

Insulation Installation

'Devils in the Details'

2018 MBCEA Conference - San Antonio
May 4, 2018

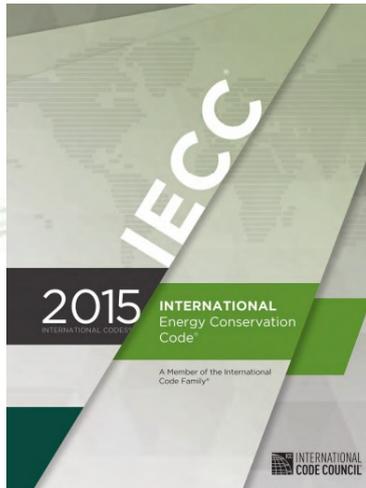
Presented By:



Brad Rowe, National Marketing Manager

National Model Energy Codes

IECC
International Energy Conservation Code



2018

2015

2012

2009

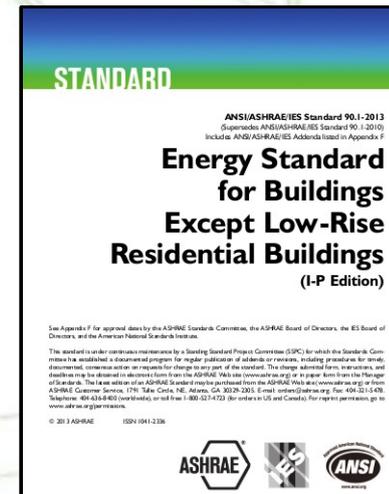
ASHRAE 90.1
Standard

2016

2013

2010

2007



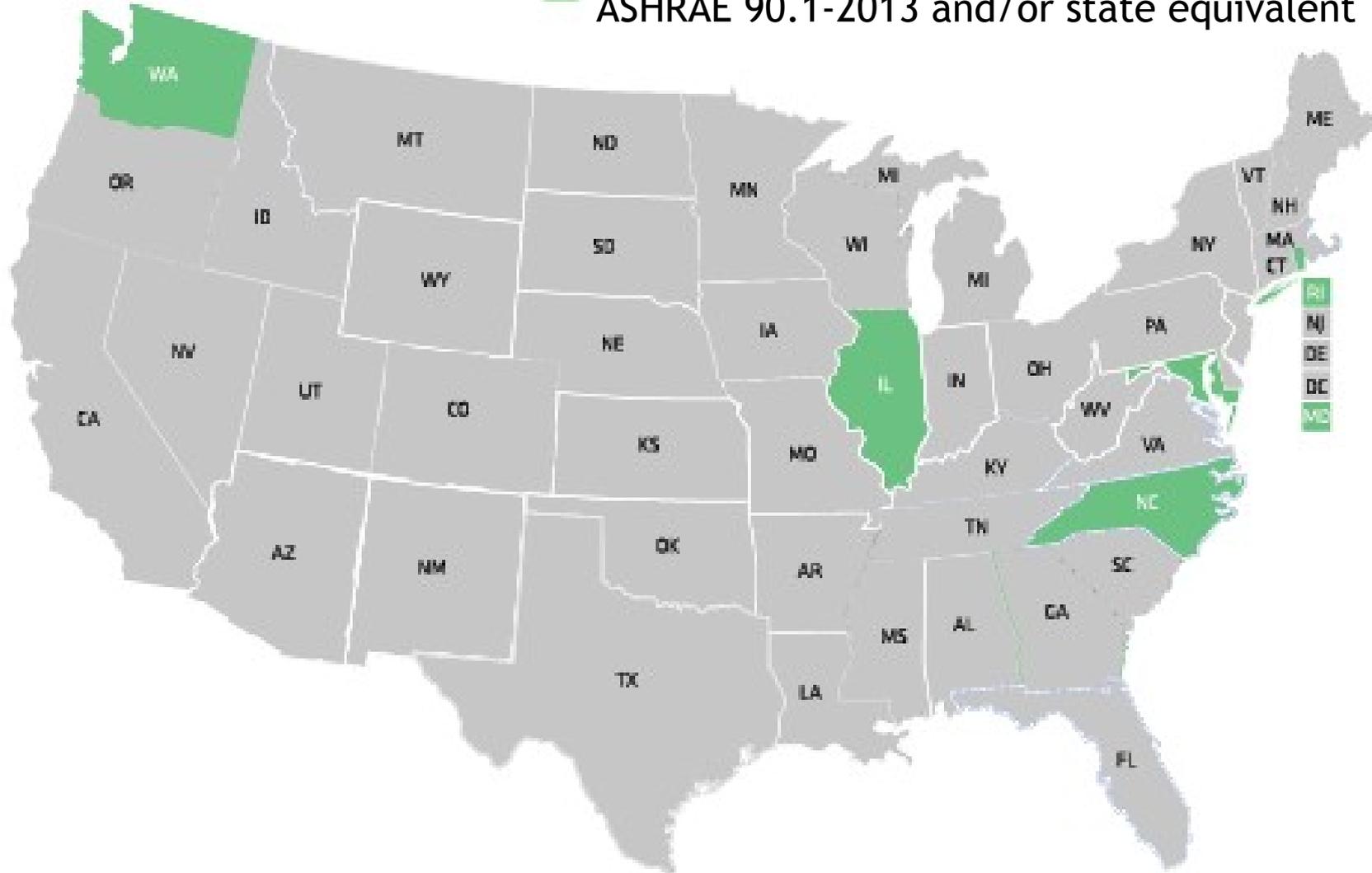
Development Process

Energy Code and Standards Require Different Methods

Each Provide Prescriptive Compliance Paths

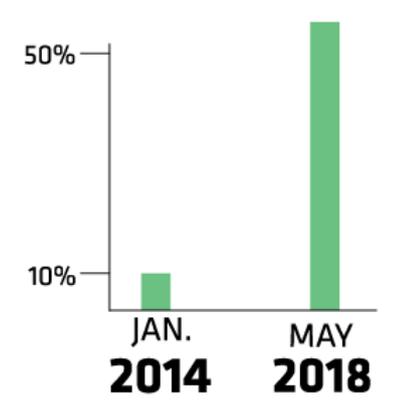
Increasing Energy Code Adoption

■ State adoption of 2012 IECC, 2015 IECC, ASHRAE 90.1-2013 and/or state equivalent



