

Commercial (& Residential)
Energy Code
Building Envelope in Multifamily Projects



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ENERGY INSTITUTE
INVESTING IN THE ENERGY WORKFORCE

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Funding for Energy Code Training



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Scope/Construction Documents - Section C103

- ✓ 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.

Consistency is Critical in Energy Code Compliance

- U-Factors and R-values, all thermal performance values **must be identical** on:
 - Plans
 - Specifications
 - Energy Compliance Documents
 - Design Calculations



Commercial Compliance Options

1 ● ASHRAE 90.1-2013

2015 IECC - Prescriptive

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

OR

OR

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



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

● Building energy cost to be ≤ 85% of standard reference design building

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
Insulation entirely above roof deck	R-20a	R-25a	R-25a	R-25a	R-25a	R-25a	R-30a	R-30a	R-30a	R-30a	R-30a	R-30a	R-35a	R-35a	R-35a	R-35a
Roof	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-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS
Walls, above grade	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Walls, below grade	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Floors	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Doors	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Windows	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Glazing	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Roofs	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Basement floors	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Unheated slabs	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Heated slabs	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5	R-5
Nonoverlapping	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/m², 1 pound per cubic foot = 16 kg/m³.

a. Continuous insulation. NR = No requirement, LS = Loose systems.

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

c. R-5.75 is allowed to be substituted with concrete block complying with ASTM C 90, aggregated or partially gressed at 32 inches or less on center vertically and 48 inches or less on center horizontally, with impregnated cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-ft²-°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 wrapping 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-18.

What is the Building Thermal Envelope?

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

Building Components providing a boundary between conditioned & Unconditioned Space

Building Envelope Requirements - Section C402.1 - General

Building thermal envelope to comply with the following:

- Specific insulation requirements of Section C402.2
- Roof solar reflectance and thermal emittance
- Fenestration in building envelope assemblies
- Air Leakage of building envelope assemblies



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

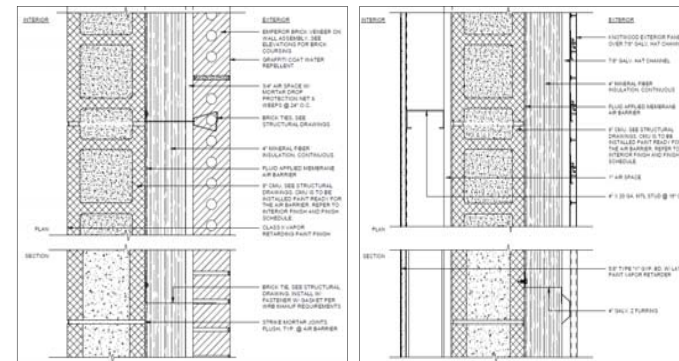


Photo courtesy of Dow Building Solutions

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

Cavity or Continuous Mineral Fiber

12



Continuous Insulation Penetrated only by Fasteners

Continuous



Cavity



Foam Insulation

Cavity



Continuous



May include both continuous and Cavity Insulation



Wall R-Value - Mass Walls

- Walls weighing at least 35 lbs/ft² of wall surface area
- 25 lbs/ft² of wall surface area if material weight is ≤ 120 lb/ft³
- Heat capacity > 7 Btu/ft²
- Heat capacity > 5 Btu/ft² if the material weight is < 120 pcf



Mass Walls - Concrete Masonry Units

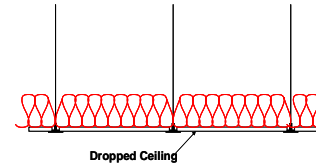
Climate Zones 1 and 2 and Climate Zone 1 (Group R) –
Can use integral insulation instead of R-5.7 ci

- ✓ 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 \leq of 0.44 Btu-in./h-ft² F

NOT an Option in Utah

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 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

Multiple Layers of Continuous Insulation - Section C402.2.1

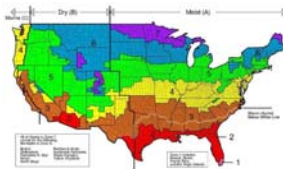
Where > 2 layers of continuous insulation board are used in a construction assembly, the boards to be installed with Section C303.2.

