

Energy Code Compliance for Metal Buildings

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U.S. Department of Energy Building Energy Codes Program
Energy Codes Commentator Webinar Series
AIA Provider #: I014 AIA Course #: BECPWS0118
ICC Provider
January 11, 2018



This webinar, which is part of DOE's Building Energy Codes Program *Energy Codes Commentator* webinar-based training series, will provide an introduction into metal building types and systems and how they are defined in the national energy codes and standards. The presentation will focus on metal building envelope assemblies and applications (e.g., roofs, exterior walls, fenestration, air barriers, and air leakage). Learn about how the energy code affects various aspects of metal building envelopes and various code compliance options. A demo of DOE's energy code compliance software will be shown focusing on how the different metal building assemblies are defined and calculated for code compliance.

Learning Objectives

1. Learn how the building energy code defines a metal building.
2. Understand the differences between unconditioned, conditioned, and semi-heated spaces.
3. Be able to look up assembly U-Factors for metal building assemblies.
4. Learn how to show compliance using *COMcheck*.

Energy Code Compliance for Metal Building Systems



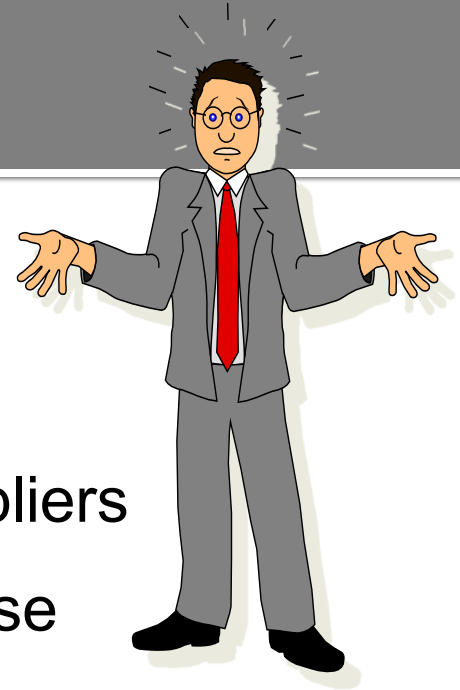
Dan Walker, P.E.
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Energy Code Compliance for Metal Building Systems

- Part 1 – Introduction & Metal Building System Primer
- Part 2 – Prescriptive Compliance - Insulation
- Part 3 – *COMcheck*

Who is MBMA?

- Founded in 1956 – Cleveland Based
- 13 Charter Member Companies
- Today – 43 Member Companies & 71 Suppliers
- Metal building systems ~45% of new low rise non-residential construction (*MBMA stats*)
- Roughly 9,000 contractors affiliated with member companies and ~ 28,000 projects / YR



Metal Building System (MBS) - Defined

- **Not** Pre-Fabricated Modular Buildings, nor are they Pre-Engineered.
- Metal Building Systems are designed using the systems approach, in which standard components are used to fit customized applications. Each building system is **custom engineered** to meet customer needs and for the particular application.

Metal Building Envelope

- **Primary Framing**

- Often Tapered
Columns & Beams

- **Secondary Framing**

- Purlins & Girts
- Open Joists

- **Metal Cladding**

- Roof & Wall Sheeting

- **Bracing**

- Lateral & Stability

- **Connections**

- Screws & Bolts

- **Additional Items**

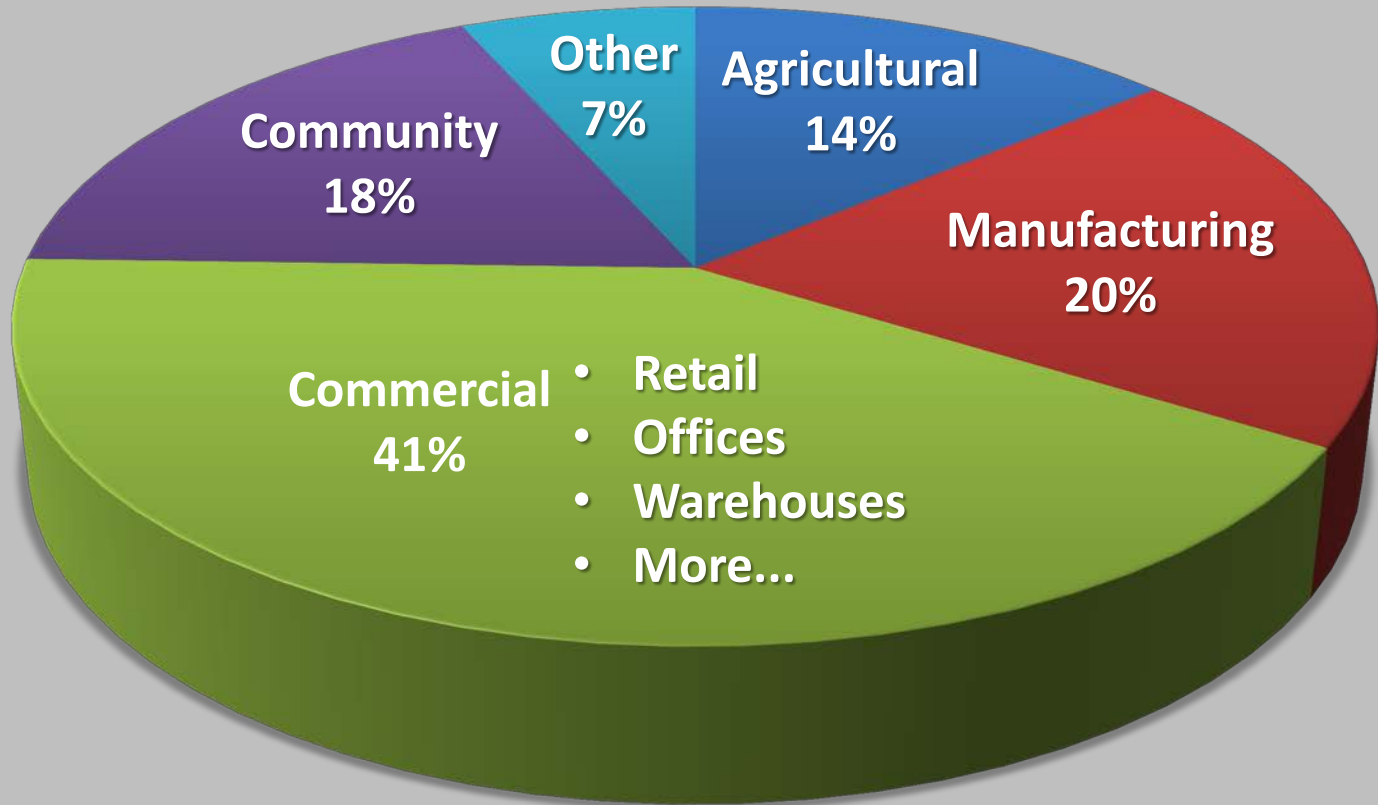
- Insulation
- Windows, Doors,
Skylights



