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Building Energy Codes

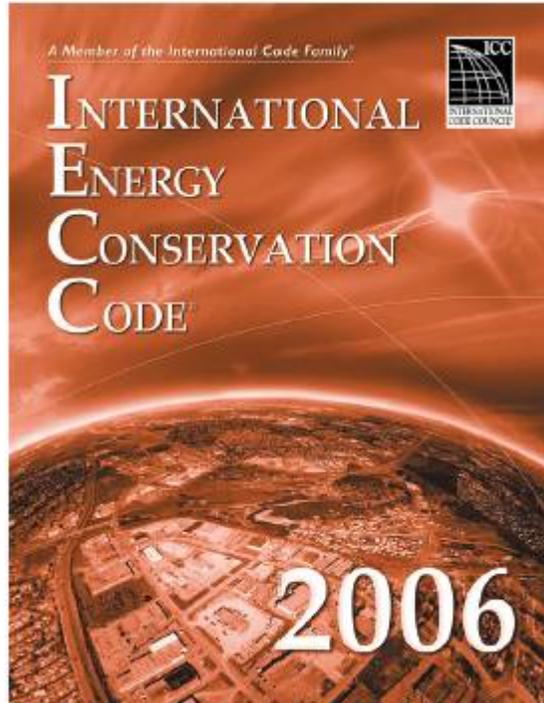
Commercial Envelope Requirements of the 2006 International Energy Conservation Code

U.S. Department of Energy
Building Energy Codes Program

Eric Makela, Britt/Makela Group

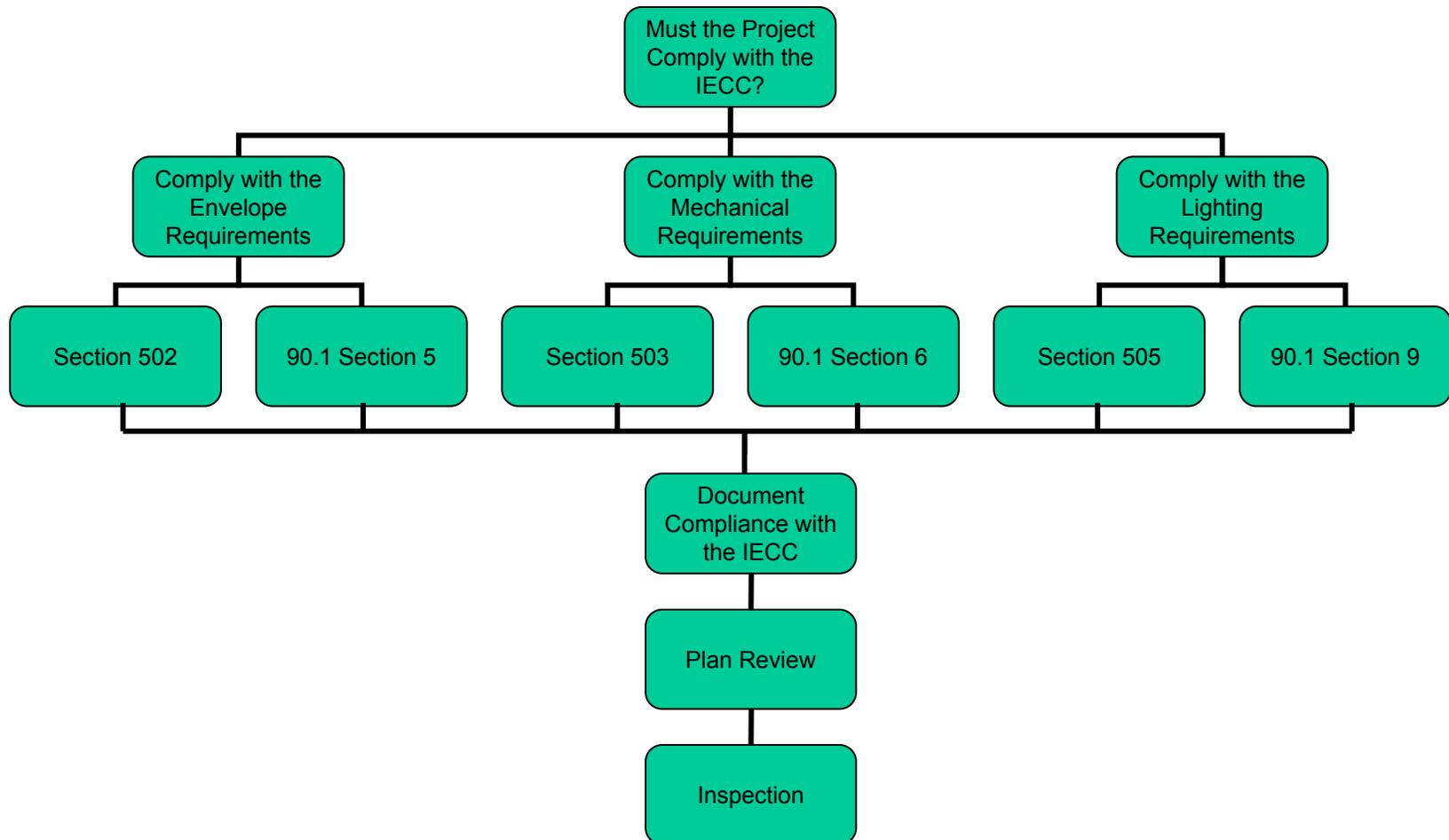
Original Materials Developed By: Britt/Makela Group, Inc.

