BUILDING ENERGY CODES PROGRAM

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

# 2015 IECC Commercial Scope and Envelope Requirements

PNNL-SA-105484

# Why Care About IECC?



- Energy codes and standards set minimum efficiency requirements for new and renovated buildings, assuring reductions in energy use and emissions over the life of the building. Energy codes are a subset of building codes, which establish baseline requirements and govern building construction.

- Code buildings are more comfortable and cost-effective to operate, assuring energy, economic and environmental benefits.

# Structure of the 2015 IECC




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


Ch. 1 Scope and Application / Administrative and Enforcement
Ch. 2 Definitions
Ch. 3 General Requirements
Ch. 4 Residential Energy Efficiency
Ch. 5 Existing Buildings - NEW
Ch. 6 Referenced Standards
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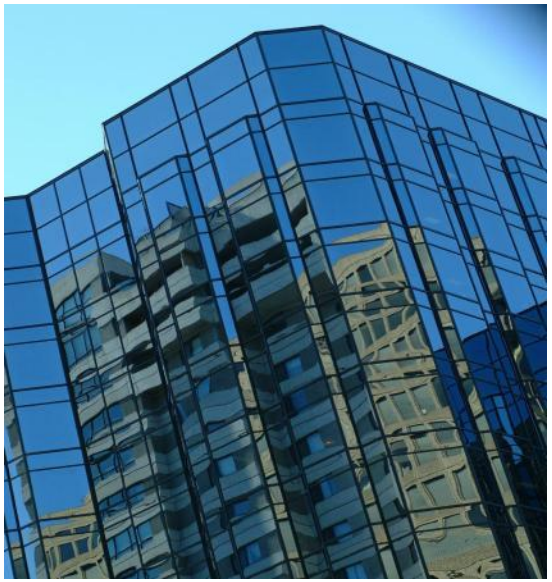
# Does My Project Need to Comply with the Commercial Provisions in the IECC?

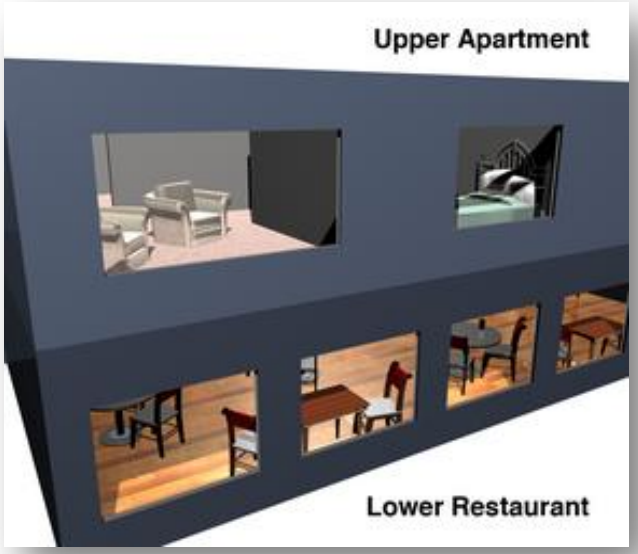


All Buildings Other Than:

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



- ✓ Treat the residential occupancy under the applicable residential code
- ✓ Treat the commercial occupancy under the commercial code
- ✓ Code Official has final authority
  - Compliance materials, Software, worksheets

# Scope

## *Section C102.1 –* Alternative Materials, Design, and Methods of Construction and Equipment



- The code is not intended to prevent installation of any material or prohibit design of construction that is not specifically prescribed in this code
- Such material, equipment, or design shall be approved by the code official

# Scope/Construction Documents
## *Section C103*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- ✓ Documentation shall be prepared by a registered design professional
- ✓ Electronic media can be used
- ✓ Information required:
  - ✓ Insulation materials and R-values
  - ✓ Fenestration U-factors, SHGC
  - ✓ Area-weighted U-factor and SHGC calculations
  - ✓ Mechanical system design criteria
  - ✓ Mechanical, SWH, equipment types, sizes, and efficiencies
  - ✓ Economizer description
  - ✓ Equipment and system controls
  - ✓ Duct sealing, duct and pipe insulation and location
  - ✓ Lighting fixture schedule with wattage and control narrative
  - ✓ Location of daylight zones
  - ✓ Air sealing details


**The building thermal envelope shall be represented on the construction drawings.**

# Scope
## *Section C104-C109*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- ✓ Inspections, C104
  - Successive and final inspections, and reinspections if necessary
- ✓ Code Validity, C105
  - Code deemed to be illegal or void shall not affect the remainder of the code
- ✓ Codes and standards, C106
  - Provisions take precedence and considered part of the requirements of the code
- ✓ Fees, C107
  - Must be paid before permit is issued
  - Required in accordance with schedule
- ✓ Stop Work Order, C108
  - ✓ Authority of code official
  - ✓ Failure to comply
- ✓ Board of Appeals, C109

- Construction work for which a permit is required is subject to inspection by code official or designated agent
- Required inspections include:
  - Footing and foundation
  - Framing and rough-in
  - Plumbing rough-in
  - Mechanical rough-in
  - Electrical rough-in
  - Final

# Referenced Codes and Standards

## *Section C106.1*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Codes and standards listed in Chapter 6 are considered part of the requirements of this code to the "prescribed extent of each such reference and as further regulated in Sections C106.1.1 and C106.1.2"

- Conflicts, C106.1.1 – where differences occur between this code and the referenced codes and standards, provisions of this code apply
- Provisions in reference codes and standards, C106.1.2 – "where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard"

Buildings or portions of buildings that are separated from remainder of building by building thermal envelope assemblies complying with C402 **are exempt** from the Envelope provisions if:

- Peak design rate of energy < 3.4 Btu/h/ft$^2$ or 1.0 watt/ft$^2$ of floor area for space conditioning purposes, **OR**
- Those portions or building that do not contain conditioned space, **OR**
- Greenhouses

# Equipment Buildings

## *Section C402.1.2*



Buildings that comply with the following are exempt from the building thermal envelope provisions:

- Separate building with floor area < 500 $ft^2$ (50 $m^2$)
- Intended to house electronic equipment with installed equipment power totaling > 7 watts/$ft^2$ (75W/$m^2$)
- Heating system capacity < 17,000 Btu/hr (5 kW) and a heating thermostat set point that is restricted to < 50ºF
- Average wall and roof U-factor < 0.200 in Climate Zones 1-5 and < 0.120 in Climate Zones 6-8
- Comply with the roof solar reflectance and thermal emittance provisions for Climate Zone 1

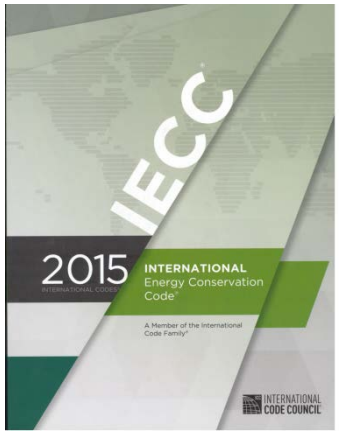
# Commercial Compliance Options

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

**1**

- ASHRAE 90.1-2013

OR




**2** 2015 IECC - Prescriptive

- C402 - Envelope
- C403 - Mechanical
- C404 - SWH
- C405 - Lighting

AND

- Pick One C406:
  - C406.2 – Eff. HVAC Performance
  - or
  - C406.3 – Reduced Lighting Power Density
  - or
  - C406.4 – Enhanced Lighting Controls
  - or
  - C406.5 – On-site Supply of Renewable energy
  - or
  - C406.6 – Dedicated Outdoor Air System or C406.7 – High Eff. Service Water Heating

OR

**3** 2015 IECC - Performance

- C407 – Total Building Performance
- C402.5 – Air Leakage
- C403.2 – Provisions applicable to all mechanical systems
- C404 - SWH
- Lighting Mandatory Sections
  - C405.2
  - C405.3
  - C405.4
  - C405.6
- Building energy cost **to be ≤ 85% of** standard reference design building