Energy Codes

- Differentiate by
 - Building type
 - Climate zone
 - Building construction

Metal Buildings by Building Type



Building Types



Manufacturing / Distribution



Agricultural



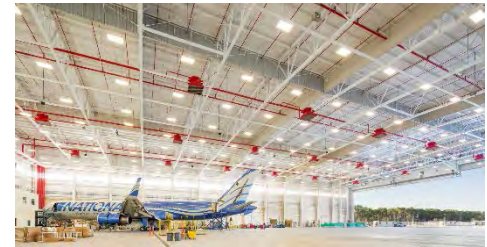
Recreational Facilities



K-12 Schools



Fire Stations



Aircraft Hangars

Building Types



Community Centers



Office / Warehouse



Retail



Religious

Energy Code defines a Metal Building

- Metal Roof & Metal Wall Panels
- Purlins (roof) spaced nominally 5 feet
- Girts (wall) average 52 inch spacing
- Metal building insulation further defined



Primary Focus Areas

Building Envelope

Mechanical Systems

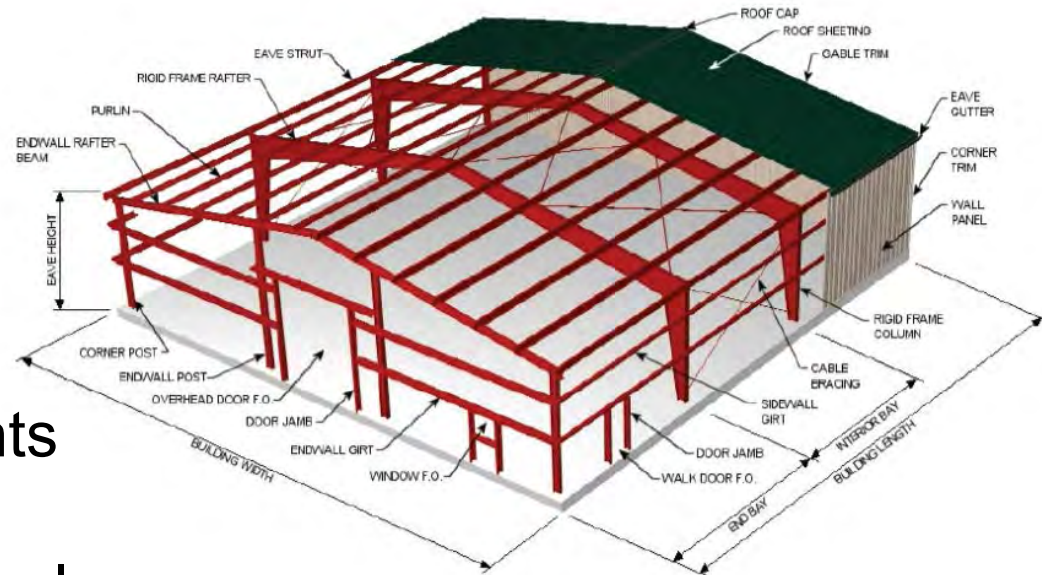
**IECC &
ASHRAE 90.1**

**Service Water
Heating**

**Power & Lighting
Systems**

Building Envelope – Focus Areas

- Insulation
 - Roof
 - Walls, above/below grade
 - Walls, below grade
 - Floors, Slab-on-grade
- Cool Roofs
- Windows, Doors, Skylights
- Air Barrier, Air Leakage
- Loading Dock Weatherseals
- Vestibules

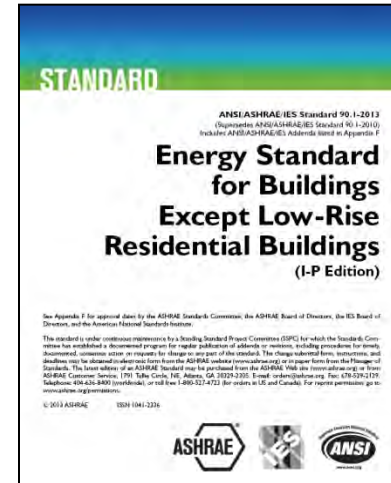
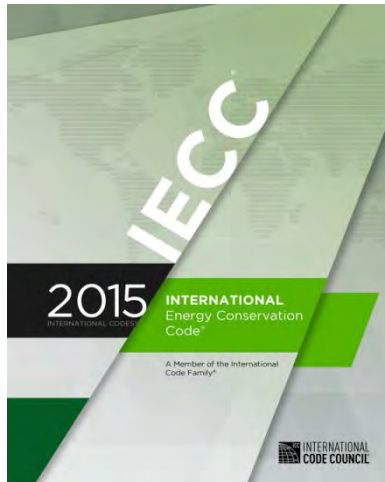


IECC and 90.1

- IECC points to ASHRAE 90.1 to define all building envelope construction types
- IECC references 90.1 on a number of occasions
- In fact, 90.1 is the first choice offered

IECC vs 90.1 – One of the Differences

- Fully Insulated despite level of heating or cooling
- Separate requirements for semi-heated space definition



Space Conditioning Needs



Agriculture



Health Care



Religious



Aircraft Hangar



Restaurant



Office/Warehouse

Space Conditioning Types

- **International Energy Conservation Code (IECC)**
 - Low Energy Buildings – Exempt from building thermal envelope provisions if peak design rate of energy usage $< 3.4 \text{ Btu/hr/ft}^2$
 - Conditioned Space – Area or room within a building being heated or cooled...or $\geq 3.4 \text{ Btu/hr/ft}^2$