Major Changes to the Envelope Requirements



- Commercial Provisions Contained in Chapter 5
 - IECC
 - ASHRAE 90.1-2004
- New Envelope Tables
- New Requirements for Metal Buildings
- Buildings Limited to 40% Glass to Wall Area

Introduction to the Energy Code Compliance Process



Does My Project Need to Comply with the IECC?

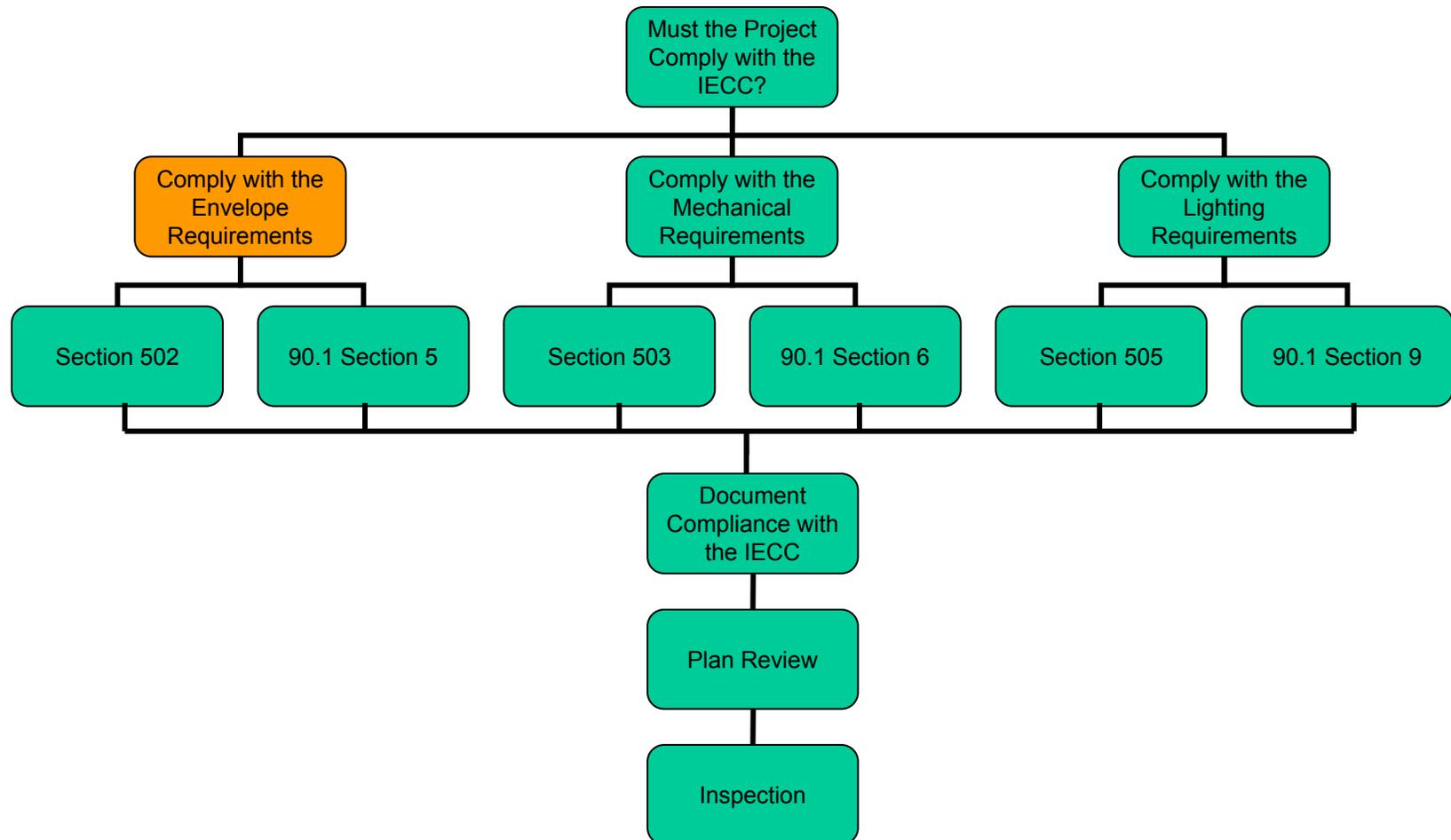


All Buildings Other Than:

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



Introduction to the Energy Code Compliance Process



What is the Building Thermal Envelope?