# Additional Efficiency Package Options

## *Section C406*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- One additional efficiency feature must be selected to comply with the IECC
  - More efficient HVAC performance, OR
  - Reduced lighting power density system, OR
  - Enhanced lighting controls, OR
  - On-site supply of renewable energy
  - Dedicated outdoor air system, OR
  - More efficient SWH

High Efficiency HVAC


More Efficient Lighting System

Onsite Renewables

# Additional Efficiency Package Options

## *Section C406*



- Efficient HVAC performance per C406.2 **OR**
  - Per Tables C403.2.3(1) thru C403.2.3(7)
  - Only used when efficiencies in the above tables are greater than 10% in addition to the requirements in C403
  - Where multiple performance requirements are provided, the equipment shall exceed all requirements by 10%
  - Variable refrigerant flow systems exceed energy efficiency provisions of 90.1-2013 by 10%
  - Equipment not listed in tables above shall be limited to 10% of total building system capacity
- Reduced lighting power per C406.3 **OR**
  - Whole building LPD determined using 90% of values in Table C405.4.2(1) x floor area for the building types OR
  - Using 90% by the space-by-space method in Section C405.4.2
  - Determine total LPD of building using reduced whole building interior lighting power in Table 406.3 x floor area for the building types

# Additional Efficiency Package Options

## *Section C406 – Cont'd.*



- Enhanced digital lighting controls per C406.4, controls located and operated in accordance with C405.2.2:
  - Luminaires capable of continuous dimming
  - Luminaires capable of being addressed individually OR a controlled group of ≤ 4 luminaires
  - ≤ 8 luminaires controlled together in a daylight zone
  - Fixtures controlled through digital control system that includes the following function:
    - Control reconfiguration based on digital addressability
    - Load shedding
    - Individual user control of overhead general illumination in open offices
    - Occupancy sensors capable of being reconfigured through the digital control system
  - Construction documents including submittal of Sequence of Operations including specs outlining each function of the fixture requirements above
  - Functional testing of controls comply with C408

# Additional Efficiency Package Options

## *Section C406 – Cont'd.*



- On-site renewable energy per C406.5 **OR**
  - Total minimum ratings to
    - Provide ≥ 1.75 Btu or ≥ 0.50 watts per $ft^2$ of conditioned floor area OR
    - Provide ≥ 3% of energy used for mechanical and SWH equipment and lighting
- Dedicated outdoor air system per C406.6 **OR**
  - Be equipped with an independent ventilation system designed to provide ≤100% outdoor air to each occupied space
  - Ventilation system capable of total energy recovery
  - HVAC system include supply-air temperature controls that automatically reset the supply-air temp. in response to building loads or outdoor air temperatures
  - Controls reset the supply-air temp. at least 25% of the difference between design supply-air temp. and design room-air temp.

# Additional Efficiency Package Options

## *Section C406 – Cont'd.*



- Reduced energy use in SWH per C406.7

  Buildings with the following types allowed to use this compliance method:

  – Group R-1: Boarding houses, hotels, or motels
  – Group I-2: Hospitals, psychiatric hospitals, and nursing homes
  – Group A-2: Restaurants and banquet halls or buildings containing food preparation areas
  – Group F: Laundries
  – Group R-2: Buildings with residential occupancies
  – Group A-3: Health clubs and spas
  – Buildings showing a service hot water load of ≥10% of total building energy loads as shown with an energy analysis per C407

# Additional Efficiency Package Options

## *Section C406 – Cont'd.*



- Reduced energy use in SWH (cont'd)

Load fraction:

Building SWH system has ≥1 of the following sized to provide > 60% of hot water requirements or sized to provide 100% of hot water requirements if building complies with C403.4.7

- Waste heat recovery from service hot water, heat recover chillers, building equipment, process, equipment, or combined heat and power system
- Solar water-heating systems

# Climate Zones

## *2015 IECC - Chapter 3*

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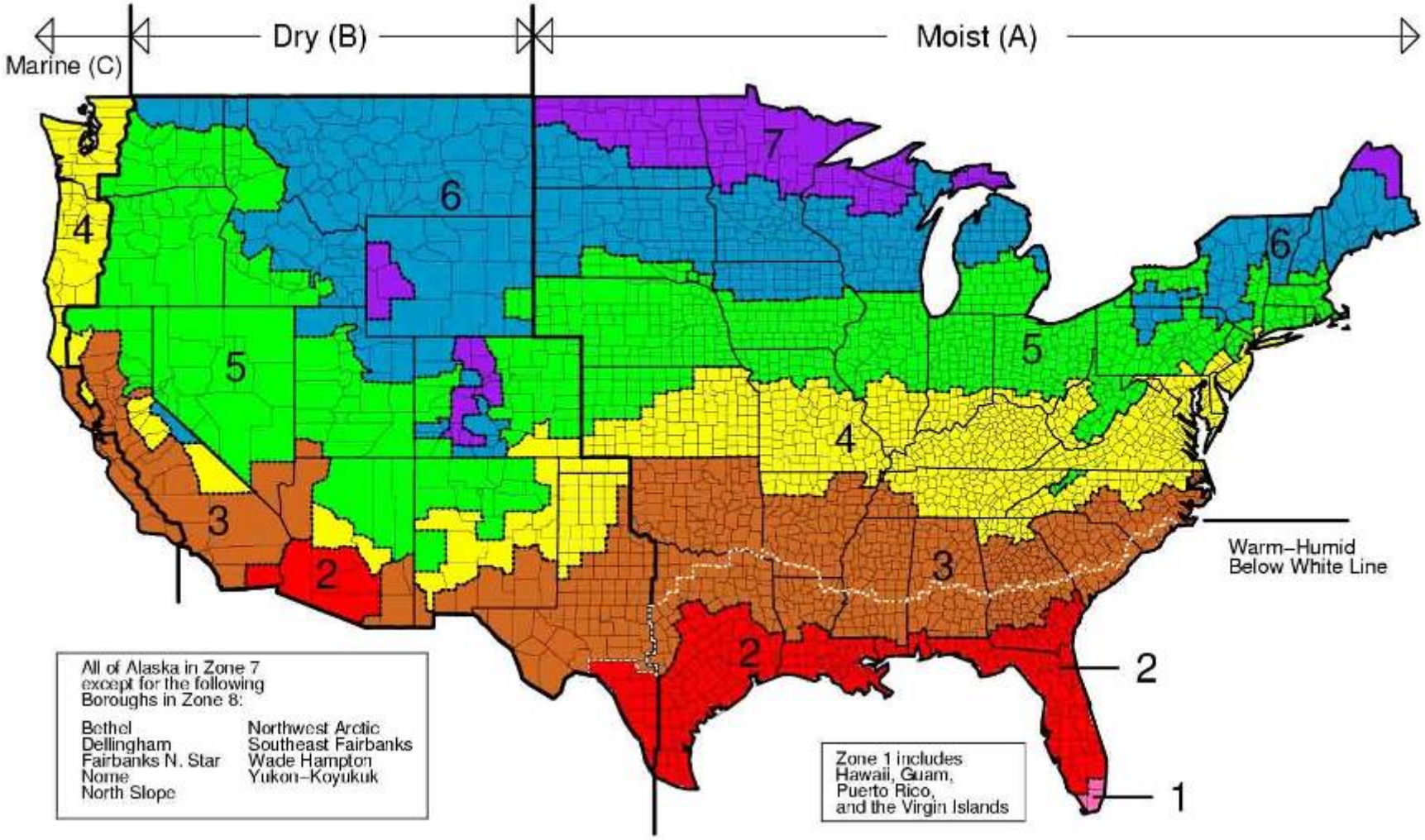


Determining Your Climate Zone is the First Step in the Process

# What is the Building Thermal Envelope?



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

# Building Envelope Requirements

## *Section C402.1 - General*



Building thermal envelope to comply with the following:

- Specific insulation requirements of Section C402.2
- Thermal requirements of either:
  - R-value-based method of Section C402.1.3
  - U-, C-, and F-factor-based method of Section C402.1.4 **OR**
  - Component performance alternative of Section C402.1.5
- Roof solar reflectance and thermal emittance
- Fenestration in building envelope assemblies
- Air Leakage of building envelope assemblies

# Building Envelope Compliance Options



3 Methods for compliance of building components:

- C402.1.3 – Insulation component R-value based method
- C402.1.4 – Assembly U-factor, C-factor or F-factor based method
- C402.1.5 – Component Performance Alternative

# Chapter 5 Prescriptive Approach Compliance

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

**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[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[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 | 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 | R13 + R-15.6ci or R-20 + R-10ci | R13 + 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[e] | 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[f] | R-30[f] | R-30[f] | R-30[f] | R-30[f] |
| **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[f] | 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** | | | | | | | | | | | | | | | | |
| Nonswinging | 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 |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m$^2$, 1 pound per cubic foot = 16 kg/m$^3$.

ci = Continuous insulation, NR = No requirement, LS = Liner 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.