Space Conditioning Types

- **ASHRAE 90.1**
 - Semi-Heated Space – Space that is heated, but not to comfort levels, and is not cooled
 - Conditioned Space – a cooled space, a heated space, or an indirectly conditioned space
 - 90.1 has a table for heating output by climate zone
 - Unconditioned Buildings – Exempt from envelope provisions if peak design rate of energy usage $< 3.4 \text{ Btu/hr/ft}^2$

Compliance Methods

Prescriptive

- Specific requirements for insulation, fenestration, air leakage
- R-value method
U-factor method
- Easiest, but limiting

Trade-Off

- UA Trade-off
- COMcheck software
- U-factor substitution
- Building envelope
- Easy to comply

Performance

- Whole building energy modeling
- Envelope, Mechanical, Lighting, ...
- More complicated

Air Leakage Provisions

2015 IECC

- Whole building testing at <0.40 cfm/ft² or the following:
- Air barrier sealing & placement and comply w/
 - Materials with air permeance ≤ 0.004 cfm/ft² or
 - Assemblies with air permeance 0.04 cfm/ft²

ASHRAE 90.1-2013

- Air barrier sealing & placement and comply w/
 - Materials with air permeance ≤ 0.004 cfm/ft² or
 - Assemblies with air permeance 0.04 cfm/ft²

Air Barrier - Requirements

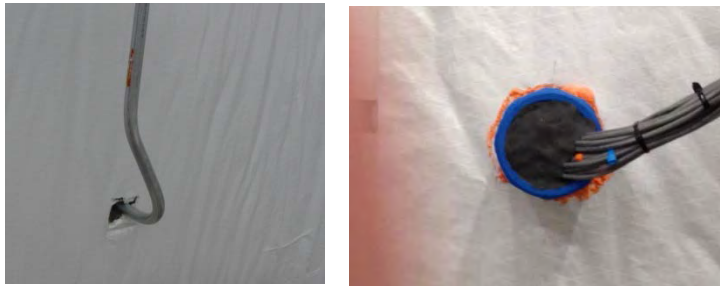
- All seams, penetrations, and transitions between materials to be sealed
- Continuous and resist positive & negative pressures
- Can be placed inside or outside of building envelope

- 2015 IECC exempts CZ 2B
- 90.1-2013 exempts
 - Single wythe concrete masonry buildings in CZ 2B
 - Semiheated Spaces in CZ 1 through CZ 6

Application to MBS



Rips or Tears



Penetrations Sealed



Insulation Seams



Interface of:
Wall to Floor
Wall to Wall
Wall to Roof

Materials – Compliance Option

Similar list in ASHRAE 90.1-2013

- ≤ 0.004 cfm/ft² under 75 Pa tested per ASTM E 2178 or use the deemed to comply list

| | |
|--|---|
| Plywood $\geq 3/8$ " | Built-up roofing membrane |
| OSB $\geq 3/8$ " | Modified bituminous roof membrane |
| Extruded polystyrene insulation board $\geq 1/2$ " | Fully adhered single-ply roof membrane |
| Foil-faced urethane insulation board $\geq 1/2$ " | Portland cement/sand parge, stucco, or gypsum plaster |
| Closed cell spray foam min. density 1.5 pcf $\geq 1-1/2$ " | Cast-in-place and precast concrete |
| Open cell spray foam density btwn 0.4 & 1.5 pcf $\geq 4-1/2$ " | Fully grouted concrete block masonry |
| Gypsum board $\geq 1/2$ " | Sheet steel or aluminum |
| Cement board $\geq 1/2$ " | Solid or hollow masonry of clay or shale |

Materials – MBS Application

- Sheet Steel meets 0.004 cfm/ft² air permeability, per the deemed to comply list.



Assemblies – Compliance Options

≤ 0.04 cfm/ft² under 75 Pa tested per

ASTM
E 2357

- Air Leakage of Air Barrier Assemblies

ASTM
E 1677

- Air Barrier Material or System for Low-Rise Framed Building Walls

ASTM
E 1680

- Air Leakage through Exterior Metal Roof Panel Systems

ASTM
E 283

- Air Leakage through exterior windows, curtain walls, and doors

Or use the deemed to comply list for concrete masonry wall systems

Assemblies – MBS Application

- 2011 NAHB Research Center
- Typical MB walls tested to meet ASTM E 283 – 8 Tests
 - Fiberglass, vapor retarder sealed
 - R-13 (0.0164 cfm/sf)
 - R-13 + R-30 Cavity Filled (0.0162 cfm/sf)
 - w/ flange brace hole (0.0198 cfm/sf)



Assemblies – MBS Application

- Typical MB roofs tested to meet ASTM E 1680
 - Standing Seam or Through Fastened Roof
 - Purlins
 - Insulation (may or may not be included)



Whole Building – MBS Application

ORNL/TM-2014/445

ORNL One-Story Flexible Research Platform Test Building Air Leakage Study

- Can exceed U.S. Army Corps of Engineers limits of 0.25 cfm/sf
- ORNL full scale study
 - Pre-Retrofit = 0.26 cfm/sf
 - Post-Retrofit = 0.12 cfm/sf