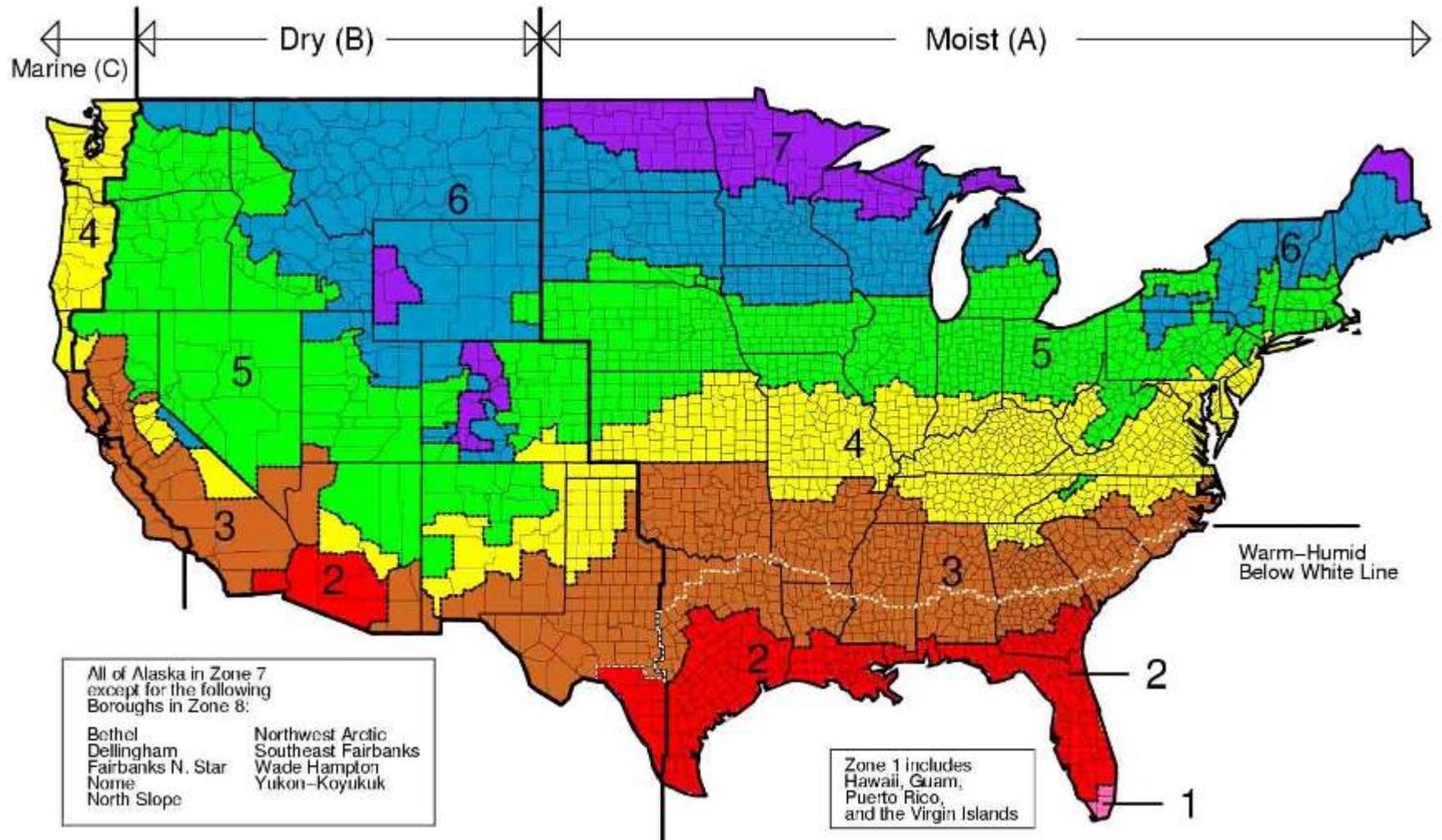
- Roof/Ceiling Assembly
- Wall Assembly
- Vertical Fenestration and Skylights
- Floor Assembly
- Slab Edge
- Below Grade Wall

What are My Options for Complying with the IECC?