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

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. "Mass floors" shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

f. Steel floor joist systems shall be insulated to R-38.

# Multiple Layers of Continuous Insulation

***Section C402.2.1***

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Where > 2 layers of continuous insulation board are used in a construction assembly, the boards to be installed with Section C303.2.

Where manufacturer instructions do not address the installation, the edge joints between each layer should be staggered.

# Chapter 5 Prescriptive Approach Compliance

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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[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-49 | R-49 | R-49 | R-49 | R-49 | R-49 |
| | | | | | | | | | | | | | | | | |
| Mass | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| **Opaque doors** | | | | | | | | | | | | | | | | |
| Nonswinging | 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 |

ROOFS

| Climate Zone | 1 | 2 | 3 | 4 Except Marine | 5 And Marine 4 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Insulation entirely above deck | R-20ci | R-25ci | R-25ci | R-30ci | R-30ci | R-30ci | 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-25+ 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-49 | R-49 | R-49 |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m$^2$, 1 pound per cubic foot = 16 kg/m$^3$.

ci = Continuous insulation, NR = No requirement, LS = Liner 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.

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

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. "Mass floors" shall include floors weighing not less than:

1. 35 pounds per square foot of floor surface area; or
2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

f. Steel floor joist systems shall be insulated to R-38.

# Chapter 5 Prescriptive Approach Compliance

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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[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 | | | | | R-49 | R-49 | R-49 | R-49 | R-49 | R-49 |

## WALLS, ABOVE GRADE

| Climate Zone | 1 | | 2 | | 3 | | 4 Except Marine | | 5 And Marine 4 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass | R-5.7ci | 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+6.5ci | R-13+6.5ci | R-13+6.5ci | R-13+R-13 ci | R-13+R-13 ci | R-13+R-13 ci | R-13+R-13 ci | R-13+R-13 ci | R-13+R-13 ci i | R-13+R-13 ci | R-13+R-13 ci | R-13+R-13 ci | R-13+R-13 ci | R-13+R-19.5 ci | R-13+R-13 ci | R-13+R-19.5 ci |
| Metal Framed | R-13=R-5 ci | R-13=R-5 ci | R-13=R-5 ci | R-13+7.5ci | R-13+7.5ci | R-13+7.5ci | R-13+7.5ci | R-13+7.5ci | R-13+7.5ci | R-13+7.5ci | R-13+7.5ci | R-13+7.;5ci | R-13+7.5cfi | R-13+15.6ci | R-13+7.5ci | R-13+17.5ci |
| 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-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 3 | 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-3.8 ci | R-13+R-7.5ci or R-20+R-3.8 ci | R-13+R-7.5ci or R-20+R-3.8 ci | R-13+R-7.5ci or R-20+R-3.8 ci | R-13+R-7.5ci or R-20+R-3.8 ci | R-13+R-15.6ci or R-20+R-10ci | R-13+R-15.6ci or R-20+R-10 ci |

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.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f$^2$ °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
e. "Mass floors" shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
f. Steel floor joist systems shall be insulated to R-38.

# Chapter 5 Prescriptive Approach Compliance

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

**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[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 | | | | | R-49 | R-49 | R-49 | R-49 | R-49 | R-49 |
| **Walls, above grade** | | | | | | | | | | | | | | | | |
| Below-grade wall[c] | 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[e] | 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[f] | R-30[f] | R-30[f] | R-30[f] | R-30[f] |
| **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[f] | 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** | | | | | | | | | | | | | | | | |
| Nonswinging | 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 |

**WALLS, BELOW GRADE**

| Climate Zone | 1 | 2 | 3 | 4 Except Marine | 5 And Marine 4 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Below grade wall | NR | NR | NR | R-7.5ci | R-7.5ci | R-7.5ci | R-10ci | R-12.5ci |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m$^2$, 1 pound per cubic foot = 16 kg/m$^3$.

ci = Continuous insulation, NR = No requirement, LS = Liner 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.

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

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. "Mass floors" shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

f. Steel floor joist systems shall be insulated to R-38.

# Chapter 5 Prescriptive Approach Compliance

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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[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 | | | | | R-49 | R-49 | R-49 | R-49 | R-49 | R-49 |
| Mass | | | | | | | | | | | | | | | | |

FLOORS

| Climate Zone | 1 | | 2 | | 3 | | 4 Except Marine | | 5 And Marine 4 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass[e] | 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[f] | R-30[f] | R-30[f] | R-30[f] | R-30[f] |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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[f] | 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** | | | | | | | | | | | | | | | | |
| Nonswinging | 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 |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m$^2$, 1 pound per cubic foot = 16 kg/m$^3$.
ci = Continuous insulation, NR = No requirement, LS = Liner 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.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f$^2$ °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
e. "Mass floors" shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
f. Steel floor joist systems shall be insulated to R-38.

# Chapter 5 Prescriptive Approach Compliance

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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[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 | | | | | R-49 | R-49 | R-49 | R-49 | R-49 | R-49 |

SLAB-ON GRADE FLOORS

| Climate Zone | 1 | | 2 | | 3 | | 4 Except Marine | | 5 And Marine 4 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unheated Slabs | NR | NR | NR | NR | NR | NR | R-10 for 24 in. below | R-10 for 24 in. below | R-10 for 24 in. below | R-10 for 24 in. below | R-10 for 24 in. below | R-15 for 24 in. below | R-15 for 24. in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-20 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-10 for 24 in below | R-10 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-15 for 36 in. below | R-15 for 36 in. below | R-15 for 48 in. below | R-20 for 48 in. below | R-20 for 24 in. below | R-20 for 48 in. below | R-20 for 48 in. below | R-20 for 48 in. below |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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[f] | 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** | | | | | | | | | | | | | | | | |
| Nonswinging | 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 |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m$^2$, 1 pound per cubic foot = 16 kg/m$^3$.
ci = Continuous insulation, NR = No requirement, LS = Liner 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.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f$^2$ °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
e. "Mass floors" shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
f. Steel floor joist systems shall be insulated to R-38.

# Chapter 5 Prescriptive Approach Compliance

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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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[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 | | | | | R-49 | R-49 | R-49 | R-49 | R-49 | R-49 |
| | | | | | | | | | | | | | | | | |
| **Floors** | | | | | | | | | | | | | | | | |
| Mass[e] | 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[f] | R-30[f] | R-30[f] | R-30[f] | R-30[f] |
| **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[f] | 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** | | | | | | | | | | | | | | | | |
| Nonswinging | 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 |

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m$^2$, 1 pound per cubic foot = 16 kg/m$^3$.
ci = Continuous insulation, NR = No requirement, LS = Liner system.
a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.
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e. "Mass floors" shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
f. Steel floor joist systems shall be insulated to R-38.