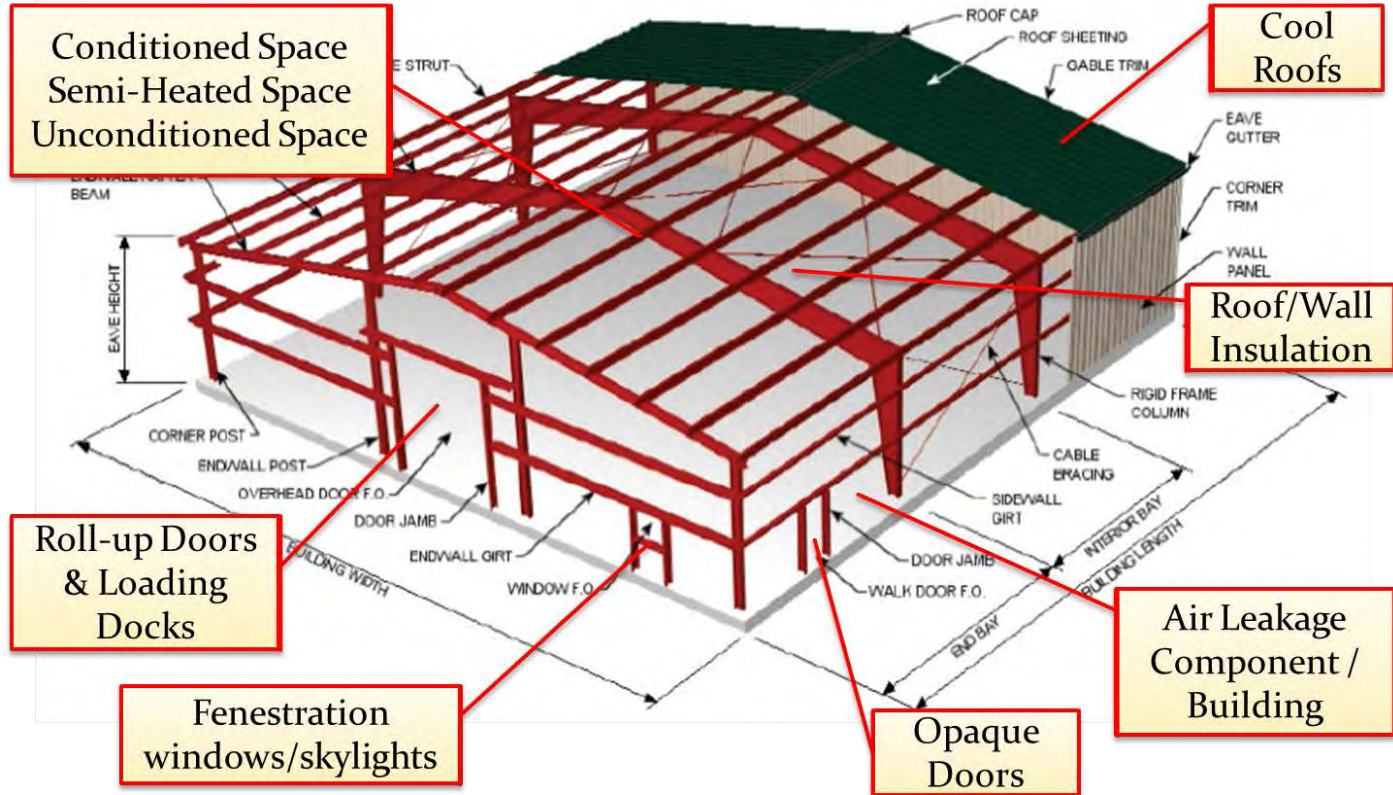


OAK RIDGE NATIONAL LABORATORY
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Part 2

Prescriptive Compliance - Insulation

Energy Codes and a Metal Building



R-value Method

- C402.1.3 Insulation component R-value-based method -
C402.2 and C402.4
- C402.2.2.2 **Roof assembly** –
Table C402.1.3
- C402.2.3 **Above-grade walls** -
Table C402.1.3
- C402.4 **Fenestration** –
C402.4 through C402.4.4 and
Table C402.4
- Daylight controls –
Fenestration sections above and
C405.2.3.1

U-factor Method

- C402.1.4 Assembly U-factor, C-factor, or F-factor-based method –
Table C402.1.4

2015 IECC Table

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

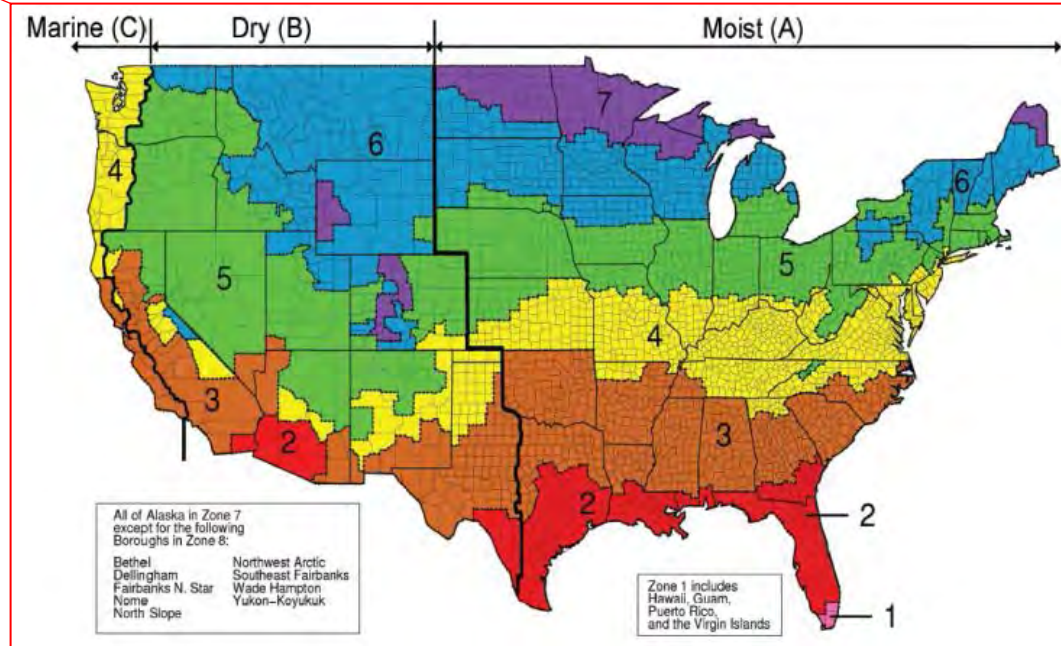
| CLIMATE ZONE | 1 | | 2 | | 3 | | 4 EXCEPT MARINE | | 5 AND MARINE 4 | | 6 | | 7 | | 8 | |
|-------------------------------------|----------------------|----------------------|----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-------------------|--------------------|
| | 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-35ci | R-35ci | R-35ci | R-35ci |
| Metal buildings ^b | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-25 + R-11 LS | R-25 + 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 ^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 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 |

Group R = Commercial Residential Application. Living/Sleeping areas (i.e. dorms, nursing homes, prisons, ...)
All other = Enclosing occupancies other than Group R

| | |
|-------------------------------------|--|
| Insulation entirely above roof deck | Roofs |
| <u>Metal buildings^b</u> | |
| Attic and other | |
| Mass | Walls, above grade |
| <u>Metal building</u> | |
| Metal framed | |
| Wood framed and other | Walls, below grade |
| Below-grade wall ^d | |
| Mass ^e | Floors |
| Joist/framing | |
| Unheated slabs | Slab-on-grade |
| Heated slabs | |
| Nonswinging | Opaque doors (i.e. garage doors, rolling doors) |



For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.

ci = Continuous insulation. NR = No requirement. I.S. = Inner system.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.

b. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.