- Chapter 5 of the IECC General Prescriptive Approach
 - Use for $\leq 40\%$ of gross wall area in glazing
- Section 506 Total Building Performance Approach
- ASHRAE/IESNA Standard 90.1-2004

Climate Zones—2006 IECC



Determining Your Climate Zone is the First Step in the Process

Compliance with Chapter 5 Prescriptive Approach

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS – OPAQUE ASSEMBLIES

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Roofs								
Insulation entirely above deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-20 ci	R-20 ci	R-25 ci	R-25 ci
Metal buildings (with R-5 thermal blocks) ^b	R-19 + R-10	R-19	R-19	R-19	R-19	R-19	R-19 + R-10	R-19 + R-10
Attic and other	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38
Walls, Above Grade								
Mass	NR	NR	R-5.7 ci ^c a	R-5.7 ci ^c	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci
Metal building ^b	R-13	R-13	R-13	R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13
Metal framed	R-13	R-13	R-13	R-13	R-13 + R-3.8 ci	R-13 + R-3.8 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13 + R-7.5 ci
Walls, Below Grade								
Below grade wall ^d	NR	NR	NR	NR	NR	NR	R-7.5 ci	R-7.5 ci
Floors								
Mass	NR	R-5 ci	R-5 ci	R-10 ci	R-10 ci	R-10 ci	R-15 ci	R-15 ci
Joist/Framing	NR	R-19	R-19	R-19	R-19	R-30	R-30	R-30
Slab-on-Grade Floors								
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 24 in. below	R-10 for 36 in. below	R-10 for 36 in. below	R-10 for 48 in. below
Opaque Doors								
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.

ci – Continuous Insulation

NR – No Requirement

a. Thermal blocks are a minimum R-5 of rigid insulation, which extends 1-inch beyond the width of the purlin on each side, perpendicular to the purlin.

b. Assembly descriptions can be found in Table 502.2(2).

c. R-5.7 ci may be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 in. or less on center vertically and 48 in. or less on center horizontally, with ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu-in./h-² F.

d. When heated slabs are placed below grade, below grade walls must meet the exterior insulation requirements for perimeter insulation according to the heated slab-on-grade construction.

e. Insulation is not required for mass walls in Climate Zone 3A located below the "Wet-Humid" line, and in Zone 3B.

Compliance with Chapter 5 Prescriptive Approach

TABLE 502.2(2)
METAL BUILDING ASSEMBLY DESCRIPTIONS

ROOFS	DESCRIPTION	REFERENCE
R-19 + R-10	<p>Filled cavity roof.</p> <p>Thermal blocks are a minimum, R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin.</p> <p>This construction is R-10 insulation batts draped perpendicularly over the purlins, with enough looseness to allow R-19 batt to be laid above it, parallel to the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins. In the metal building industry, this is known as the “sag and bag” insulation system.</p>	ASHRAE/IESNA 90.1 Table A2.3
R-19	<p>Standing seam with single insulation layer.</p> <p>Thermal blocks are a minimum R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin.</p> <p>This construction R-19 insulation batts draped perpendicularly over the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins.</p>	ASHRAE/IESNA 90.1 Table A2.3
Walls		
R-13	<p>Single insulation layer</p> <p>The first layer of R-13 insulation batts is installed continuously perpendicular to the girts and is compressed as the metal skin is attached to the girts.</p>	ASHRAE/IESNA 90.1 Table A3.2
R-13 + R-13	<p>Double insulation layer</p> <p>The first layer of R-13 insulation batts is installed continuously perpendicular to the girts, and is compressed as the metal skin is attached to the girts. The second layer of R-13 insulation batts is installed within the framing cavity.</p>	ASHRAE/IESNA 90.1 Table A3.2

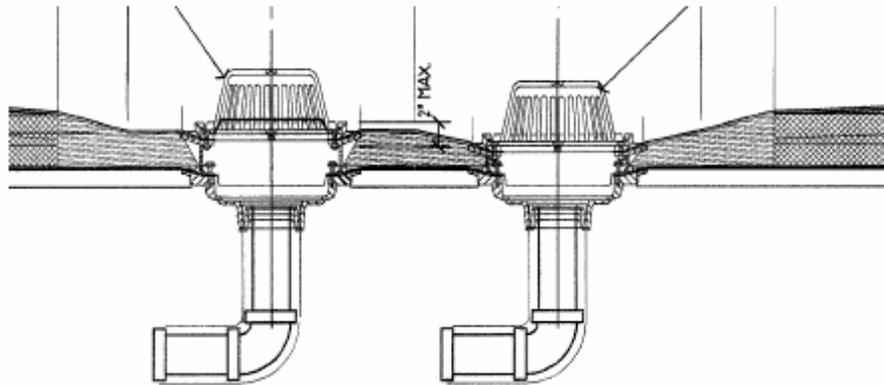
Roof R-value (502.2.1)