OPAQUE DOORS

| Climate Zone | 1 | 2 | 3 | 4 Except Marine | 5 And Marine 4 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Nonswinging | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 |

# Roof Assembly

## *Section C402.2.2*



Roof R-values and U-factor requirements are based on assembly type / insulation placement

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

Skylight curbs to be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less

# Roof Assembly

## *Section C402.2.2 - Exceptions*



- Continuously insulated roof assemblies where the thickness of insulation varies by ≤ 1” and area-weighted U-factor is equivalent to the same assembly with the R-value specified in Table C402.1.3
- Tapered insulation is used with insulation entirely above deck, the R-value where the insulation thickness varies ≤ 1” from the minimum thickness of tapered insulation must comply with the R-value specified in Table C402.1.3
- Unit skylight curbs included as a component of an NFRC 100 listed and labeled assembly is not required to be insulated

# Roof Solar Reflectance and Thermal Emittance

## *Section C402.3*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Required in Climate Zones 1-3 for low-sloped roofs (less than 2 units vertical in 12 horizontal), directly above cooled conditioned spaces

**Comply with one or more options:**

1) Minimum three-year aged solar reflectance of 0.55 and minimum three-year aged thermal emittance of 0.75

**OR**

2) Three-year aged solar reflectance index of 64

Where aged solar reflectance required by Section C402.3 is not available, it should be determined with Equation 4-3

$$R_{aged} = [0.2+0.7(R_{initial} -0.2)]$$

# Roof Solar Reflectance and Thermal Emittance
## *Section C402.3 - Exceptions*



- Portions of roofs that include or are covered by:
  - PV systems or components
  - Solar air or water heating systems or components
  - Roof gardens or landscaped roofs
  - Above-roof decks or walkways
  - Skylights
  - HVAC systems, components, and other opaque objects mounted above the roof
- Portions of roofs shaded during peak sun angle on June 21 by permanent features of the building or permanent features of adjacent buildings
- Ballasted roofs with minimum stone ballast of 17 lbs/ft$^2$ or 23 lbs/ft$^2$ pavers
- Roofs, where a minimum of 75% of the roof area meets one or more of the above exceptions

# High Albedo Roof - Example

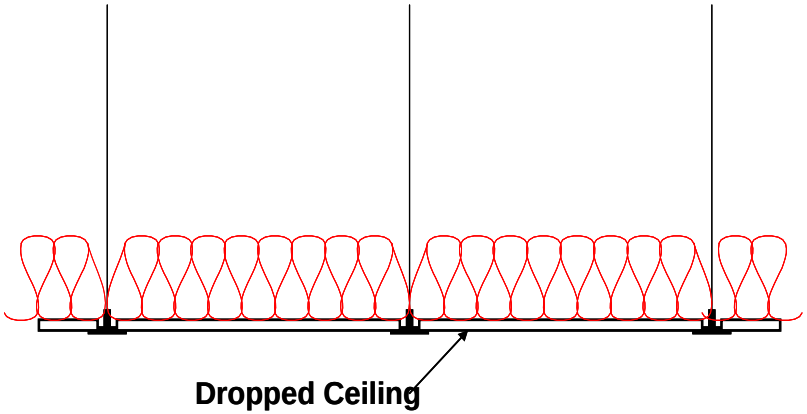
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

# Roof R-Value
## Insulation Completely Above Deck

- ✓ Insulation considered continuous (*CI*)
- ✓ Insulation thickness can vary ≤ 1” and area weighted U-factor meets the requirements of Table C402.1.3

# Roof Assembly
## Insulation Placed on Suspended Ceiling with Removable Ceiling Tiles

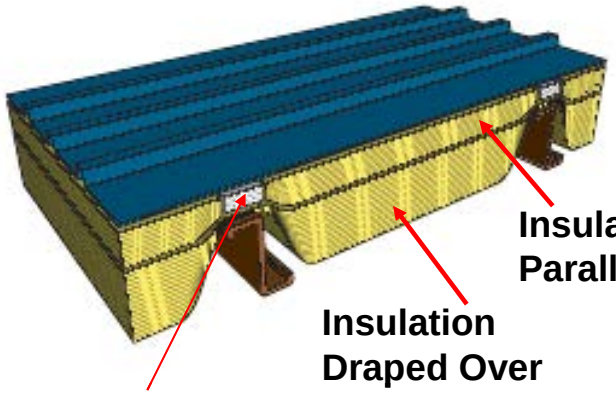





- ✓ Will not count for code compliance
- ✓ Not considered part of the minimum thermal resistance of the roof insulation

# Roof R-Value
## Metal Buildings






Thermal spacer block required on all metal buildings or must use U-factor Compliance Method

Two layers of insulation required

- ✓ CZ 1-5 and marine 4: R-19+R-11 LS
- ✓ CZ 6: R-25+R-11 LS
- ✓ CZ 7-8: R-30+R-11 LS

**Liner System includes the following:**

- Continuous vapor barrier liner membrane that is installed below the purlins and that is uninterrupted by framing members
- An uncompressed, unfaced insulation resting on top of the liner membrane and located between purlins
- Multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and compressed when the metal roof panes are attached

# Metal Building Roofs

Photos courtesy of MBMA

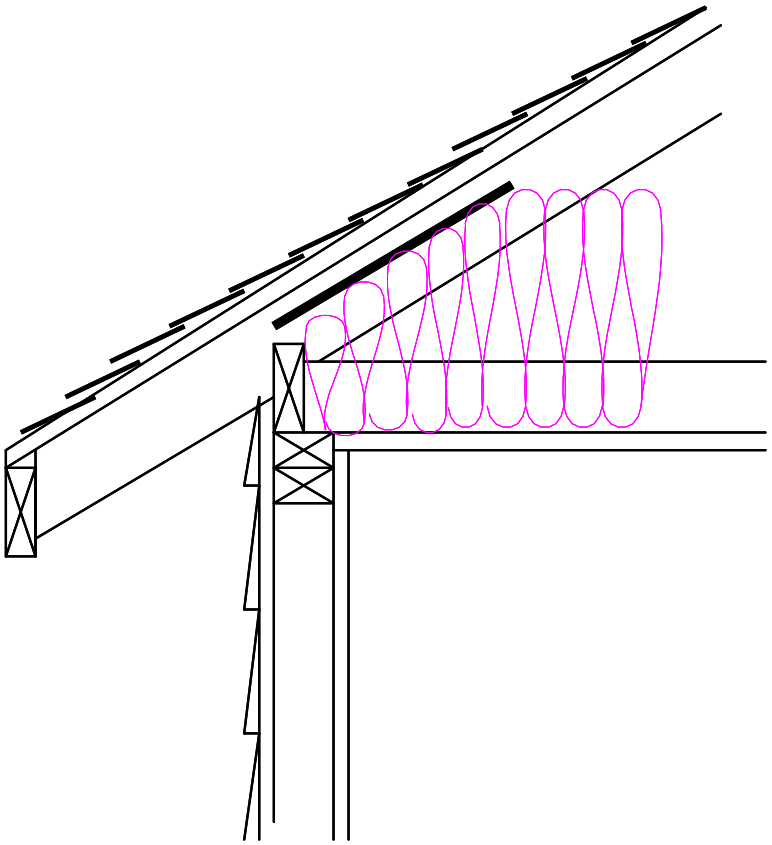
# Metal Building Roofs



Photos courtesy of MBMA

# Roof R-Value
## Ceilings with Attic Spaces





- ✓ Install insulation between framing
- ✓ R-38 in Climate Zones 1-5 and marine 4 “All Other”
- ✓ R-49 in Climate Zones 5-8 and marine 4 “Group R”

# Wall R-Value
## Mass Walls



- Walls weighing at least 35 lbs/ft$^2$ of wall surface area
- 25 lbs/ft$^2$ of wall surface area if material weight is ≤ 120 lb/ft$^3$
- Heat capacity > 7 Btu/ft$^2$
- Heat capacity > 5 Btu/ft$^2$ if the material weight is < 120 pcf

Climate Zones 1 and 2 (all other) and Climate Zone 1 (Group R) – 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 ≤ of 0.44 Btu-in./h-ft$^2$ F