R-value Method

2015 IECC Table - Roofs

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

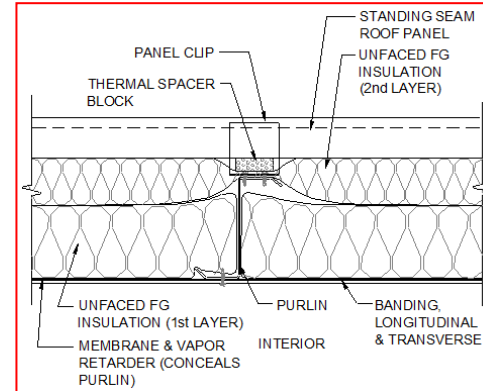
| CLIMATE ZONE | 1 | | 2 | | 3 | | 4 EXCEPT MARINE | | 5 AND MARINE 4 | | 6 | | 7 | | 8 | | |
|------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| | 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 | | | | | | | | | | | | | | | | |
| Metal buildings^b | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-25 + R-11 LS | R-25 + R-11 LS | R-30 + R-11 LS | R-30 + R-11 LS | R-30 + R-11 LS | R-30 + R-11 LS |

Note a - Assembly Descriptions can be found in ASHRAE 90.1 Appendix A under:

- **A2.3 Metal Building Roofs**
- **A2.3.2.4 Liner System (Ls)**

Note b summarized: R-value method requires thermal spacer block.

Thermal spacer blocks are used with Standing Seam Roofs, not Through Fastened Roofs



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

CZ 6 = R-25 + R-11 LS

CZ 7-8 = R-30 + R-11 LS

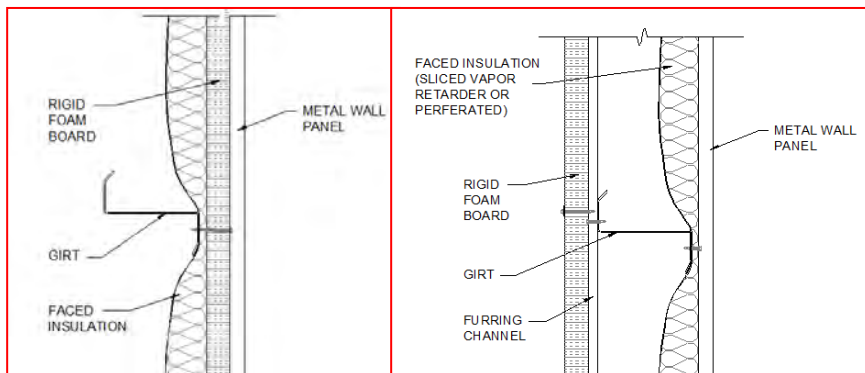
2015 IECC Table – Above-Grade Walls

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 |
| | Walls, above grade | | | | | | | | | | | | | | | |
| 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 |

ci = Continuous Insulation. 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.

**Note a - Assembly Descriptions can found in ASHRAE 90.1 Appendix A
A3.2.2 Rated R-Value of Insulation for Metal Building Walls**



CZ 1-3 = R-13 + R-6.5 ci

CZ 4-8 = R-13 + R-13 ci

ci shown as rigid foam board, other materials may apply.

2015 IECC Table - Roofs

C-34

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 |

a. Use of Opaque assembly *U*-factors, *C*-factors, and *F*-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.

b. Opaque assembly *U*-factors based on designs tested in accordance with ASTM C1363 shall be permitted. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original

Note a – Allows 90.1 Assemblies

Note b – Also allows U-factors by suppliers if validated by testing means

Consider contacting MBMA Building Systems Members and MBMA Associate Members for product specific options.

- Fiberglass
- Continuous Insulation
- Insulated Metal Panels

CZ 1-5: U-0.035
CZ 6: U-0.031
CZ 7-8: U-0.029

Note: Doesn't tell you what type of insulation system to use.

2015 IECC Table – Above-Grade Walls

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 |
| 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 |

- a. Use of Opaque assembly *U*-factors, *C*-factors, and *F*-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.
- b. Opaque assembly *U*-factors based on designs tested in accordance with ASTM C1363 shall be permitted. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original

CZ 1-3: U-0.079
CZ 4-8: U-0.052

Note a – Allows 90.1 Assemblies

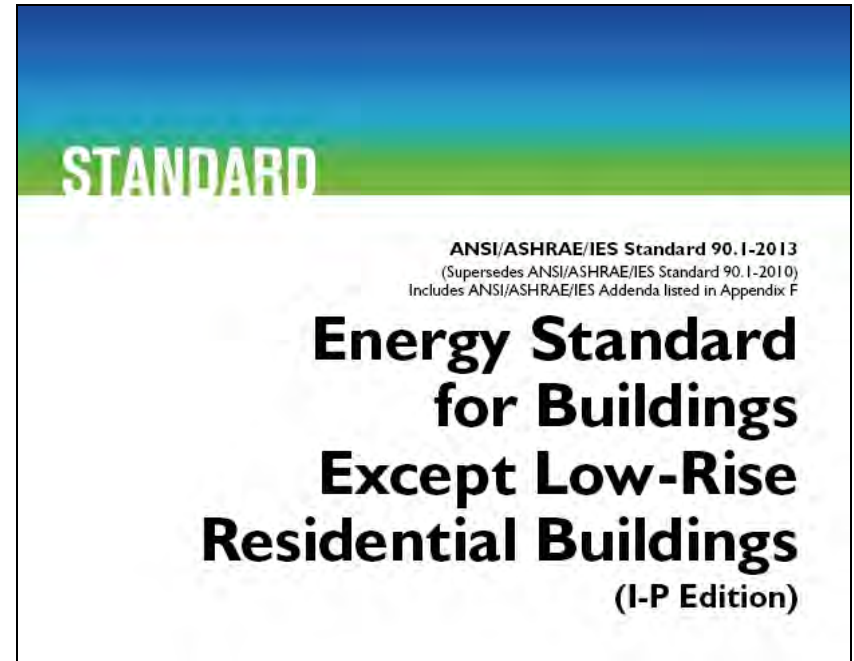
Note b – Also allows U-factors by suppliers if validated by testing means

Consider contacting MBMA Building Systems Members and MBMA Associate Members for product specific options.