Roof R-value Requirements Based on Assembly Type/ Insulation Placement

- Insulation entirely above deck
- Metal buildings
- Attic and other

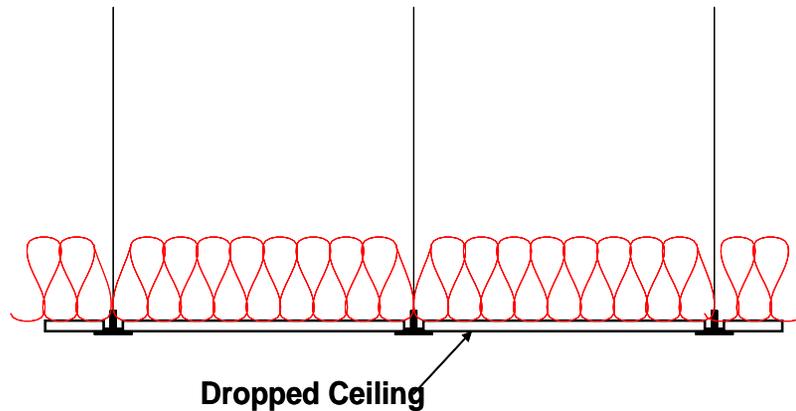
Roof R-value



Insulation Completely Above Deck

- Insulation considered continuous (*C*)
- Insulation thickness can vary ≤ 1 " when area weighted U-factor meets the requirements of Table 502.2(1)

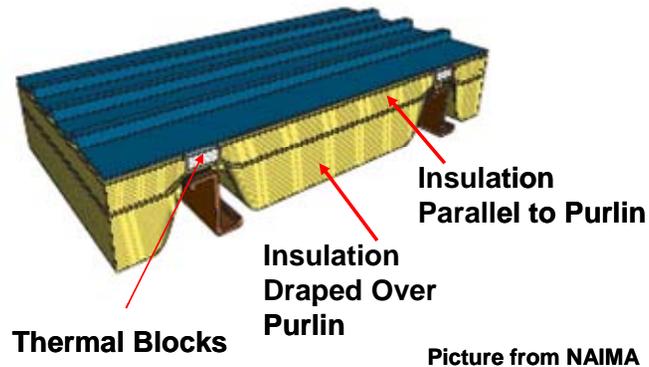
Roof R-value



Insulation Placed On Suspended Ceiling With Removable Ceiling Tiles

- Will not count for code compliance
- Will not comply with Section 502.4.3 – Sealing of the building envelope

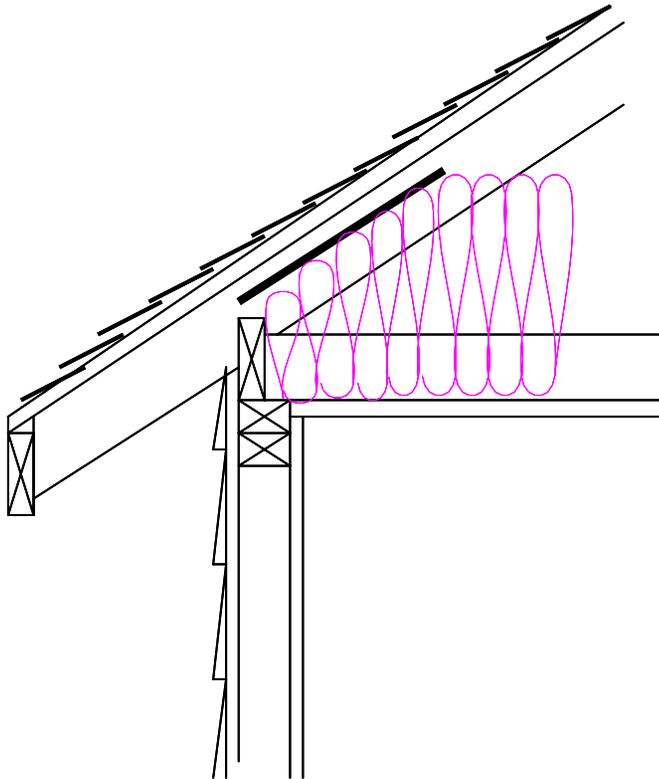
Roof R-value



Metal Buildings

- R-5 thermal blocks required on all metal buildings
- Climate Zones 1, 7 and 8 require two layers of insulation (R-19 + R-10)
- R-10 draped perpendicularly to the purlins
- R-19 running parallel to the purlins supported by the R-10

Roof R-value



Ceilings With Attic Spaces

- Install insulation between framing
- R-30 in most Climate Zones
- R-38 in Climate Zones 7 and 8

Wall R-value



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 $\leq 120 \text{ lb/ft}^3$

Mass Walls – Concrete Masonry Units

- Climate Zones 3 and 4 – Can use integral insulation instead of R-5.7 ci
 - Concrete block walls must comply with ASTM C 90, and
 - UngROUTED or partially grouted @ 32 inch. o.c. or less vertically or 48 inch. o.c. or less horizontally, and
 - UngROUTED cells must be filled with insulation material \leq of 0.44 Btu-in./h-ft² F
- Climate Zones 3A (Below “Warm-Humid” line) and 3B
 - No insulation required for mass walls

Wall R-value

Wood and metal framed walls

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

Metal Building Walls (Table 502.2(2))



Picture from NAIMA

- Climate Zones 1 – 4 except Marine
 - R-13 Insulation installed perpendicular to the girts and compressed by the metal skin
- Climate Zones Marine 4 and higher
 - R-13 insulation installed perpendicular and continuously to the girts
 - Addition R-13 insulation installed within the framing cavity

