
Fixed fenestration	0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29
Operable fenestration	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Entrance doors	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
SHGC								
SHGC	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
Skylights								
***U*-factor**	0.75	0.65	0.55	0.50	0.50	0.50	0.50	0.50
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

Fenestration [C402.3]

VERTICAL FENESTRATION		
Climate Zone / Specification	**4 & 5 / U-factor**	**4 & 5 / SHGC**
Fixed	0.38	0.40
Operable	0.45	0.40
Entrance doors	0.77	0.40
Skylights	0.50	0.40

What is Solar Heat Gain Coefficient?
“The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation.”

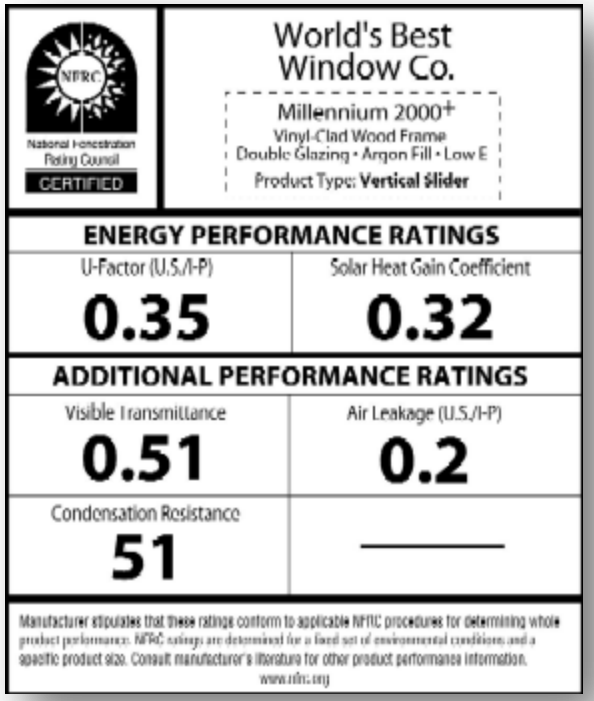


Maximum U-Factor and SHGC [C402.3.3]

- Fenestration product rating in accordance to NFRC
- Labeled and certified by the manufacturer
- Non-NFRC rated fenestration
  - Default Glazed Fenestration U-factor Table C303.1.3(1)

TABLE C303.1.3(1)
DEFAULT GLAZED FENESTRATION U-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			



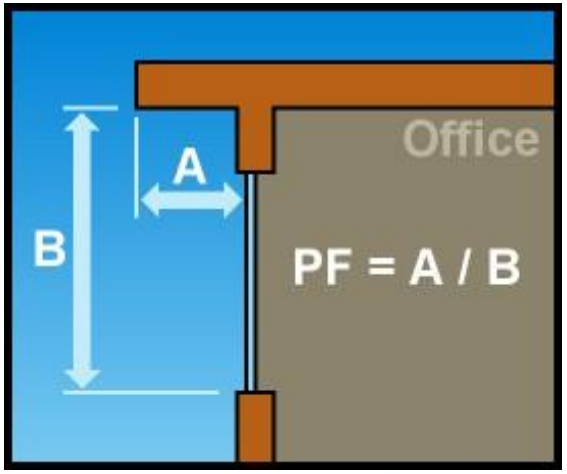
SHGC Adjustment [C402.3.3.1]

The Effect of Overhangs on Fenestration SHGC

- Overhangs can allow a higher SHGC product to be installed
- Projection factor must be calculated
- When PF ≥ 0.2, the maximum allowed SHGC can be increased:
  - SHGC x Multiplier (1.1, 1.2, 1.6)
  - 0.40 could increase to 0.44, 0.48, or 0.64

TABLE C402.3.3.1
SHGC ADJUSTMENT MULTIPLIERS

PROJECTION FACTOR	ORIENTED WITHIN 45 DEGREES OF TRUE NORTH	ALL OTHER ORIENTATION
$0.2 \leq PF < 0.5$	1.1	1.2
$PF \leq 0.5$	1.2	1.6



Increased Skylight U-Factor and SHGC [C402.3.3.3-4]

In Climate Zones 4 and 5, skylights above daylight zones with automatic daylight controls are permitted a maximum:

- U-Factor of 0.75
- SHGC of 0.60

Dynamic Glazing [C402.3.3.5]