- Fiberglass
- Continuous Insulation
- Insulated Metal Panels

From IECC to ASHRAE Standard 90.1

2015 IECC refers to 90.1-2013 as
a compliance option



Requirements based on:

Space Conditioning Type
Climate Zone

Two methods:

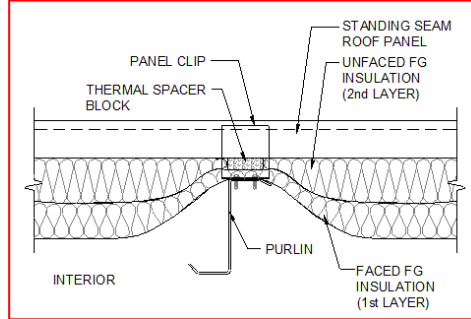
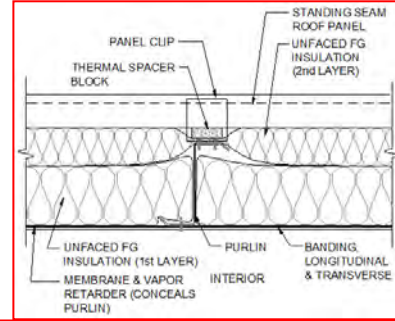
R-value
Method

U-factor
Method

90.1 Table

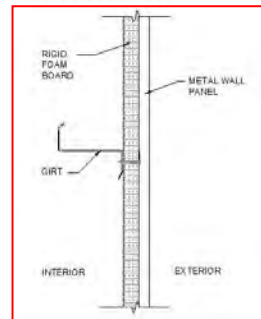
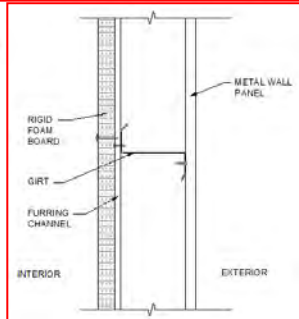
Table 5.5-6 Building Envelope Requirements for Climate Zone 6 (A,B)*

| Opaque Elements | Nonresidential | | Residential | | Semiheated | |
|--------------------------------|------------------|--------------------------------------|------------------|--------------------------------------|----------------------|-------------------------|
| | Assembly Maximum | Insulation Min. R-Value | Assembly Maximum | Insulation Min. R-Value | Assembly Maximum | Insulation Min. R-Value |
| <i>Roofs</i> | | | | | | |
| Insulation Entirely above Deck | U-0.032 | R-30 c.i. | U-0.032 | R-30 c.i. | U-0.063 | R-15 c.i. |
| 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 |
| Attic and Other | U-0.021 | R-49 | U-0.021 | R-49 | U-0.034 | R-30 |
| <i>Walls, above Grade</i> | | | | | | |
| Mass | U-0.080 | R-13.3 c.i. | U-0.071 | R-15.2 c.i. | U-0.151 ^b | R-5.7 c.i. ^b |
| 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. |
| Steel Framed | U-0.049 | R-13 + R-12.5 c.i. | U-0.049 | R-13 + R-12.5 c.i. | U-0.084 | R-13 + R-3.8 c.i. |
| Wood Framed and Other | U-0.051 | R-13 + R-7.5 c.i. or R-19 + R-5 c.i. | U-0.051 | R-13 + R-7.5 c.i. or R-19 + R-5 c.i. | U-0.089 | R-13 |



* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5) Ls = liner system (see Section A2.3.2.4) NR = no (insulation) requirement

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).



R-value Method

U-factor Method

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 | | | | | | | | | |

Options to meet U-factors in CZ 6:
Conditioned: U-0.031
Semi-Heated: U-0.060

- 1 – Cont. Insulation Only
- 2 – Fiberglass Systems + Continuous Insulation
- 3 – Fiberglass Only (Conditioned case)
- 4 – Or...simply use the R-value method for the Roof only



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Part 5

Building Envelope Trade-Off Method

2015 IECC Component Performance Alternative

DOE COMcheck Software Program



COM*check* and Metal
Buildings Demo

Prepared by Pacific Northwest
National Laboratory for the
U.S. Department of Energy

2015 IECC Component Performance Alternative (i.e. Trade-Off Option)

- Section C402.1.5 (New)

Proposed U-, F- and C-factors

COMPARED to

Prescriptive U-, F- and C-factors

- $A + B + C + D + E \leq \text{Zero}$
 - A = Roof & Above Grade Walls, & Fenestration
= UA Dif +/-
 - B = Slab-On-Grade
= FL Dif +/-
 - C = Below Grade Walls
= CA Dif +/-
 - D = Windows above 30% Area
= UA Dif + only
 - E = Skylights above 3% Area
= UA Dif + only

COMcheck Overview

TODAY'S PRESENTATION

- High Level Overview
 - Input Screens
 - Building Envelope Only
 - Overview of Checklists
- Metal Building Application
 - Primary Focus
 - Case Studies

TOPICS NOT COVERED

- Listen to PNNL Webinar
- COMcheck Basics (2016)
- www.energycodes.gov/training
- Detailed Review of
 - Building Envelope, Lighting, & Mechanical Inputs/Outputs
 - Understand Compliance Reports
 - Includes a Metal Building Case Study

- **COMcheck Basics - 120 Minute Webinar**
 - Recorded June 2016, Listen on Demand
- **Alterations using COMcheck – 90 Minute Webinar**
 - Recorded in February 2017, Listen on Demand