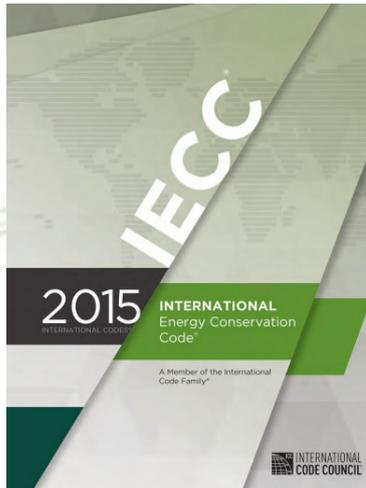
Increasing Energy Code Adoption

■ State adoption of 2012 IECC, 2015 IECC, ASHRAE 90.1-2013 and/or state equivalent

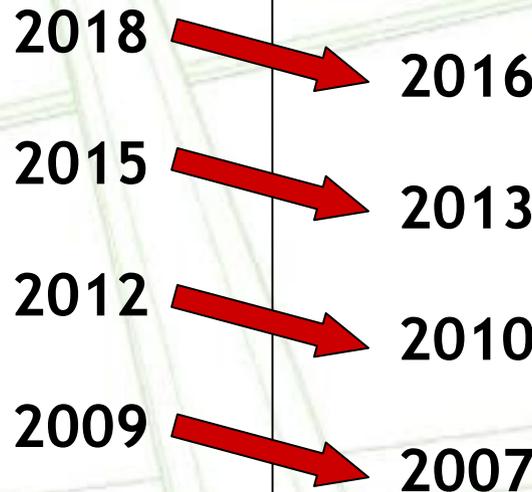
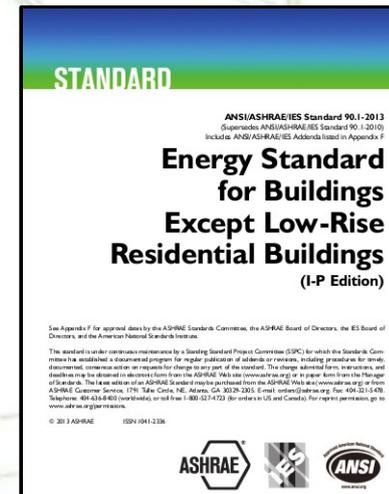


National Model Energy Codes

IECC
International Energy
Conservation Code



ASHRAE 90.1
Standard



**IECC references 90.1 and
Appendix Tables and
Assembly Descriptions**

**Publishes assembly U-factors
for a variety of insulation
combinations for all types
of roof and wall**

Example: ASHRAE 90.1-2013 Table A2.3.3

TABLE A2.3.3 Assembly U-Factors for Metal Building Roofs

Insulation System	Rated R-Value of Insulation	Overall U-Factor for Entire Base Roof Assembly	Overall U-Factor for Assembly of Base Roof Plus Continuous Insulation (Uninterrupted by Framing)								
			Rated R-Value of Continuous Insulation								
			R-6.5	R-9.8	R-13	R-15.8	R-19	R-22.1	R-25	R-32	R-38
Standing Seam Roofs with Thermal Spacer Blocks^{a, b}											
Single Layer	None	1.280	0.137	0.095	0.073	0.060	0.051	0.044	0.039	0.031	0.026
	R-10	0.115	0.066	0.054	0.046	0.041	0.036	0.032	0.030	0.025	0.021
	R-11	0.107	0.063	0.052	0.045	0.040	0.035	0.032	0.029	0.024	0.021
	R-13	0.101	0.061	0.051	0.044	0.039	0.035	0.031	0.029	0.024	0.021
	R-16	0.096	0.059	0.049	0.043	0.038	0.034	0.031	0.028	0.024	0.021
	R-19	0.082	0.053	0.045	0.040	0.036	0.032	0.029	0.027	0.023	0.020
Double Layer	R-10 + R-10	0.088	0.056	0.047	0.041	0.037	0.033	0.030	0.028	0.023	0.020
	R-10 + R-11	0.086	0.055	0.047	0.041	0.036	0.033	0.030	0.027	0.023	0.020
	R-11 + R-11	0.085	0.055	0.046	0.040	0.036	0.033	0.030	0.027	0.023	0.020
	R-10 + R-13	0.084	0.054	0.046	0.040	0.036	0.032	0.029	0.027	0.023	0.020
	R-11 + R-13	0.082	0.053	0.045	0.040	0.036	0.032	0.029	0.027	0.023	0.020
	R-13 + R-13	0.075	0.050	0.043	0.038	0.034	0.031	0.028	0.026	0.022	0.019
	R-10 + R-19	0.074	0.050	0.043	0.038	0.034	0.031	0.028	0.026	0.022	0.019
	R-11 + R-19	0.072	0.049	0.042	0.037	0.034	0.030	0.028	0.026	0.022	0.019
	R-13 + R-19	0.068	0.047	0.041	0.036	0.033	0.030	0.027	0.025	0.021	0.019
	R-16 + R-19	0.065	0.046	0.040	0.035	0.032	0.029	0.027	0.025	0.021	0.019
R-19 + R-19	0.060	0.043	0.038	0.034	0.031	0.028	0.026	0.024	0.021	0.018	
Liner System	R-19 + R-11	0.037									
	R-25 + R-8	0.037									
	R-25 + R-11	0.031									
	R-30 + R-11	0.029									
	R-25 + R-11 + R-11	0.026									
Filled Cavity with Thermal Spacer Blocks^c											
	R-10+R-19	0.041	0.032	0.029	0.027	0.025	0.023	0.022	0.020	0.018	0.016

Compliance Paths

Prescriptive vs Trade Off

TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD^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 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-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings ^{a, 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-25 + R-11 LS	R-25 + 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							
Walls, above grade																	
Mass	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	R-25ci	R-25ci	
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-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	

Table 5.5-6 Building Envelope Requirements for Climate Zone 6 (A,B)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Metal building ^a	U-0.031	R-25 + R-11 Ls	U-0.029	R-30 + R-11 Ls	U-0.060	R-19 + R-19
Walls, above Grade						
Metal building	U-0.050	R-0 + R-19 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.094	R-0 + R-9.8 c.i.