# Wall R-Value
## Wood, Metal Frame, and Other




Photo courtesy of Dow Building Solutions

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

# Metal Building Walls

## *Table C402.1.3*

Photo courtesy of Ken Baker, K energy

# Below Grade Walls

## *Table C402.1.3 or Table C402.1.4*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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 lowest floor, whichever is less

Heated slabs installed below grade *(footnoted to Tables C402.1.3 and C402.2.14)*

- ✓ Below grade walls must meet exterior insulation requirements for heated slabs

# Below-Grade Wall Insulation




Photo courtesy of Dow Building Solutions

# Floors Over Outdoor Air or Unconditioned Space
## *Section C402.2.4*



### Joist/Framing (Steel/Wood)

- ✓ Insulation installed between framing

### Mass Floors

- ✓ Materials weighing (of floor surface area) 35 lbs/ft$^2$, **or**
- ✓ 25 lbs/ft$^2$ if material weight is ≤ 120 lbs/ft$^3$
- ✓ Insulation installed continuously

### Steel Floor Joist Systems
*(footnoted to Table C402.1.3)*

- ✓ R-38 in Climate Zones 6 Group R) and 7-8 (Group R and All other)

# Floors

## *Section C402.2.4*



Floor framing cavity insulation or structural slab insulation should be installed to maintain permanent contact with underside of subfloor decking or structural slabs

**Exceptions**:

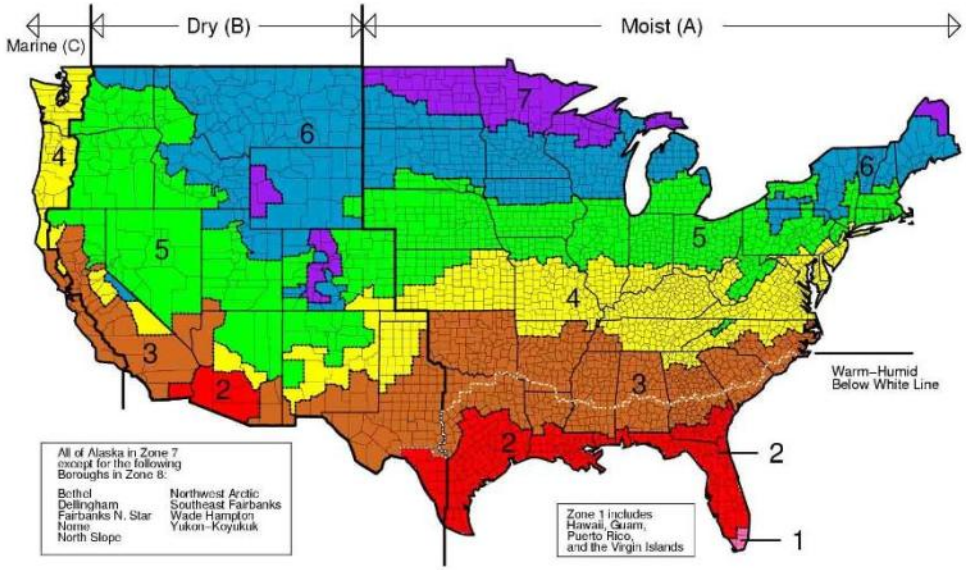
- Framing cavity insulation or structural slab insulation is permitted to be in contact with top side of sheathing or ci installed on the bottom side of floor where combined with insulation that meets or exceeds R-value in Table C402.1.3 for “Metal framed” or “Wood framed and other” values for “Walls, Above Grade” and extends from the bottom to the top of all perimeter floor framing or floor assembly members
- Insulation applied to underside of concrete floor slabs is permitted an airspace of < 1” where it turns up and is in contact with underside of floor under walls associated with the building thermal envelope

# Slab-on-Grade Floors

## *Section C402.2.5*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Unheated slab – insulation required:
  - ✓ Climate Zones 4-8
- Heated slabs – insulation required in all Climate Zones
- **Exception**: where slab-on-grade floor is > 24” below finished exterior grade



# Insulation of Radiant Heating Systems

## *Section C402.2.6*



Radiant heating system panels and their associated components:

- Installed in interior or exterior assemblies to be insulated with ≥ R-3.5 on all surfaces not facing the space being heated
- Installed in the building thermal envelope should be separated from the exterior of the building or unconditioned or exempt spaces by not less than the R-value installed in the opaque assembly in which they are installed or assembly comply with Section C402.1.4

**Exception**: heated slabs-on-grade insulated in accordance with Section C402.2.5

**TABLE C402.4**
**BUILDING ENVELOPE FENESTRATION MAXIMUM *U*-FACTOR AND SHGC REQUIREMENTS**

| CLIMATE ZONE | 1 | | 2 | | 3 | | 4 EXCEPT MARINE | | 5 AND MARINE 4 | | 6 | | 7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vertical fenestration** | | | | | | | | | | | | | | |
| ***U*-factor** | | | | | | | | | | | | | | |
| Fixed fenestration | 0.50 | | 0.50 | | 0.46 | | 0.38 | | 0.38 | | 0.36 | | 0.29 | |
| Operable fenestration | 0.65 | | 0.65 | | 0.60 | | 0.45 | | 0.45 | | 0.43 | | 0.37 | |
| Entrance doors | 1.10 | | 0.83 | | 0.77 | | 0.77 | | 0.77 | | 0.77 | | 0.77 | |
| **SHGC** | | | | | | | | | | | | | | |
| Orientation[a] | SEW | N | SEW | N | SEW | N | SEW | N | SEW | N | SEW | N | SEW | N |
| PF < 0.2 | 0.25 | 0.33 | 0.25 | 0.33 | 0.25 | 0.33 | 0.40 | 0.53 | 0.40 | 0.53 | 0.40 | 0.53 | 0.45 | NR |
| 0.2 ≤ PF < 0.5 | 0.30 | 0.37 | 0.30 | 0.37 | 0.30 | 0.37 | 0.48 | 0.58 | 0.48 | 0.58 | 0.48 | 0.58 | NR | NR |
| PF ≥ 0.5 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | NR | NR |
| **Skylights** | | | | | | | | | | | | | | |
| *U*-factor | 0.75 | | 0.65 | | 0.55 | | 0.50 | | 0.50 | | 0.50 | | 0.50 | |
| SHGC | 0.35 | | 0.35 | | 0.35 | | 0.40 | | 0.40 | | 0.40 | | NR | |

NR = No requirement, PF = Projection factor.

a. "N" indicates vertical fenestration oriented within 45 degrees of true north. "SEW" indicates orientations other than "N." For buildings in the southern hemisphere, reverse south and north. Buildings located at less than 23.5 degrees latitude shall use SEW for all orientations.

C-36

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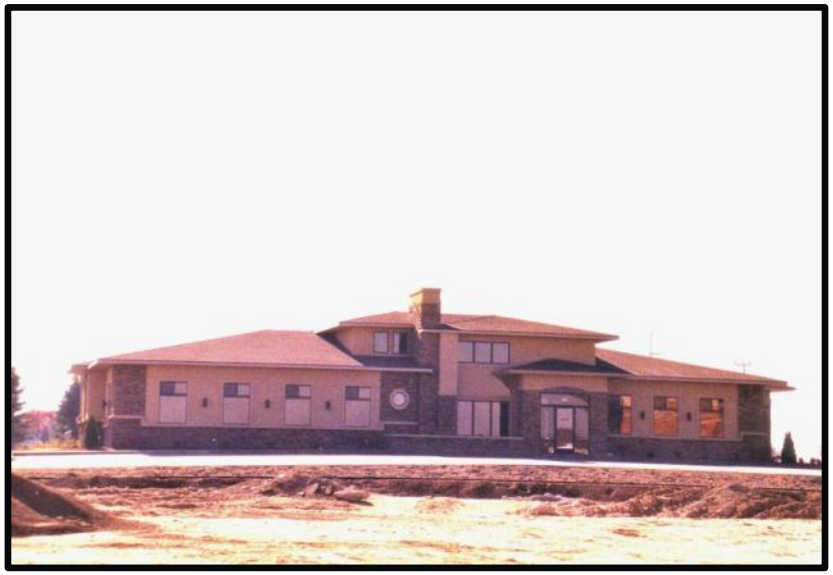
# Vertical Fenestration Requirement
## *Section C402.4.1 – Prescriptive (Max area)*