- SHGC determined using manufacturer's lowest-rated SHGC
- VT/SHGC ratio determined using maximum VT and maximum SHGC
- Considered separately from other fenestration
- Area-weighted averaging isn't allowed

Area-Weighted U-Factor [C402.3.4]

- Allowed to meet U-factor requirements for each fenestration category
- Can’t combine fixed windows and door entrances to meet requirements

Air Leakage [C402.4]

- Air barriers
- Penetrations
- Air leakage of fenestration
- Doors and access openings to shafts, chutes, stairways, and elevator lobbies
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weatherseals
- Entry vestibules
- Air leakage of recessed lighting

Air Barrier Compliance [C402.4.1]

Continuous air barrier required **AND**

One of three options to comply with air barrier compliance

- Materials
  - Air permeability not to exceed 0.004 cfm/ft^2 at a pressure differential of 75 Pascals
- Assemblies
  - Air leakage not to exceed 0.04 cfm/ft^2 at a pressure differential of 75 Pascals
- Building test
  - Air leakage rate of completed building not to exceed 0.40 cfm/ft^2 (envelope area) at a pressure differential of 75 Pascals

Air Barrier - Materials [C402.4.1.2.1]

These materials meet this requirement:

Material	Thickness (minimum)
Plywood	3/8 in.
Oriented strand board	3/8 in.
Extruded polystyrene insulation board	1/2 in.
Foil-faced urethane insulation board	1/2 in.
Exterior gypsum sheathing or interior gypsum board	1/2 in.
Cement board	1/2 in.
Built up roofing membrane	
Cast-in-place and precast concrete	

(partial table)

Air Barrier - Assemblies [C402.4.1.2.2]

These assemblies meet this requirement:

Material
Concrete masonry walls coated with one application either of block filler and two applications of a paint or sealer coating
A Portland cement/sand parge, stucco or plaster minimum ½ inch in thickness

Air Barrier - Building Test [C402.4.1.2.3]

Building leakage test

- Blower door
- Multiple fan blower door
- Mobile fan attached to building
- Building air handler unit

Picture from The Energy Conservatory

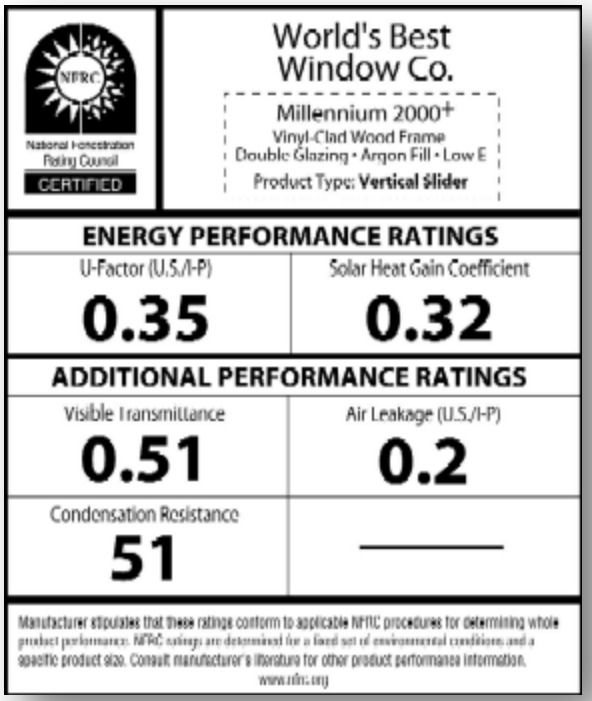
Air Barrier Penetrations [C402.4.2]

Joints or penetrations of air barrier and air leakage paths to be

- Caulked,
- Gasketed,
- Taped,
- Otherwise sealed

Air Leakage of Fenestration [C402.4.3]

Fenestration Assembly	cfm/ft^2
Windows, sliding glass doors, and swinging doors	0.20
Skylights - with condensation weepage openings	0.30
Skylights – all other	0.20
Curtain walls and storefront glazing	0.06
Commercial glazed swinging entrance doors	1.00
Revolving doors	1.00
Garage doors	0.4
Rolling doors	1.00



Exceptions

- Field-fabricated fenestration assemblies
- Fenestration in buildings that meet the building air leakage test

Doors [C402.4.4]

- Gasketed, weatherstripped, or sealed
- Previous table for fenestration

Stairway and Shaft Vents [C402.4.5.1]