Compliance Paths

Prescriptive vs Trade Off

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

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 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-0.044	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-0.151	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-0.061	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 ^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-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.036

'Trade Off' compliance path provides greater flexibility when choosing U-factor alternative.

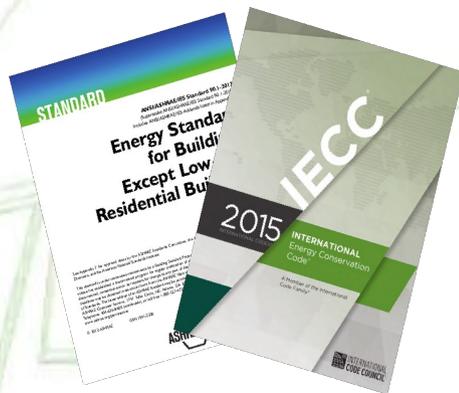
1 / U-factor = Installed R-value

Lower the U-factor = Higher Installed R-value

Identify Expectations & Clarifying Specifications

1

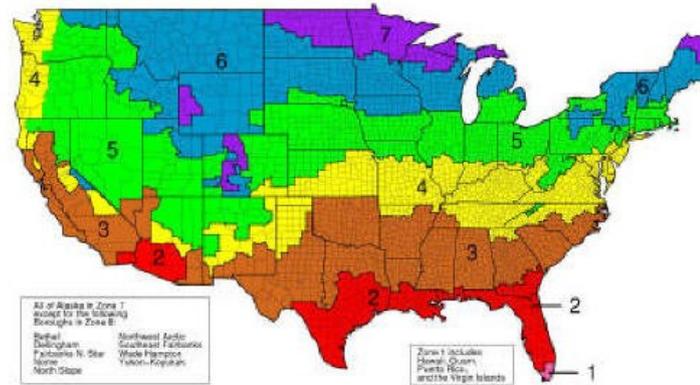
What Code/Standard?



Identify project stringency and requirements

2

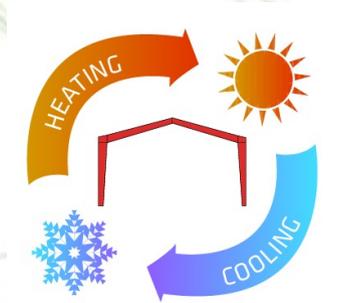
What Climate Zone?



Project location identifies envelope requirements

3

What Conditioning?



Space Conditioning:
Heating
Cooling
Semi-heated

Installation Responsibilities

Achieving claimed installed performance for the roof and wall envelope assembly.

“Get me something to meet the code”

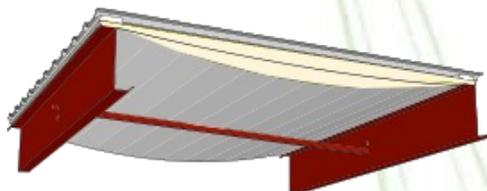
“I need an R30 for the roof”

“Wall spec is R19”

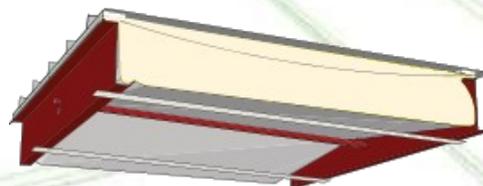
Ask and request from your insulation supplier how you need to install the assembly to yield the claimed installed performance.

“R30 Roof”

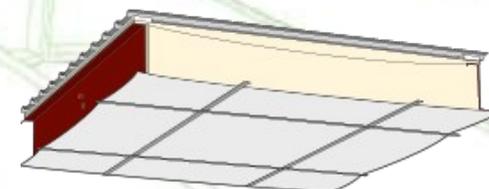
Double Layer
'Sag & Bag'



Filled
Cavity (FC)



Liner
System (Ls)