COMcheck™ Basics and Compliance Determination

PAM COLE, PACIFIC NORTHWEST NATIONAL LABORATORY
BOB SCHULTZ, PACIFIC NORTHWEST NATIONAL LABORATORY

2016 Department of Energy National Energy Codes Conference
Building Energy Codes Program

Showing Compliance for Additions and Alterations using REScheck and COMcheck

Pam Cole - Pacific Northwest National Laboratory



U.S. Department of Energy Building Energy Codes Program
Energy Codes Commentator Webinar Series

Pacific Northwest
NATIONAL LABORATORY
Privately Operated by BBNBL Since 2002

PNNL-SA-123839



<https://www.energycodes.gov/resource-center/training>

COMcheck

Commercial Compliance Using COMcheck™

The COMcheck software product group makes it easy for architects, builders, designers, and contractors to determine whether new commercial or high-rise residential buildings, additions, and alterations meet the requirements of the IECC and ASHRAE Standard 90.1, as well as several state-specific codes. COMcheck also simplifies compliance for building officials, plan checkers, and inspectors by allowing them to quickly determine if a building project meets the code.

COMcheck Desktop may be downloaded and installed directly to your desktop, while COMcheck-Web™ is accessible directly from the website without having to download and install.

[View a list of supported software versions for code compliance tools](#) .

[See if your state or county can use COMcheck to show compliance](#) .

COMcheck™ for Windows®

Runs on Windows 7/8/10 in either single, multi-user, or network environments.

Note that the Mac version of COMcheck has been discontinued. Mac users are advised to use [COMcheck-Web](#).

Version 4.0.7 (Build Version: 4.0.7.2)

Version 4.0.7 includes support for ASHRAE 90.1-2016. View [Release Notes](#) for additional details.

Supported Codes:

2009, 2012 and 2015 IECC.

ASHRAE Standard 90.1-2007, 2010, 2013, 2016

Various state-developed energy codes.

COMcheck-Web

COMcheck-Web simplifies commercial and high-rise residential energy code compliance. It performs just like the desktop version of COMcheck, but you don't need to download or install any software on your computer.



Popular Links

Tools



Technical Assistance



Status of State Energy Codes



Select a state

COMcheck – Allows all different roof and wall types...including hybrid construction



Agriculture



Health Care



Religious

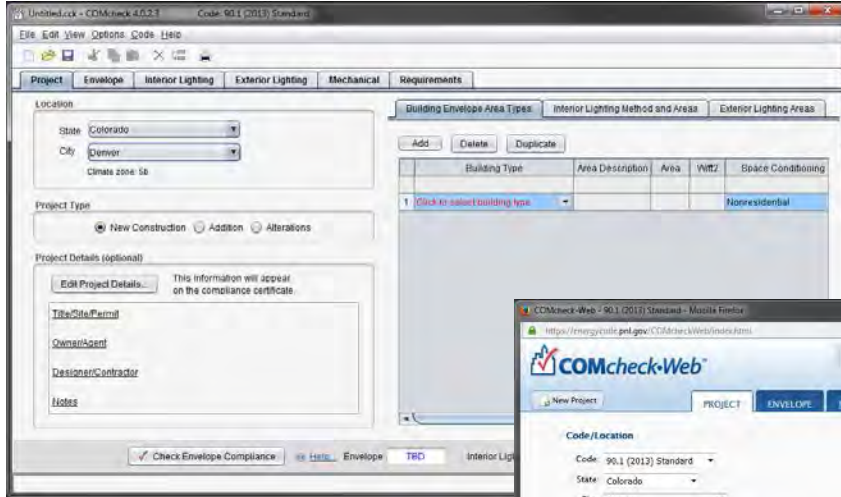


Restaurant



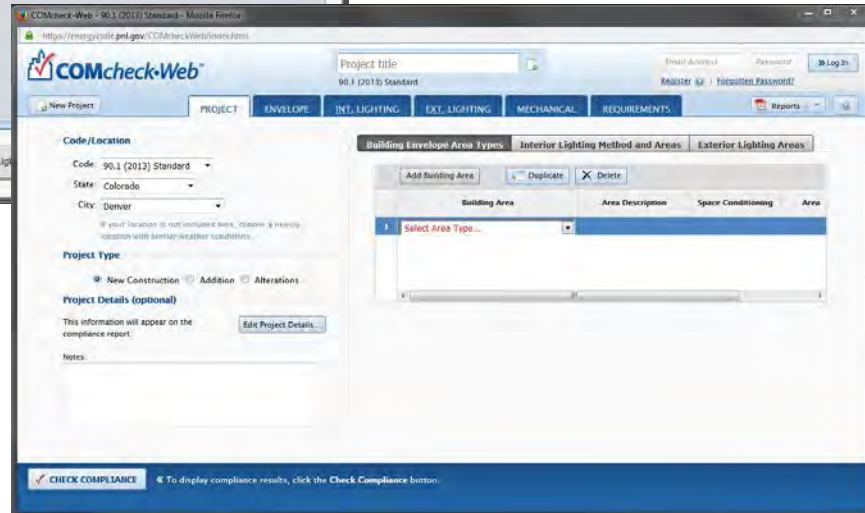
Office/Warehouse

COMcheck



“DESKTOP”

WEB



Resources



Energy Design Guide for Metal Building Systems

Second Edition



Energy Design Guide for Metal Building Systems (Jan. 2017)

200+ Pages

- Ch. 1 – Introduction
- Ch. 2 – MBS & Applications
- Ch. 3 – Energy Code Fundamentals
- Ch. 4 – Energy Codes & Standards
- Ch. 5 – Compliance Tools
- Ch. 6 – Insulating MBS
- Ch. 7 – Cool Roofs
- Ch. 8 – Daylighting
- Ch. 9 – Green Building
- Ch. 10 – Advanced Energy Codes
- Appendix A – PV Roof Panels
- Appendix B – Daylighting Design

Energycodes.gov Resource Center

- Compliance software
- Compliance checklists
- Technical support
- Code notes
- Publications
- Resource guides
- Training materials



U.S. DEPARTMENT OF ENERGY Energy Efficiency & Renewable Energy
BUILDING TECHNOLOGIES PROGRAM