Below Grade Walls (502.2.4)

- What is a below grade wall?
 - Basement or first-story walls $\geq 85\%$ below grade
- Insulation must extend down 10 ft from the finished grade level or to the level of the floor, whichever is less

Floors Over Outdoor Air or Unconditioned Space (502.2.5)



- Joist/Framing
 - Insulation installed between framing
- Mass Floors
 - Materials weighing 35 lbs/ft², or
 - 25 lbs/ft² if material weight is \leq 120 lbs/ft³
 - Insulation installed continuously

Slab-on-Grade Floors (502.2.6)

- Unheated slab – insulation not required except in Climate Zone 8
- Heated slabs – insulation required in all Climate Zones

Opaque Doors (502.2.7)



- Doors having $< 50\%$ glass area
- Swinging doors
 - Meet U-factor requirement
- Roll-up or sliding doors
 - Climate zones 1 – 5 and Marine 4: U-1.45
 - Climate zones 6 – 8: U-0.50

Compliance with Chapter 5 Prescriptive Approach

TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Vertical Fenestration (40% maximum of above-grade wall)								
<i>U</i> -Factor								
Framing materials other than metal with or without metal reinforcement or cladding								
<i>U</i> -Factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain Wall/Storefront <i>U</i> -Factor	1.20	0.70	0.60	0.50	0.45	0.45	0.45	0.45
Entrance Door <i>U</i> -Factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All Other <i>U</i> -Factor ^a	1.20	0.75	0.65	0.55	0.55	0.55	0.50	0.50
SHGC-All Frame Types								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	NR	NR
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
Glass								
<i>U</i> -Factor	1.60	1.05	0.90	0.60	0.60	0.60	0.60	0.60
SHGC	0.40	0.40	0.40	0.40	0.40	0.40	NR	NR
Plastic								
<i>U</i> -Factor	1.90	1.90	1.30	1.30	1.30	0.90	0.90	0.60
SHGC	0.35	0.35	0.35	0.62	0.62	0.62	NR	NR

Vertical Fenestration Requirement (502.3.1)



Percentage of Vertical Fenestration Area to Gross Wall Area

- Allowed up to 40% maximum of above grade wall

Vertical Fenestration Requirement (502.3.1)



- Based on above-grade wall area (gross)
 - Includes walls between conditioned space and unconditioned space or the great outdoors
 - Includes walls that are > 15% above grade
- Total fenestration area (includes frame and glazing)
 - Does not include opaque door area

Fenestration U-factor (502.3.2)

Framing Materials Other Than Metal w/ or w/o metal reinforcement or cladding

- Includes vinyl and wood frame products or other non-metal frames
- Typically manufactured fenestration products



Fenestration U-factor



Metal framing with or without thermal break

- Curtain Wall
 - By definition: Fenestration products used to create an external nonload-bearing wall that is designed to separate the exterior and interior environments

Fenestration U-factor



Metal framing with or without thermal break

- Storefront
 - By definition: A nonresidential system of doors and windows mullied as a composite fenestration structure that has been designed to resist heavy use and possible abuse and provide a high level of resistance to window load and impact from wind borne debris

Fenestration U-factor



Metal framing with or without thermal break

- Entrance Door
 - By definition: Fenestration products used for ingress, egress an access to nonresidential buildings, including but not limited to, exterior entrances that utilize latching hardware, automatic closers and contain over 50% glass specifically designed to withstand heavy use and possibly abuse

Fenestration U-factor

Metal framing with or without thermal break

- All other
 - Includes operable windows, fixed windows and non-entrance doors

Fenestration U-factor (102.1.3)

How Do You Meet the Requirement?

 <p>National Fenestration Rating Council CERTIFIED</p>		<p>World's Best Window Co.</p> <p>Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider</p>	
ENERGY PERFORMANCE RATINGS			
U-Factor (U.S./I-P)		Solar Heat Gain Coefficient	
0.35		0.32	
ADDITIONAL PERFORMANCE RATINGS			
Visible Transmittance		Air Leakage (U.S./I-P)	
0.51		0.2	
Condensation Resistance		_____	
51			
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information. www.nfrc.org</small>			

- Fenestration product rating in accordance to NFRC 100
- Labeled and certified by the manufacturer
- Non-NFRC 100 rated fenestration
- Default Glazed Fenestration U-factor Table 102.1.3(1)

Default U-factors from Table 102.1.3(1) – (2)

TABLE 102.1.3(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			

TABLE 102.1.3(2)
DEFAULT DOOR *U*-FACTORS

DOOR TYPE	<i>U</i> -FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

Glazed Fenestration SHGC (502.3.2)



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.”