Pre-Installed
R-value

R11+R19

R10+R19 FC

R19+R11 LS

U-factor

U-0.072

U-0.041

U-0.037

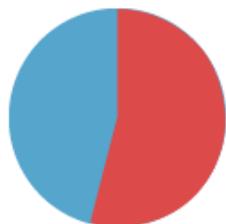
Installed
R-value

R-13.88

R-24.39

R-27.02

% Loss



53.8%



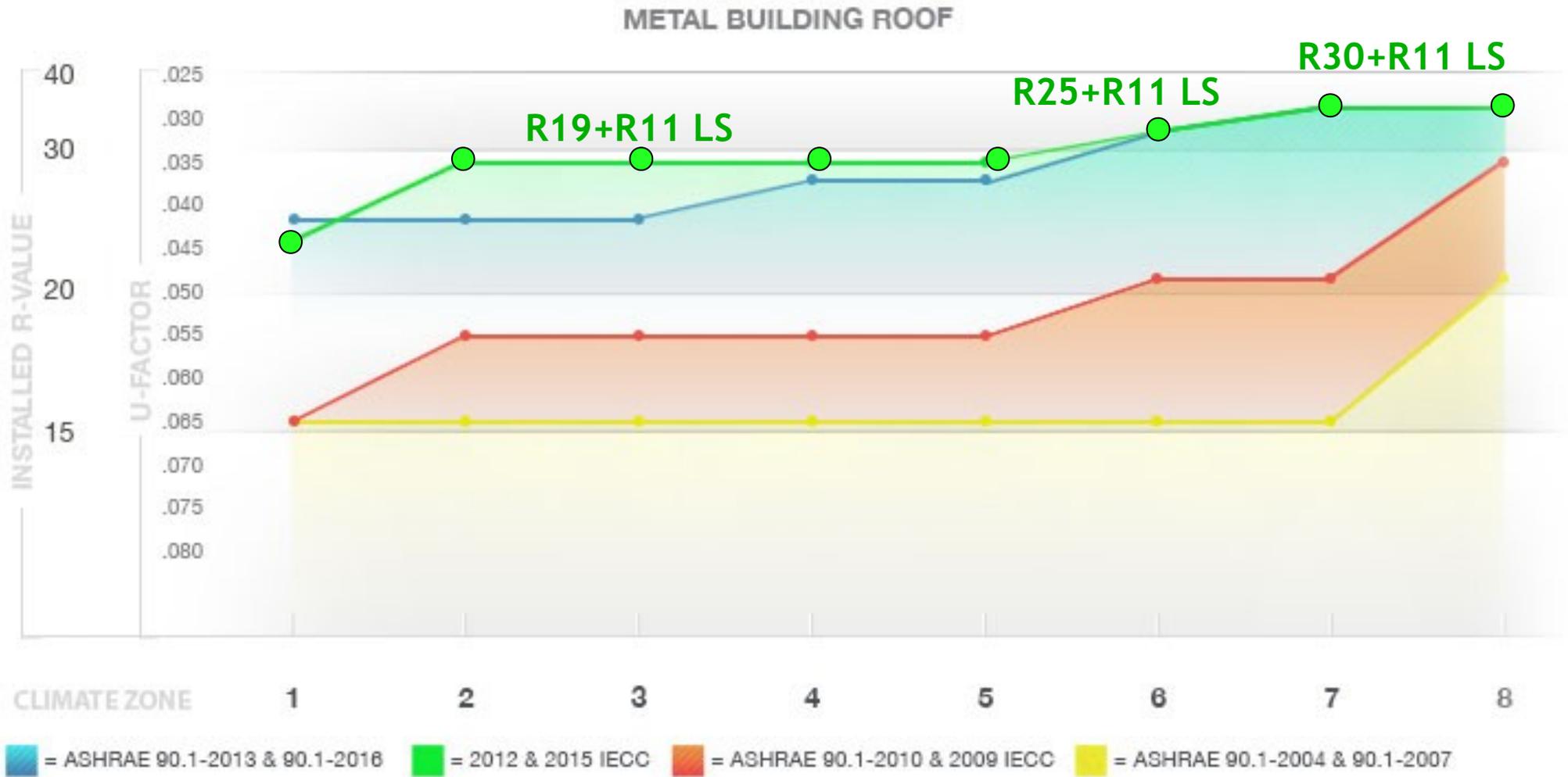
15.9%



10.0%

Roof Stringency per Code/Standard

-prescriptive requirements by climate zone (U-factor)



Metal Building Roof Prescriptive R-value Assemblies

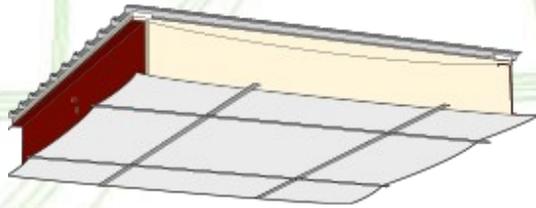
National Model Energy Code	Climate Zone							
	1	2	3	4	5	6	7	8
* 2018 IECC	■	■	■	■	■	■	■	■
* 90.1 - 2016	■	■	■	■	■	■	■	■
* 2015 IECC	■	■	■	■	■	■	■	■
* 90.1 - 2013	■	■	■	■	■	■	■	■
* 2012 IECC	■	■	■	■	■	■	■	■
* 90.1 - 2010	□	□	□	□	□	□	□	■
2009 IECC	□	□	□	□	□	□	□	■
90.1 - 2007	□	□	□	□	□	□	□	□

* *Air Barrier Requirements*

Filled Cavity (FC) ■

■ Liner System (LS)

Assembly Descriptions



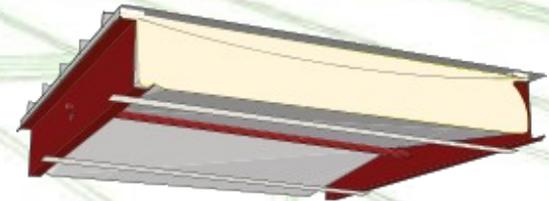
LINER SYSTEM (LS):

A continuous membrane is installed below the purlins and uninterrupted by framing members.

Uncompressed, unfaced insulation rests on top of the membrane between the purlins.

For multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached.

ASHRAE 90.1-2013, A2.3.2.4



FILLED CAVITY (FC):

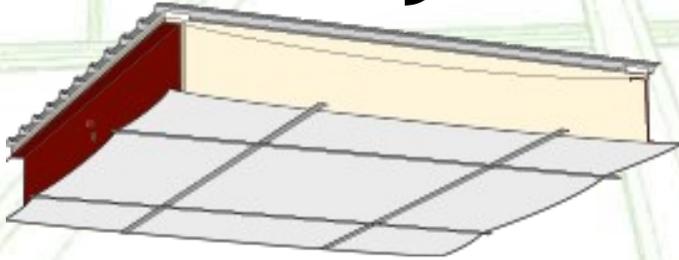
The first rated R-value of insulation represents faced or unfaced insulation installed between the purlins.

The second rated R-value of insulation represents unfaced insulation installed above the first layer, perpendicular to the purlins and compressed when the metal roof panels are attached.