- Class I motorized dampers with maximum leakage rate of 4 cfm/ft^2 at 249 Pascals
- Dampers to be installed with controls to be able to open automatically upon
  - Activation of any fire alarm
  - Interruption of power to the damper

Outdoor Air Intakes and Exhausts [C402.4.5.2]

Class IA motorized leakage-rated damper with maximum leakage rate 4 cfm/ft^2 @ 249 Pascals

Exceptions

- Gravity (nonmotorized) damper, protected from direct exposure to wind, with maximum leakage rate of 20 cfm/ft^2 at 249 Pascals are allowed:
  - For exhaust and relief dampers
  - Buildings < 3 stories in height
  - Where design outdoor air intake or exhaust capacity is < 300 cfm
- Dampers < 24 inches in either dimension may have a leakage of 40 cfm/ft2 at 1.0 inch water gauge

Loading Dock Weatherseals [C402.4.6]

Restrict infiltration

- Cargo and loading dock doors equipped with weatherseals

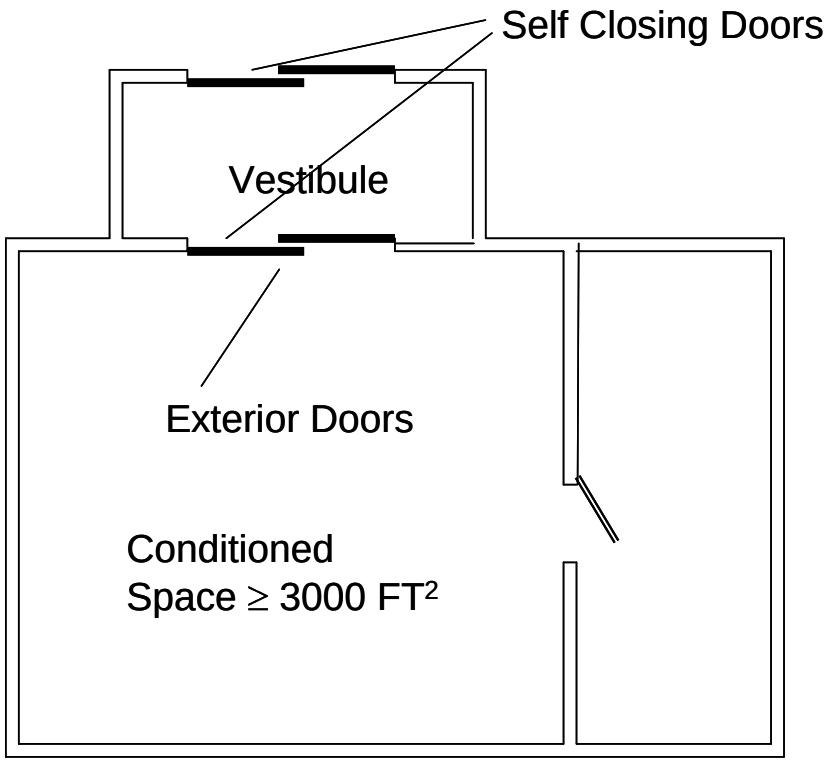
Vestibules [C402.4.7]

Required to reduce infiltration into spaces

- Required on entrance doors leading into spaces ≥ 3,000 ft^2
- Self-closing devices

Exceptions

- Doors from a dwelling unit
- Revolving doors
- Doors not intended for public use or intended solely for employee use



Recessed Lighting [C402.4.8]

All recessed luminaires installed in the building envelope

- Type IC rated and labeled to allow ≤ 2.0 cfm of air movement
- Sealed with gasket or caulk between housing and wall or ceiling

Topic 3 Summary

Envelope Requirements of the 2012 IECC

Insulation and Fenestration

- Roof
- Above grade wall
- Below grade wall
- Floor
- Slab-on-grade
- Windows, skylights, doors

Air Leakage

- Air barriers
- Penetrations/openings/shafts
- Fenestration
- Loading docks
- Vestibules
- Recessed lighting

Summary

- Missouri – no state code
- 2012 IECC Compliance Options
  - Prescriptive
  - Performance
  - ASHRAE 90.1-2010 (Prescriptive or Performance)
- Requirements of the 2012 IECC
  - Envelope
  - Mechanical
  - Service Water Heating
  - Lighting
  - Additional Efficiency Package

Next Steps

Workshop 2

Discuss other requirements

- Mechanical
- Lighting
- Energy efficiency package

Thank You – comment card

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MISSOURI DEPARTMENT OF NATURAL RESOURCES