Fenestration SHGC Requirements (102.1.3)

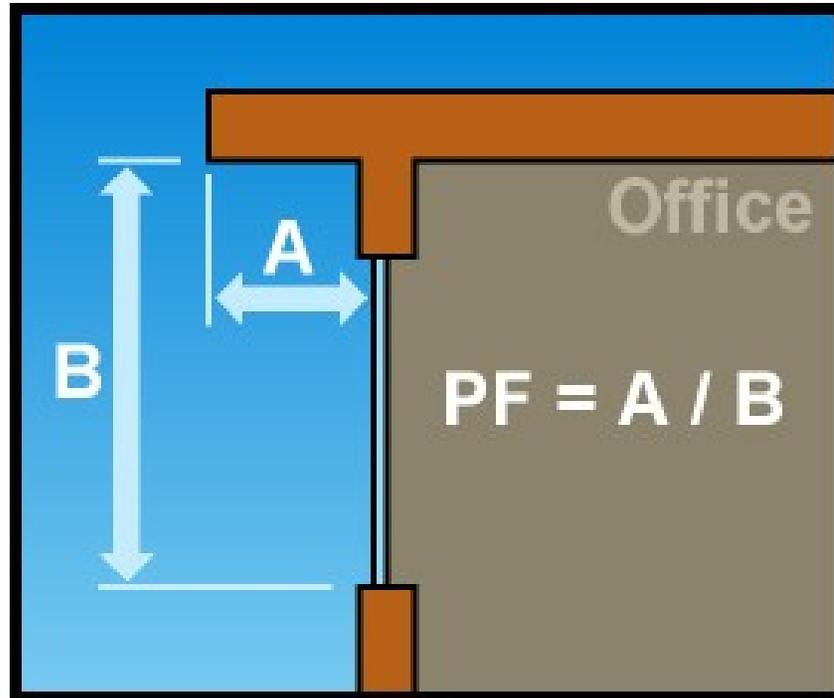
TABLE 102.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC

SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
Clear	Tinted	Clear	Tinted	
0.8	0.7	0.7	0.6	0.6

Two Options for Meeting the SHGC Requirements

- Fenestration product rated and labeled to NFRC 200, or
- Select default from Table 102.1.3(3)

Fenestration SHGC Requirements

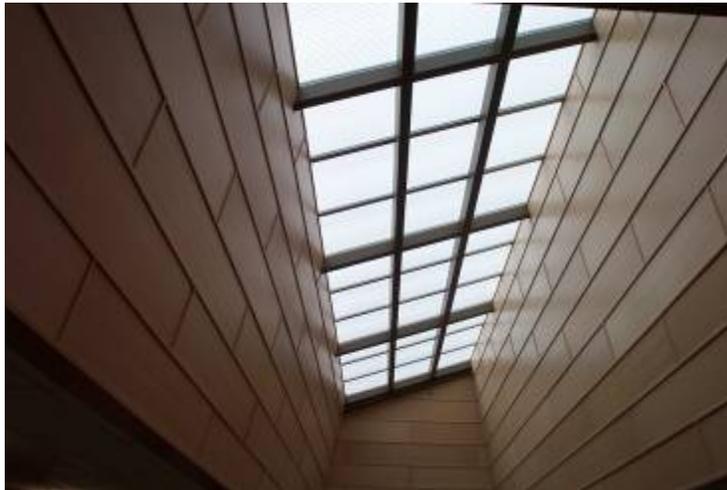


The Effect of Overhangs on Fenestration SHGC

- Overhangs allow a higher SHGC product to be installed
- Projection factor must be calculated

Skylight U-value/ SHGC

- Limited to $\leq 3\%$ of Roof Area
- U-factor and SHGC Based on Material Type
 - Glass or Plastic
- NFRC 100 Rating for U-factor or Default Table



NFRC 100 Rating for U-factor or Default Table

TABLE 102.1.3(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			

Mandatory Requirements

Sealing of the Building Envelope (502.4.3)

- All penetrations, openings, joints and seams in the building envelope must be sealed.

Materials that can be used include:

- Caulking
- Gasketing
- Tapes
- Moisture vapor-permeable wrapping material

Mandatory Requirements



Sealing of the Building Envelope (502.4.3)

- Sealing materials spanning joints between dissimilar materials must allow for expansion and contraction

Mandatory Requirements (502.4.4)



Outdoor Air Intakes, Exhaust Openings and Vents Integral to the Building Envelope

- Buildings ≥ 3 stories in height above grade
 - Class 1 motorized leakage-rated damper
 - Maximum leakage rate $\leq 4\text{cfm /ft}^2 @ 1.0$ inch w.g.
- Buildings < 3 stories in height
 - Gravity (nonmotorized) allowed

Mandatory Requirements (502.4.5)