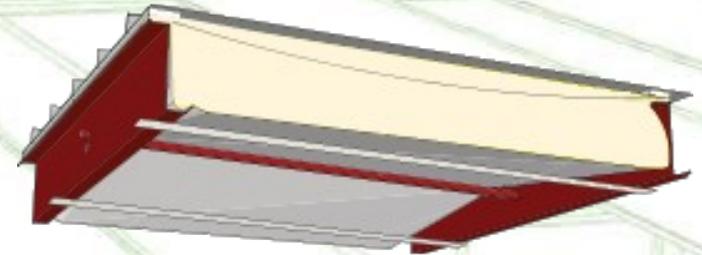
A supporting structure retains the bottom of the first layer at the prescribed depth required for the full thickness of insulation.

ASHRAE 90.1-2013, A2.3.2.5

Production Rates for Liner Systems and Filled Cavity



Liner System (Ls)



Filled Cavity (FC)

Support Platform

Equipment

Air Barrier
Responsibilities

Insulation
Compression

Bracing in
Purlin Cavity

Weather Days

Fall Protection
and Safety

Effective Sealing

Gaps and Spaces

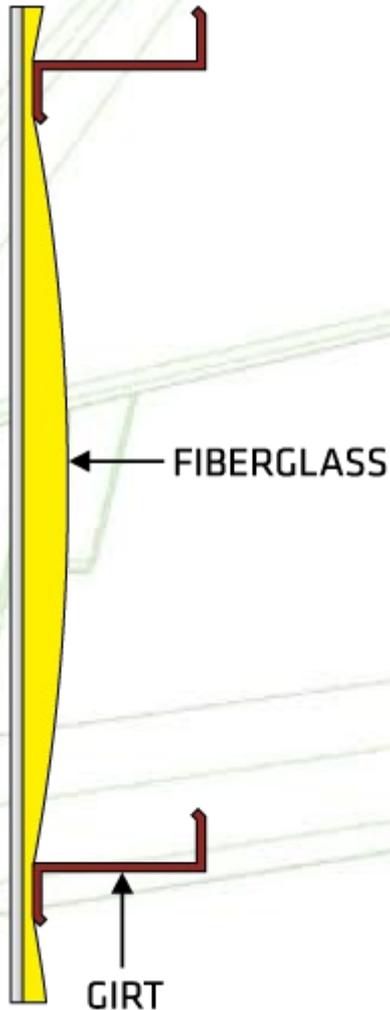
Know Your Production Rates: Man Hour per Square Foot

“R19 Wall”

Single Layer
Compressed
Fiberglass

U-0.147
R-6.8

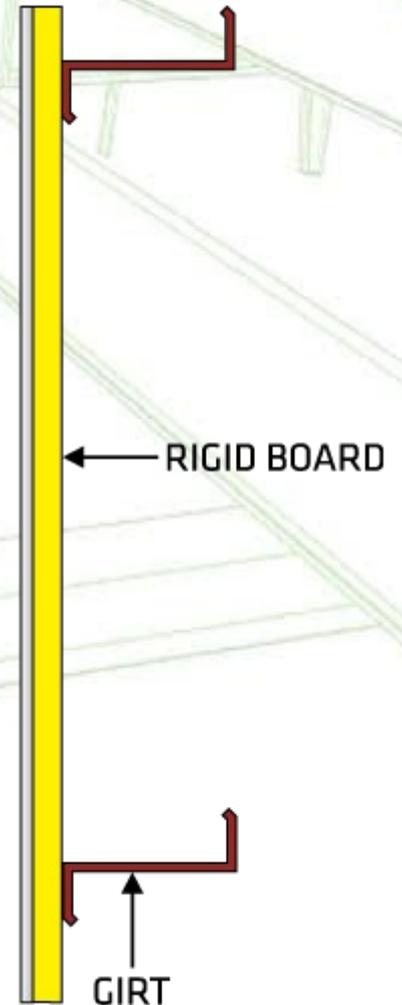
First rated R-value of insulation is for insulation compressed behind the metal wall panels and steel structure.



U-0.050
R-20

Continuous insulation is installed on the outside or inside the girts, uncompressed and uninterrupted by the framing members

Continuous
Insulation (ci)



All insulation shall be continuously sealed to provide a continuous air barrier.

Metal Building Wall: Continuous Insulation (ci)

CONTINUOUS INSULATION (ci).

Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

(2015 IECC - CHAPTER 2: DEFINITIONS)

A3.2.2.2 Continuous Insulation.

For assemblies with continuous insulation, the continuous insulation is installed on the outside or inside the girts, uncompressed and uninterrupted by the framing members.

(ASHRAE 90.1-2013, Appendix A3.2.2.2)

Metal Building Wall: Continuous Insulation (ci)

2012 IECC, Table C402.2: Opaque Thermal Envelope Requirements

Footnote a (as it relates to prescriptive R-value assemblies)

“Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A”