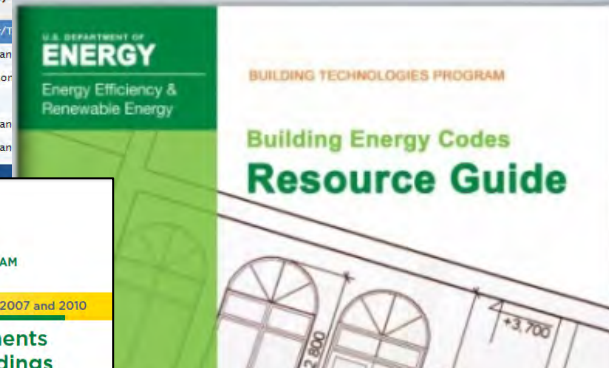
2009 and 2012 IECC; ASHRAE 90.1-2007 and 2010

Vestibule Requirements in Commercial Buildings

The intent of the vestibule requirement is to reduce infiltration of air into a space, thereby addressing energy conservation and comfort issues for occupants located near primary entrance doors. The majority of infiltration comes through primary entrance doors that are typically used to access public areas, and have higher usage rates than doors classified for personnel use. Vestibules can reduce the infiltration losses (or gains) from wind and stack effects by creating an air lock entry.

Commercial building designers are required to install vestibules on primary entrance doors leading to and from spaces greater than or equal to 3,000 square feet (298 m²), with some exceptions. Many designers are unclear on what is included in determining the 3,000 ft² that defines a space. For example, if an entrance door leading from a lobby is attached to a corridor with a combined total area of 3,000 ft², must the door meet the vestibule requirement? Similarly, which doors must have vestibules when several doors leave a space greater than or equal to 3,000 ft²?

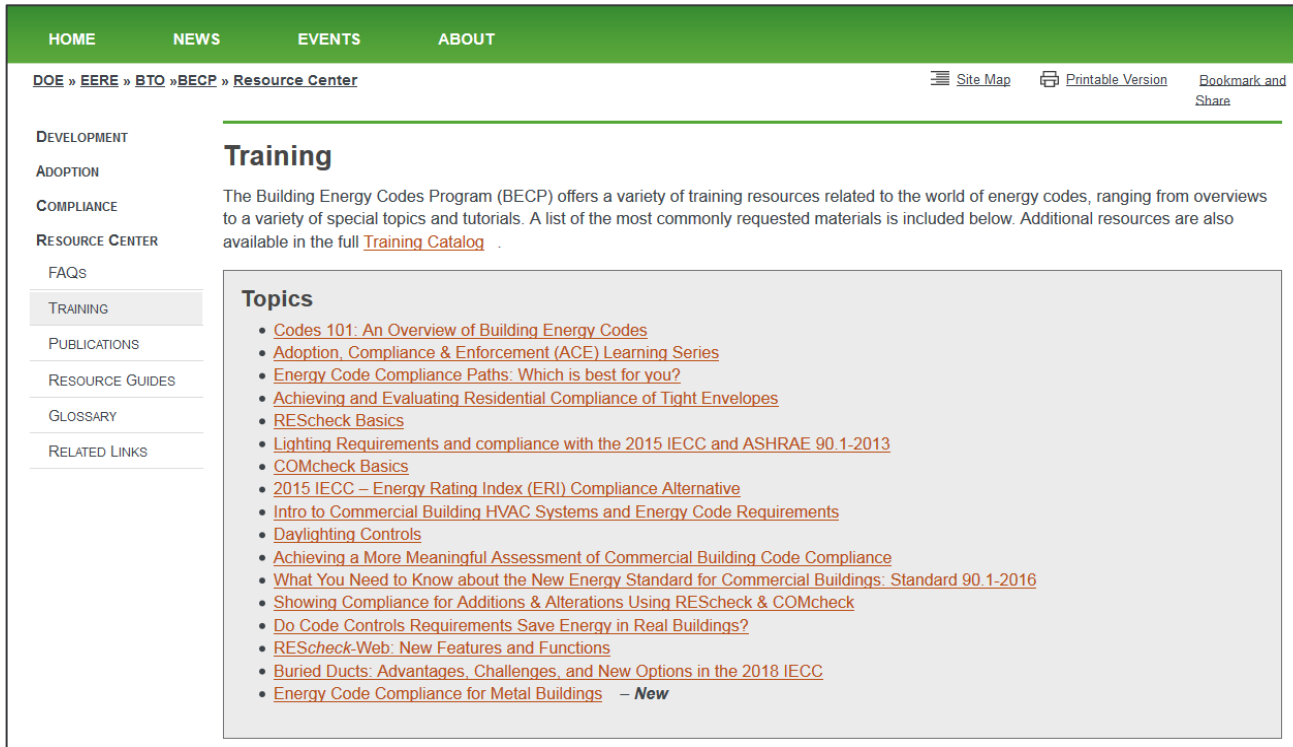
Figure 1. from the entrance door are included when



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Training

The Building Energy Codes Program (BECP) offers a variety of training resources related to the world of energy codes, ranging from overviews to a variety of special topics and tutorials. A list of the most commonly requested materials is included below. Additional resources are also available in the full [Training Catalog](#).

Topics

- [Codes 101: An Overview of Building Energy Codes](#)
- [Adoption, Compliance & Enforcement \(ACE\) Learning Series](#)
- [Energy Code Compliance Paths: Which is best for you?](#)
- [Achieving and Evaluating Residential Compliance of Tight Envelopes](#)
- [REScheck Basics](#)
- [Lighting Requirements and compliance with the 2015 IECC and ASHRAE 90.1-2013](#)
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- [2015 IECC – Energy Rating Index \(ERI\) Compliance Alternative](#)
- [Intro to Commercial Building HVAC Systems and Energy Code Requirements](#)
- [Daylighting Controls](#)
- [Achieving a More Meaningful Assessment of Commercial Building Code Compliance](#)
- [What You Need to Know about the New Energy Standard for Commercial Buildings: Standard 90.1-2016](#)
- [Showing Compliance for Additions & Alterations Using REScheck & COMcheck](#)
- [Do Code Controls Requirements Save Energy in Real Buildings?](#)
- [REScheck-Web: New Features and Functions](#)
- [Buried Ducts: Advantages, Challenges, and New Options in the 2018 IECC](#)
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