Percentage of Vertical Fenestration Area to Gross Wall Area

- ✓ Allowed up to 30% maximum of above grade wall
  - ✓ In Climate Zones 1-6, up to 40% maximum of above grade wall with daylighting controls

# Vertical Fenestration Requirement
## *Section C402.4.1*

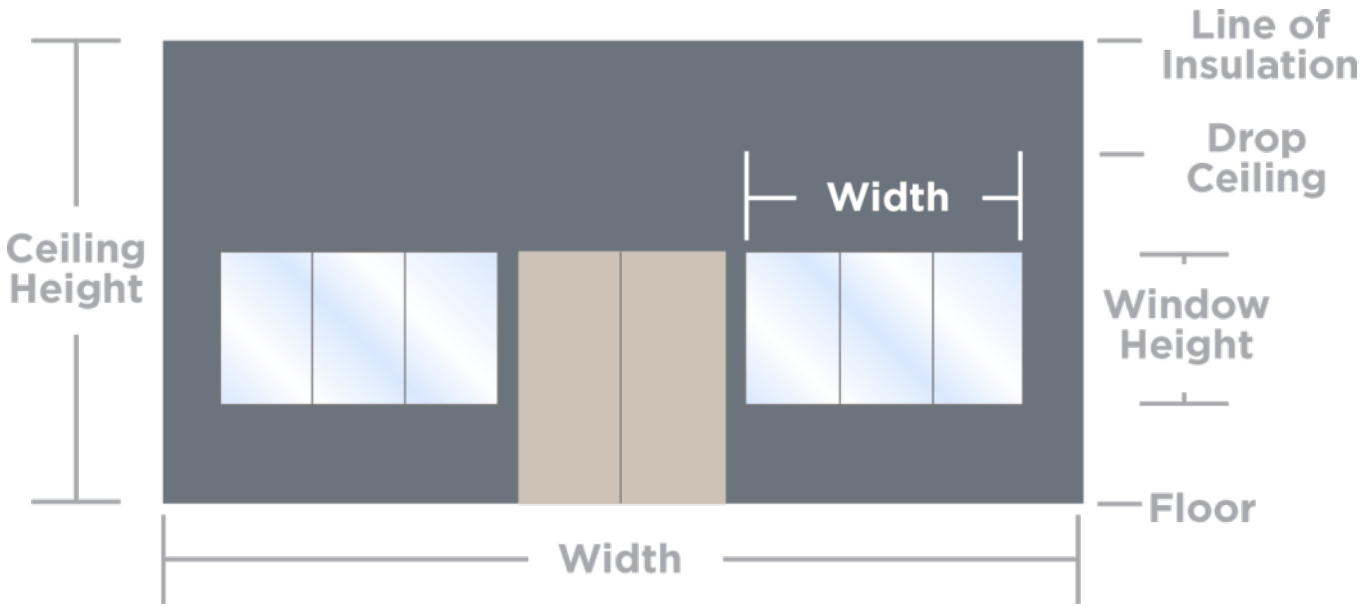


Based on above-grade wall area *(gross)*

- ✓ 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



# Skylight Minimum Fenestration Area

## *Section C402.4.1 Prescriptive*



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

# Increased Vertical Fenestration with Daylight Responsive Controls

***Section C402.4.1.1***



- ✓ Up to 40% vertical fenestration area allowed in Climate Zones 1-6, provided
  - No less than 50% of the conditioned floor area is within a daylight zone in buildings < 2 stories above grade
  - No less than 25% of the net floor area is within a daylight zone in building ≥ 3 stories above grade
  - Daylight responsive controls complying with C405.2.3.1 are installed in daylight zones
  - VT of vertical fenestration is ≥ 1.1 times SHGC

**Exception**:

Fenestration that is outside the scope of NFRC 200 isn't required to comply with VT

# Increased Skylight Area with Daylighting Controls

***Section C402.4.1.2***



- ✓ Up to 5% of the roof area provided daylight responsive controls are installed in daylight zones under skylights per C405.2.3.1

# Minimum Skylight Fenestration Area
## *Section C402.4.2*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- In certain types of enclosed spaces > 2,500 $ft^2$ in floor area directly under a roof with > 75% of ceiling area with ceiling height > 15 ft.
  - total daylight zone under skylights to not be < ½ the floor area and provide one of the following
    - Minimum of 3% of skylight area to daylight zone where all skylights have a VLT at least 0.40 **OR**
    - Provide a minimum skylight effective aperture of at least 1%

**Exceptions:**

- Climate Zones 6-8
- Spaces with LPDs < 0.5 $W/ft^2$
- Documented shaded spaces
- Daylight area under rooftop monitors is > 50% of floor area
- Spaces where total area minus area of daylight zones adjacent to vertical fenestration is < 2,500 $ft^2$ and lighting is controlled per C405.2.5 (Exterior Lighting Controls)

# Lighting Controls in Daylight Zones Under Skylights

***Section C402.4.2.1***

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Daylight responsive controls complying with C405.2.3.1 should be provided to control all lights with daylight zones under skylights

# Haze Factor

## *Section C402.4.2.2*



- 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 and installed 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

## *Section C402.4.3*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Table C402.4 requirements by these categories:

- ✓ Fixed fenestration
- ✓ Operable fenestration
- ✓ Entrance doors

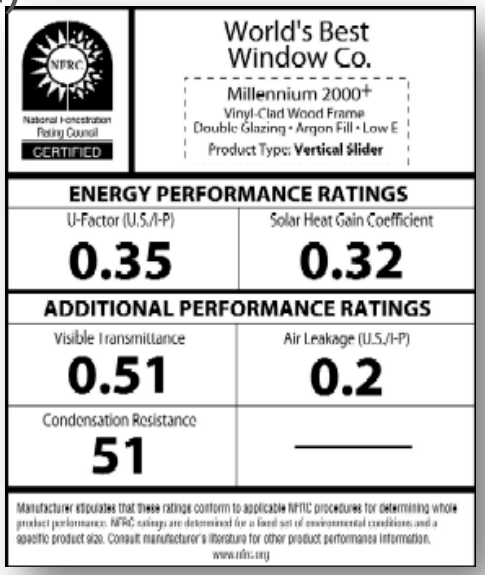
# Skylight U-Factor / SHGC



- ✓ U-factor and SHGC Based
- ✓ NFRC 100 Rating  or ANSI/DASMA 105 for U-factor or Default Table
- ✓ NFRC 200 Rating for SHGC and VT or Default Table

## How Do You Meet the Requirement?

- ✓ 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 C303.1.3(1)




# Default U-Factors
## *Tables C303.1.3(1) and (2)*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

**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 | | | |

**TABLE C303.1.3(2)**
**DEFAULT DOOR U-FACTORS**

| DOOR TYPE | *U*-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



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 and VT Product Rating Requirements

## *Table C303.1.3(3)*



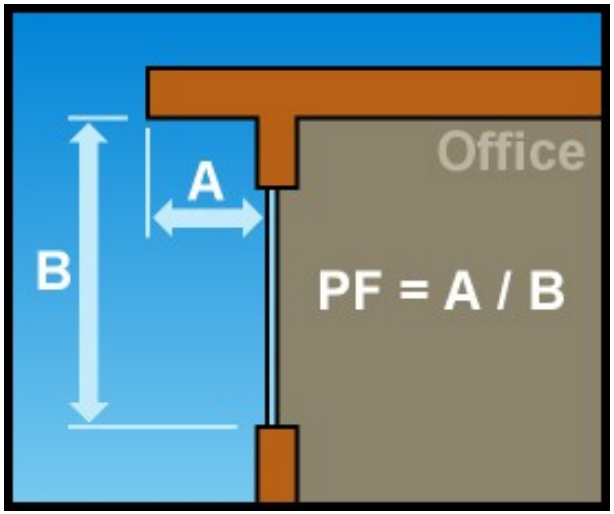
Two Options for Meeting the SHGC and VT Requirements