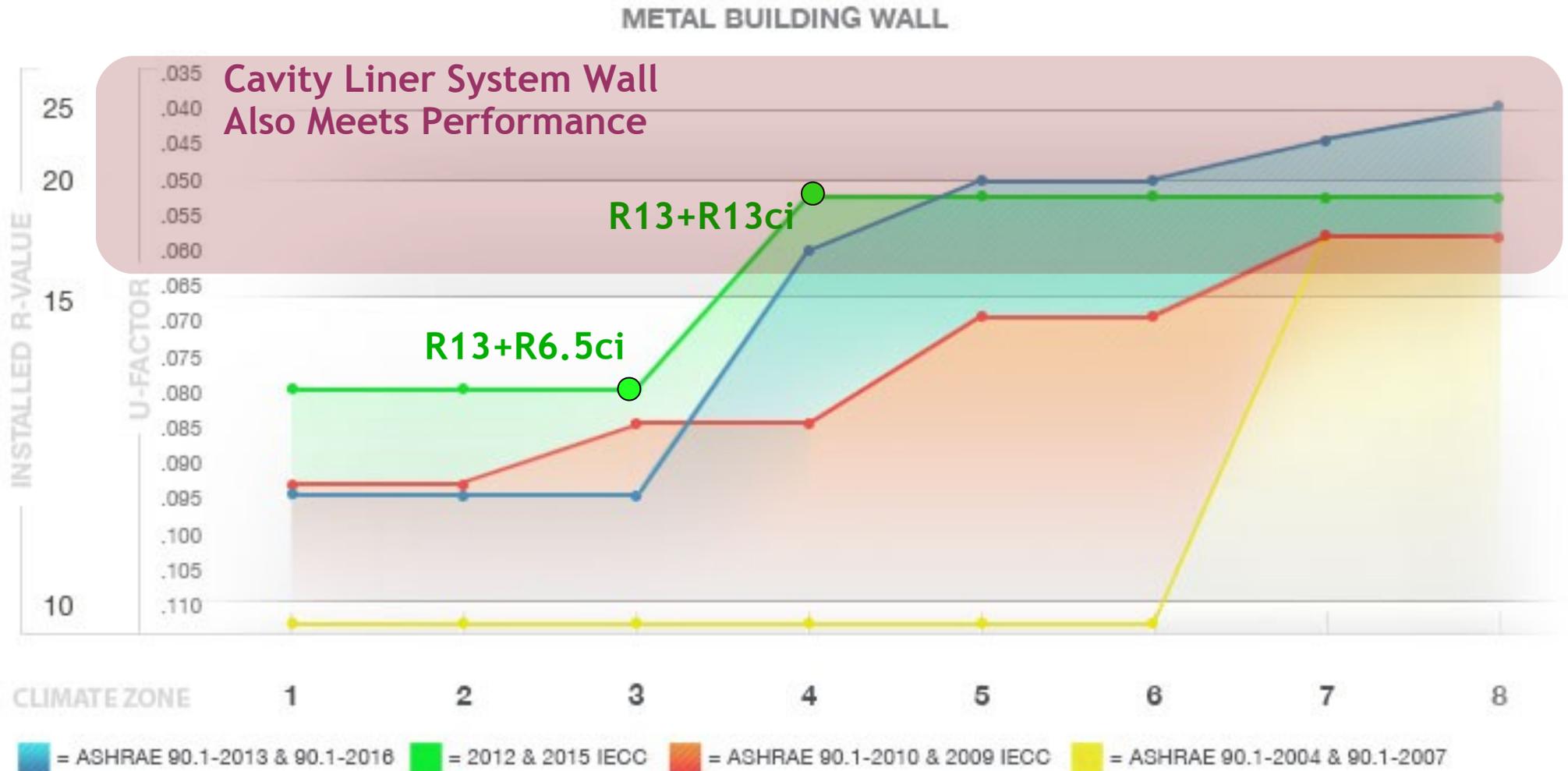
Not Continuous Insulation “ci”:

- * thermal spacer blocks located above purlins
- * compressed insulation
- * liner system and cavity walls

(as typically installed)

Wall Stringency per Code/Standard

-prescriptive requirements by climate zone (U-factor)



Metal Building Wall Prescriptive R-value Assemblies

National Model Energy Code	Climate Zone							
	1	2	3	4	5	6	7	8
* 2018 IECC	■	■	■	■	■	■	■	■
* 90.1 - 2016	■	■	■	■	■	■	■	■
* 2015 IECC	■	■	■	■	■	■	■	■
* 90.1 - 2013	■	■	■	■	■	■	■	■
* 2012 IECC	■	■	■	■	■	■	■	■
* 90.1 - 2010	□	□	□	□	■	■	■	■
* 2009 IECC	□	□	□	□	■	■	■	■
90.1 - 2007	□	□	□	□	□	□	□	□

* *Air Barrier Requirements*

■ Only ci
'continuous insulation'

■ FG+ci
'Hybrid'

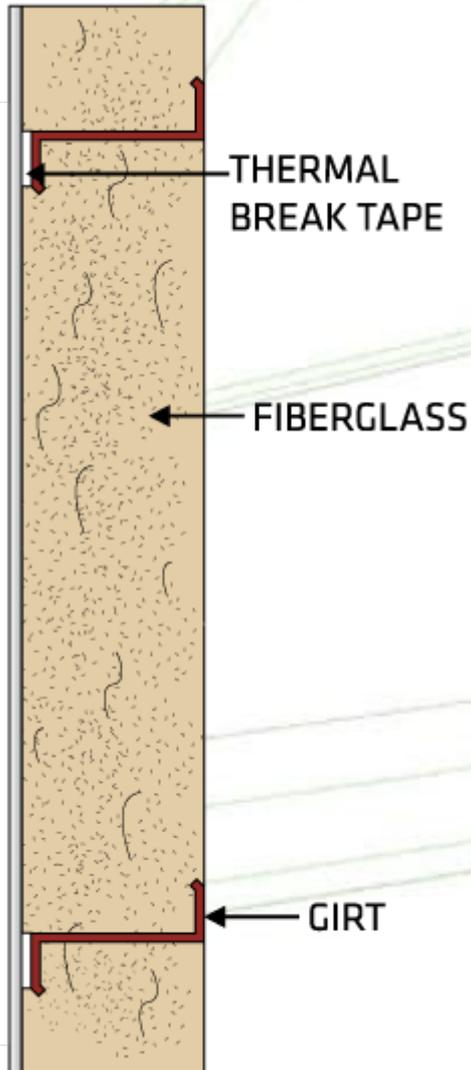
“Cavity Wall”