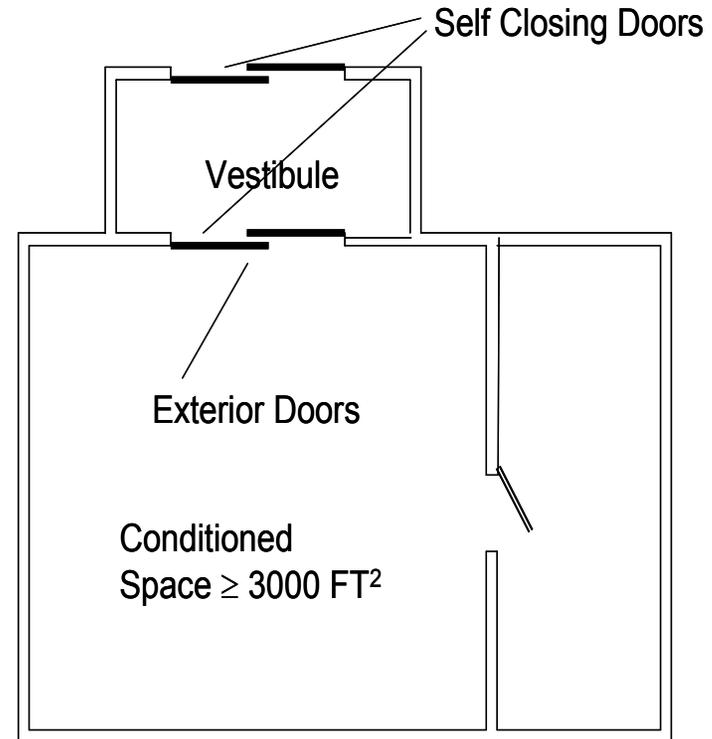
Loading Dock Weatherseals

- Equip cargo doors and loading dock doors with weatherseals
- Goal is to restrict infiltration

Mandatory Requirements (502.4.6)

Vestibules on Entrance Doors

- Required to reduce infiltration into spaces
- Required on entrance doors leading into spaces $\geq 3,000 \text{ ft}^2$
- Doors must have self-closing devices
- Exceptions
 - Buildings in Climate Zones 1 and 2
 - Doors from a guest room or dwelling unit
 - Doors used primarily for vehicular movement, material handling and adjacent personnel doors



Mandatory Requirements (502.4.7)

Recessed Luminaires Installed in the Building Envelope

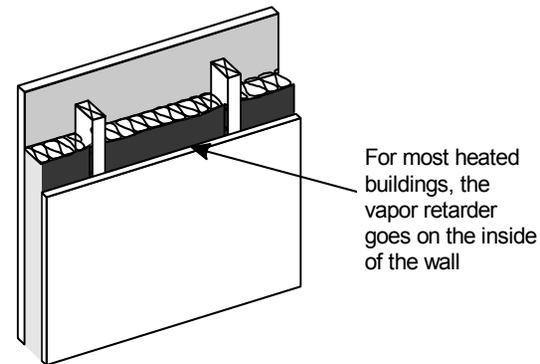
- Type IC rated w/no penetrations in the fixture and sealed or gasketed to prevent air leakage
- Type IC or non-IC rated installed in a sealed box with $\geq \frac{1}{2}$ " clearance from combustible material and ≥ 3 " from insulation
- Type IC rated and tested in accordance with ASTM E 283 to allow ≤ 2.0 cfm of air movement



Mandatory Requirements (502.5)

Moisture Control

- Approved vapor retarder required on all unvented framed cavities
- Exceptions
 - Climate Zones 1 – 3
 - Where moisture or its freezing will not damage the materials
 - Where other approved means to avoid condensation are provided



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Notice Requesting Public Input on Further Analysis Related to Wall Insulation

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Vestibules: Understanding Requirements for Air Locks in Commercial Settings for the IECC

Designers of commercial buildings are required, by the 2003 IECC, to install vestibules on the primary entrance doors leading from spaces equal to or greater than 3,000 ft² in all buildings. By creating an air lock, vestibules reduce infiltration into a space that includes doors with high volume of pedestrian traffic.

This requirement typically applies to large "box" stores where the building entrance is directly into the retail area or other buildings with large lobbies, such as hotels and office buildings. The only specific requirement in the 2003 IECC for vestibule design and operation is that the vestibule be designed so that the interior and exterior doors do not open at the same time. Some doors may be exempt from the requirement, such as revolving doors, mechanical room doors, or doors that open from spaces less than 3,000 ft² (for a full list of exempt doors, see IECC 2003, Section 802.3.6).

In reviewing commercial building plans,

1. Verify that doors separating conditioned space from the exterior leading to spaces 3,000 ft² or greater contain a vestibule.
2. Verify that doors separating conditioned space from the exterior that do not have vestibules are exempt from the requirement.
3. Verify that doors leading into and out of the vestibule are designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time.
4. Verify that doors meet the requirement for means of egress doors as stated in 2003 IBC Section 1008.
5. Verify that building assemblies between the conditioned space and the vestibule meet the envelope requirements of Section 802 of the 2003 IECC.



Vestibules reduce infiltration and gain from stack and wind effects in buildings that experience a high volume of pedestrian traffic.

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