- ✓ Fenestration product rated and labeled to NFRC 200, or
- ✓ Select default from Table C303.1.3(3)

**TABLE C303.1.3(3)**
**DEFAULT GLAZED FENESTRATION SHGC AND VT**

| | SINGLE GLAZED | | DOUBLE GLAZED | | GLAZED BLOCK |
|---|---|---|---|---|---|
| | Clear | Tinted | Clear | Tinted | |
| SHGC | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 |
| VT | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 |

## The Effect of Overhangs on Fenestration SHGC




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

# Increased Skylight SHGC and U-factor

## *Sections C402.4.3.1, C402.4.3.2*



Skylights installed above daylight zones with daylight responsive controls:

- Climate Zones 1-6, permitted maximum SHGC 0.60
- Climate Zones 1-3, permitted maximum U-factor 0.90
- Climate Zones 4-8, permitted maximum U-factor 0.75

- ✓ SHGC determined using manufacturer's ratio of the higher to lower labeled SHGC
- ✓ SHGC ratio ≥ 2.4
- ✓ Automatically controlled to modulate amount of solar gain into the space in multiple steps
- ✓ Considered separately from other fenestration
- ✓ Area-weighted averaging isn't allowed

- ✓ **Exception**: not required to comply where both the lower and higher labeled SHGC already comply with Table C402.3

# Area-Weighted U-Factor

## *Section C402.4.3.4*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- ✓ Allowed to meet requirements in Table C402.4
- ✓ Can’t combine products from different categories when calculating the area-weighted average U-factor

# Doors

## *Section C402.4.4*




Opaque doors having < 50% glass area

Comply with Tables C402.1.3 and C402.1.4

Swinging doors

- ✓ Meet U-factor requirement

Nonswinging

- ✓ R-4.75 in all climate zones

All other doors to comply with vertical fenestration requirements

# Mandatory Requirements



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

# Air Leakage
## *Section C402.5*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Tested in accordance with ASTM E 779 at pressure differential of 0.3 inch water gauge or an equivalent method approved by code official when tested air leakage rate < 0.40 cfm/ft$^2$

# Air Barriers and Construction
## *Section C402.5.1.1*



- Continuous air barrier required except in:

  Climate Zone 2B

- Air barrier placement allowed:
  - Inside of building envelope
  - Outside of building envelope
  - Located within assemblies composing envelope **OR**
  - Any combination thereof

- Continuous for all assemblies part of the thermal envelope and across joints and assemblies
- Joints and seams sealed including sealing transitions in places and changes in materials, securely installed in or on the joint for its entire length to not dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation

# Air Barriers and Construction
## *Section C402.5.1.1*



- Penetrations of air barrier and air leakage paths to be caulked, gasketed or otherwise sealed in a manner compatible with construction materials and location
- Joints and seals
  - Sealed in same manner or taped or covered with moisture vapor-permeable wrapping material
- Sealing of concealed fire sprinklers where required in a manner recommended by manufacturer
  - Caulking or other adhesive sealants should not be used to fill voids between fire sprinkler cover plates and walls, or ceilings
- Recessed lighting to comply with C402.5.7
- Where similar objects are installed that penetrate the air barrier, make provisions to maintain the air barrier's integrity

# Air Barrier Compliance Options
## *Section C402.5.1.2*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Two ways to comply with air barrier requirements:

- ✓ Materials – C402.5.1.2.1  OR
- ✓ Assemblies – C402.5.1.2.2

# Air Barrier Materials (Compliance)
## *Section C402.5.1.2.1*



Materials with air permeance ≤ 0.004 cfm/ft$^2$ under pressure differential of 0.3 in. w.g. tested in accordance with ASTM E 2178

These materials meet this requirement:

| Material | Thickness (minimum) |
|---|---|
| Plywood | 3/8 in. |
| Oriented strand board | 3/8 in. |
| Extruded polystyrene insulation board | ½ in. |
| Foil-faced urethane insulation board | ½ in. |
| Closed cell spray foam minimum density of 1.5 pcf | 1-1/2 in. |
| Open cell spray foam density between 0.4 and 1.5 pcf | 4.5 in. |
| Exterior gypsum sheathing or interior gypsum board | ½ in. |
| Cement board | ½ in. |
| Built up roofing membrane | |
| Modified bituminous roof membrane | |
| Fully adhered single-ply roof membrane | |
| A Portland cement/sand parge, stucco, or gypsum plaster | 5/8 in. |
| Cast-in-place and precast concrete | |
| Sheet metal or aluminum | |
| Solid or hollow masonry constructed of clay or shale masonry units | |

**OR**

Assemblies of materials and components (sealants, tapes, etc.) with average air leakage ≤ 0.04 cfm/ft$^2$ under pressure differential of 0.3 in. w.g. tested in accordance with ASTM E 2357, 1677 or 283

The following assemblies are deemed to comply provided that joints are sealed and Section C402.5.1.1 (Air Barrier Construction) is met:

- Concrete masonry walls coated with either one application either of block filler or two applications of a paint or sealer coating OR
- Masonry walls constructed of clay or shale masonry units with a nominal width of ≥ 4” OR
- Portland cement/sand parge, stucco or plaster > ½” thick

# Air Leakage of Fenestration
## *Section C402.5.2*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

| Fenestration Assembly | cfm/ft$^2$ | Test Procedure |
|---|---|---|
| Windows, sliding glass doors, and swinging doors | 0.20 | AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400 |
| Skylights - with condensation weepage openings | 0.30 | |
| Skylights – all other | 0.20 | |
| Curtain walls and storefront glazing | 0.06 | NFRC 400 or ASTM E 283 at 1.57 psf |
| Commercial glazed swinging entrance doors | 1.00 | |
| Revolving doors | 1.00 | |
| Garage doors | 0.4 | ANSI/DASMA 105, NFRC 400, or ASTM E 283 at 1.57 psf |
| Rolling doors | 1.00 | |
| High-speed doors | 1.30 | |

- ✓ **Exceptions:**
  - Field-fabricated fenestration assemblies
  - Fenestration in buildings that meet the building test for air barrier compliance option

# Rooms Containing Fuel-burning Appliances

***Section C402.5.3***

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Appliances and combustion air openings to be located outside the building thermal envelope or enclosed in a room isolated from inside the thermal envelope in Climate Zones 3-8
- Where open combustion air ducts provide combustion air to open combustion space conditioning fuel-burning appliances
- Rooms to be sealed and insulated per envelope requirements
- Doors into the rooms fully gasketed
- Water lines and ducts insulated
- Combustion air ducts that pass through conditioned space, insulated to $\geq$ R-8

# Rooms Containing Fuel-burning Appliances

## *Section C402.5.3 – Cont'd.*



**Exceptions**:

- Direct vent appliances with both intake and exhaust pipes installed continuous to the outside
- Fireplaces and stoves complying with 901-905 IMC and Section 2111.13 IBC

# Doors and Access Openings to *Section C402.5.4 Shafts, Chutes, Stairways, and Elevator Lobbies*



Doors and access openings from conditioned space to shafts, chutes, stairways, and elevator lobbies not within the scope of the fenestration assemblies in Section C402.5.2 to be gasketed, weatherstripped, or sealed