Single Layer

R30
U-0.052
R-19.2

R25+R10
U-0.047
R-21.2

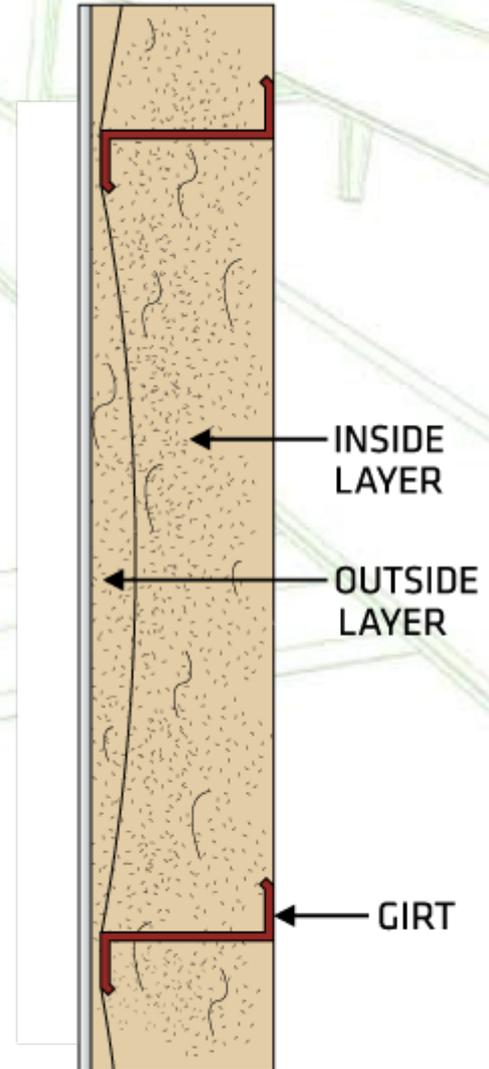
Double Layer



First rated R-value is the insulation is installed in the cavity between the girts, not compressed by the framing.

Second rated R-value is the insulation compressed between the metal wall panels and the steel structure.

A membrane or facing installed separately or adhered to the insulation is installed inside of the girts to form a continuous layer.



“Cavity Wall” - 90.1-2016

Table A3.2.3 Assembly *U*-Factors for Metal Building Walls

Insulation System	Rated <i>R</i> -Value of Insulation	Overall <i>U</i> -Factor for Entire Base Wall Assembly	Overall <i>U</i> -Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing)								
			R-6.5	R-9.8	R-13	R-15.8	R-19	R-22.1	R-25	R-32	R-38
Continuous insulation only	R-0	1.180	0.136	0.094	0.072	0.060	0.050	0.044	0.039	0.030	0.026
Single compressed layer	R-10	0.186	0.084	0.066	0.054	0.047	0.041	0.036	0.033	0.027	0.023
	R-11	0.185	0.084	0.066	0.054	0.047	0.041	0.036	0.033	0.027	0.023
	R-13	0.162	0.079	0.063	0.052	0.046	0.040	0.035	0.032	0.026	0.023
	R-16	0.155	0.077	0.062	0.051	0.045	0.039	0.035	0.032	0.026	0.022
	R-19	0.147	0.075	0.060	0.050	0.044	0.039	0.035	0.031	0.026	0.022
Single layer in cavity	R-25 ^a	0.059	0.044	0.039	0.035	0.032	0.029	0.027	0.025	0.021	0.019
	R-30 ^b	0.052	0.042	0.037	0.033	0.031	0.028	0.026	0.024	0.021	0.019
Double layer	R-25 + R-10	0.047									
	R-25 + R-16	0.042									
	R-25 + R-10 ^c	0.039									
	R-30 + R-16	0.039									

(Multiple *R*-values are listed in order from inside to outside.)

a. A minimum R-0.375 thermal spacer block or thermal break strip is required when installed without *continuous insulation*.

b. A minimum R-0.75 thermal spacer block or thermal break strip is required when installed without *continuous insulation*.

c. A minimum R-3 thermal spacer block is required.

U-factor Alternative Compliance

C402.1.4 Assembly U-factor, C-factor or F-factor-based method. Building thermal envelope opaque assemblies intended to comply on an assembly U-, C- or F-factor basis shall have a U-, C- or F-factor not greater than that specified in Table C402.1.4.

Footnote a: Use of Opaque assembly U-factors from ANSI/ASHRAE/IESNA 90.1 Appendix A shall be permitted, provided the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A.

Footnote b: Opaque assembly U-factors based on designs tested in accordance with ASTM C1363 shall be permitted.

energycode.pnl.gov says: ×

The 'Other' option is for assemblies with a known assembly U-factor. Enter an overall assembly U-factor for the assembly in the U-factor field. The U-factor is assumed consistent throughout the entire assembly.

Documentation must be submitted verifying the overall assembly U-factor. The U-factor must be developed in accordance with accepted engineering practice.

OK

COMcheck screenshot



COMcheck logo courtesy of DOE

COMcheck Compliance


2015 IECC

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PROJECT ENVELOPE INT. LIGHTING EXT. LIGHTING MECHANICAL REQUIREMENTS

Code/Location

Code:
State:
City:
If your location is not included here, choose a nearby location with similar weather conditions.

Project Type

New Construction Addition Alterations

Compliance Options

Efficiency:

Project Details (optional)

This information will appear on the compliance report.

Notes:

Building Envelope Area Types

	Building Area	Area Description	Space Conditioning	Area	W/ft ²
1	Warehouse		Nonresidential	30000 ft ²	0.66

← To display compliance results, click the **Check Compliance** button.

COMcheck Compliance



PROJECT
ENVELOPE
INT. LIGHTING
EXT. LIGHTING
MECHANICAL
REQUIREMENTS

Row:

Add:

[Fenestration Requirements](#)

	Component	Assembly	Orientation	Building Area Type	Fenestration Details	Construction Details	Gross Area or Slab Perimeter	Cavity Insulation R-Value	Continuous Insulation R-Value	U-Factor
1	Roof	Metal Building, Standing Seam: High Albed...		1 - Warehouse (Nonresid...		Unspecified	30000 ft ²	30	0	0
2	Ext. Wall	Metal Building Wall	Unspecified	1 - Warehouse (Nonresid...		Single Layer Mineral	5000 ft ²	0	0	1.18
3	Door	Insulated Metal				Swinging	63 ft ²			0
4	Window	Metal Frame with Thermal Break: Fixed			Code default	Glazing: Double Pane, Ti...	0 ft ²			0.65
5	Ext. Wall	Other Metal Building Wall	Unspecified	1 - Warehouse (Nonresid...			5000 ft ²			0
6	Ext. Wall	Other Metal Building Wall	Unspecified	1 - Warehouse (Nonresid...			5000 ft ²			0
7	Ext. Wall	Metal Building Wall	Unspecified	1 - Warehouse (Nonresid...		Single Layer Mineral	5000 ft ²	0	0	1.18
8	Door	Uninsulated Double-Layer Metal								
9	Floor	Unheated Slab-On-Grade		1 - Warehouse (Nonresid...						