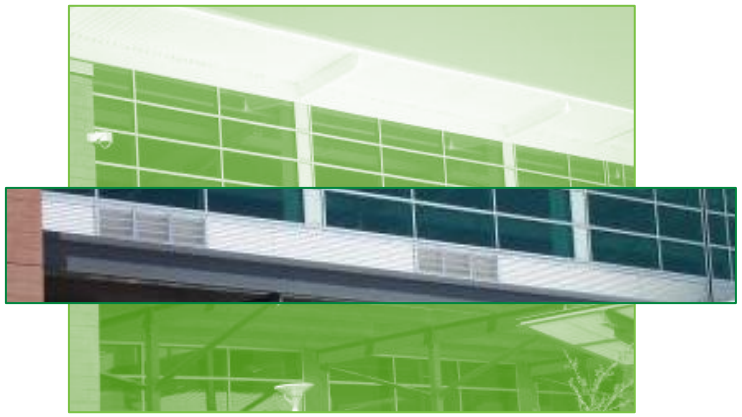
**Exceptions**:

- Door openings required to comply with 716 or 716.4 IBC
- Doors or door openings required to comply with UL 1784 IBC

# Air Intakes, Exhaust Openings, Stairways, and Shafts

## *Section C402.5.5*





Openings integral to the building envelope to have dampers per Section C403.2.4.3 (Shut Off Dampers)

# Loading Dock Weatherseals
## *Section C402.5.6*

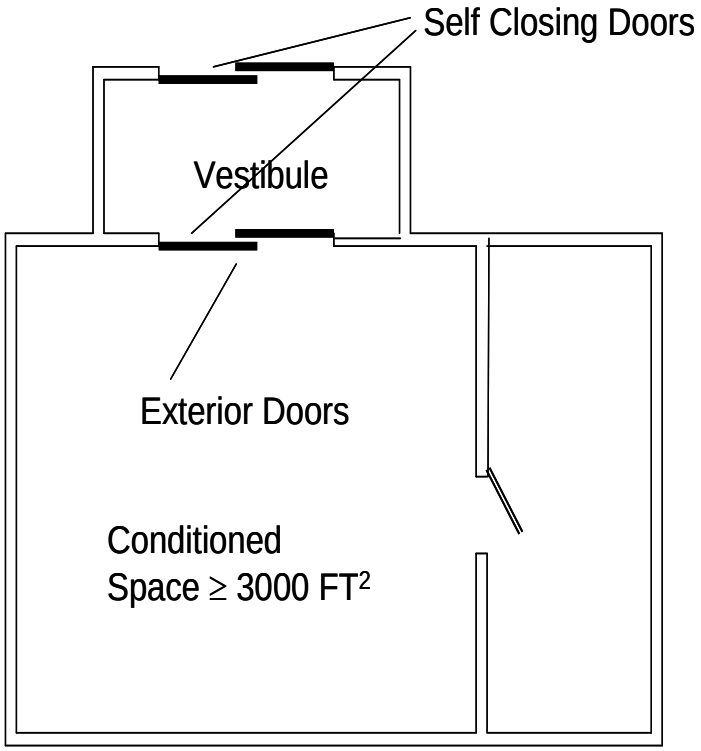
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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

# Vestibules
## *Section C402.5.7*



- ✓ Required to reduce infiltration into spaces
- ✓ Required on entrance doors leading into spaces ≥ 3,000 ft$^2$
- ✓ Doors must have self-closing devices
- ✓ **Exceptions:**
  - Buildings in Climate Zones 1 and 2
  - Doors from a sleeping unit or dwelling unit
  - Revolving doors
  - Doors that have an air curtain with velocity > 6.56 ft/second at the floor tested in accordance with ANSI/AMCA 220 installed in accordance with manufacturer's instructions. Manual or automatic controls provided that will operate the air curtain with opening and closing. Air curtain and their controls to comply with Section C408.2.3.



# Recessed Lighting
## *Section C402.5.8*



All recessed luminaires installed in the building thermal envelope

Type IC rated to have all of the following:

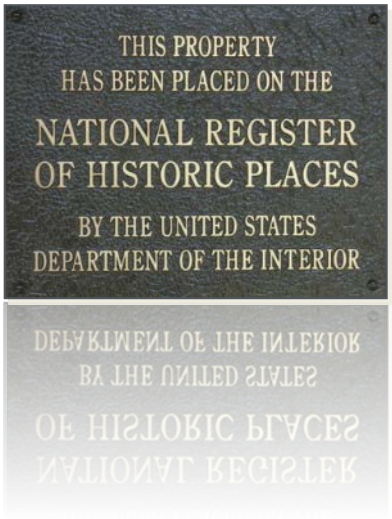
- ✓ Sealed with gasket or caulk between housing and interior wall or ceiling covering **AND**
- ✓ Labeled in accordance with ASTM E 283 to allow ≤ 2.0 cfm of air movement between conditioned and unconditioned spaces

# Existing Buildings Chapter 5 -- NEW

## *Section C501 - General*



- ✓ Additions, alterations, or repairs
- ✓ Existing buildings
- ✓ Maintenance
- ✓ Compliance
- ✓ New and replacement materials
- ✓ Buildings designated as historic



Any nonconditioned space that is altered to become conditioned space shall be required to be brought into full compliance with this code

**Examples:**

- ✓ Converting part of an unconditioned warehouse to office space
- ✓ Shell building tenant build-out

Vertical fenestration: new fenestration that results in a total building fenestration area ≤ 30% must comply with C402.4

- If > 30% for total building or addition alone, must comply with C402.4.1.1 Increased Vertical Fenestration Area with Daylight Responsive Control for the addition only
- Additions that result in total building vertical glass >40% must comply with C407 Total Building Performance

Skylight Area: new skylight area that is ≤ 3% complies with C402.4

- If > 3% for total building or addition alone, must comply with C402.4.1.2 Increased Skylight Area with Daylight Responsive Control for addition only
- Additions that result in total building skylight area >5% must comply with C407 Total Building Performance

- Mechanical Systems comply with C403
- SWH – C404
- Pools and inground permanently installed spas – C404.9
- Lighting power and systems – C405
  - Interior comply with addition alone or addition plus existing building
  - Exterior comply with addition alone or addition plus existing

Code applies to any new construction

Unaltered portion(s) do not need to comply

Alterations comply with ASHRAE 90.1-2013 do not need to comply with C402-C405

Vertical Fenestration and Skylight Area similar to requirements for additions

# Alterations
## *Section C503.2 – Change in Occupancy*

- ✓ Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code

- ✓ Where the use in a space changes from one to another in Tables C405.4.2(1) or C405.4.2(2), the installed lighting wattage shall comply with Section 405

# Change in Space Conditioning
## *Section C503.2*



Any non-conditioned or low energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code

Image courtesy of Ken Baker, K energy

**Exceptions:**

- ✓ Storm windows over existing fenestration
- ✓ Surface-applied window film installed on existing single pane
- ✓ Exposed, existing ceiling, wall or floor cavities if already filled with insulation
- ✓ Where existing roof, wall or floor cavity isn't exposed
- ✓ Roof recover
- ✓ Reroofing for roofs where neither sheathing nor insulation exposed
  - Insulate above or below the sheathing
    - Roofs without insulation in the cavity
    - Sheathing or insulation is exposed
- ✓ Lighting alterations if:
  - <50% of luminaries in a space are replaced
  - Only bulbs and ballasts within existing luminaries are replaced (provided installed interior lighting power isn't increased)

- Heating and Cooling
  - New HVAC systems and duct systems that are part of the alteration to comply with Section C403
    - Economizers – new cooling systems that are part of the alteration to comply with Section C403.3
- Service hot water systems
  - New SWH systems that are part of the alteration to comply with C404
- Lighting Systems
  - New Lighting systems that are part of the alteration to comply with C404
    - **Exception** – alteration that replace <10% of the luminaires in a space provided such alteration does not increase the installed interior lighting power

- Work on nondamaged components necessary for the required repair or damaged components shall be considered part of the report and subject to the alterations requirements
- Repairs considered part of the code
  - Glass-only replacements in an existing sash and frame
  - Roof repairs
  - Replacement of existing doors that separate conditioned space from the exterior do not require the installation of a vestibule or revolving door, provided that an existing vestibule that separate a conditioned space from the exterior shall not be removed
  - Repairs where only the bulb and/or ballast within the existing luminaires in a space are replaced provided the replacement does not increase the installed interior lighting power