Create Roof

- Insulation Entirely Above Deck
- Metal Building, Standing Seam
- Metal Building, Screw Down
- Attic Roof, Wood Joists
- Attic Roof, Steel Joists
- Other (U-Factor option)

or

Create Ext. Wall

- Wood-Framed, 16in. o.c.
- Wood-Framed, 24in. o.c.
- Steel-Framed, 16in. o.c.
- Steel-Framed, 24in. o.c.
- Metal Building Wall
- Solid Concrete Wall
- Concrete Block Thickness:
- Other (U-Factor option)

or

COMcheck Inspection Checklist

Envelope PASSES: Design 0.4% better than code

Envelope Compliance Statement

Compliance Statement: The proposed envelope design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed envelope systems have been designed to meet the 2015 IECC requirements in COMcheck Version 4.3.5.1 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

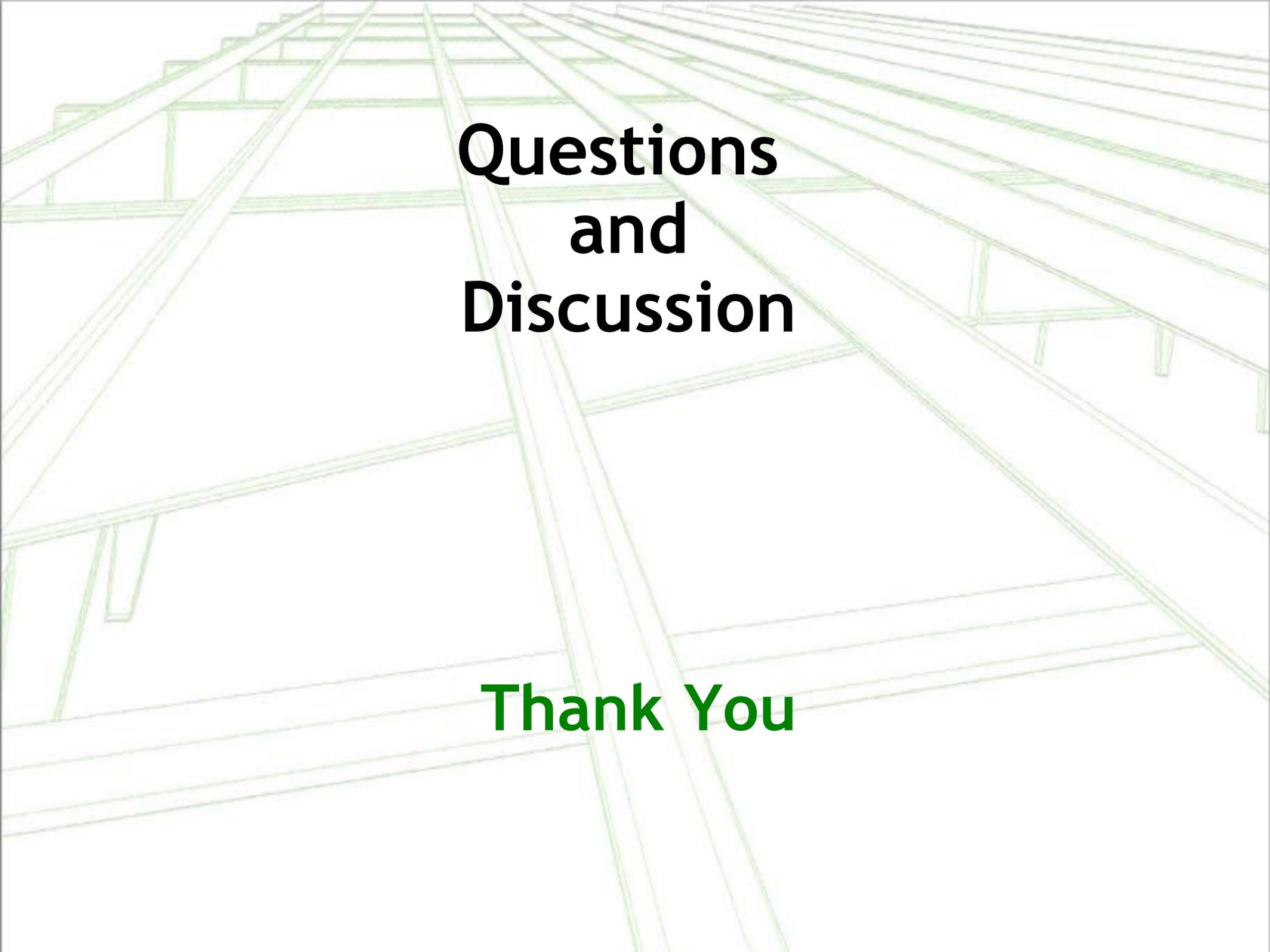
Name - Title _____ Signature _____ Date _____

Section # & Req.ID	Plan Review	Complies?
C103.2 [PR1] ¹	Plans and/or specifications provide all information with which compliance can be determined for the building envelope and document where exceptions to the standard are claimed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable

C402.5.1.2.1 [FR19] ¹	The building envelope contains a continuous air barrier that is sealed in an approved manner and material permeability ≤ 0.004 dfm/ft ² . Air barrier penetrations are sealed in an approved manner.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable
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C303.1 [IN3] ¹	Roof insulation installed per manufacturer's instructions. Blown or poured loose-fill insulation is installed only where the roof slope is ≤ 3 in 12.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable
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C303.2 [IN7] ¹	Above-grade wall insulation installed per manufacturer's instructions.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable
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Questions and Discussion

Thank You