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



Slab-on-Grade Floors - Section C402.2.5

- 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



Fenestration U-Factor - Section C402.4.3

Table C402.4 requirements by these categories:

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



NEW

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

Fenestration U-Factor - Section C303.1.3

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)

NFRC PERFORMANCE RATINGS	
U-Factor	SHGC
0.35	0.32
ADDITIONAL PERFORMANCE RATINGS	
U-Factor	SHGC
0.51	0.2
51	

NFRC PRODUCT CERTIFICATION PROGRAM	
NFRC Label Certificate for Site-Built Products	
U-Factor	SHGC
0.35	0.32
U-Factor	SHGC
0.51	0.2
Project Location	
Street Address:	City: _____ State: _____ Zip Code: _____
Project Name:	Design (Optional): _____
Product Line Information	
Operator Type (per Table 4.1 of NFRC 100): _____	Insulated Inset (I) No: _____
Product Line (I) No: _____	Location in Building: _____
How many of this product are installed: _____	Permitted Incident & Air Infiltration (I) No: _____
Elevation Drawing (I) No: _____	Frame Material Supplier Company name: _____
City: _____ State: _____ Zip Code: _____	Street Address: _____ City: _____ State: _____ Zip Code: _____
Country: _____ Phone: _____ Fax: _____	Glazing Material Supplier Company name: _____
City: _____ State: _____ Zip Code: _____	City: _____ State: _____ Zip Code: _____
Country: _____ Phone: _____ Fax: _____	Glazing Contractor/Installer Company name: _____
City: _____ State: _____ Zip Code: _____	City: _____ State: _____ Zip Code: _____
Country: _____ Phone: _____ Fax: _____	Certification Authorization (Independent Certification & Inspection Agency) (IC): _____
Date Certification Authorization Issued: _____	

Doors - Section C402.4.4



Opaque doors having < 50% glass area
Comply with Tables C402.1.3 and C402.1.4

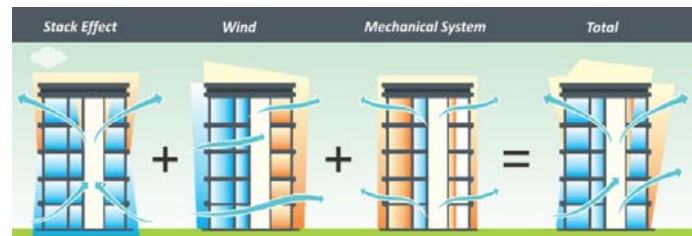
Swinging doors
✓ Meet U-factor requirement



Nonswinging
✓ R-4.75 in all climate zones
All other doors to comply with vertical fenestration requirements

IECC C402.5 Air Leakage Commercial 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
- ✓ **NO STATE AMENDMENTS to commercial leakage**

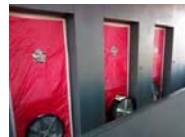


Commercial Air Leakage Section C402.5

Install Air Barriers, specific materials, tested assemblies, caulking sealing- comply with C402.5.1 through C402.5.8



OR

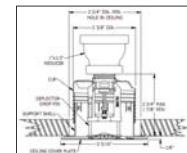


Tested in accordance with ASTM E 779 at pressure differential of 0.3 inch water gauge (75 pascals) or an equivalent method approved by code official when tested air leakage rate ≤ 0.40 cfm/ft²

- Blower door testing
- Tested at a higher pressure than residential 50 pascal test pressure
- Leakage based on square footage rather than cubic footage/volume
- Comply with C402.5.5 through C402.5.7 (air intakes, docks, vestibules)

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

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/ft² 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	1/2 in.
Foil-faced urethane insulation board	1/2 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	1/2 in.
Cement board	1/2 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	

Air Barrier Assemblies (Compliance) - Section C402.5.1.2.2

OR

Assemblies of materials and components (sealants, tapes, etc.) with average air leakage ≤ 0.04 cfm/ft² 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 $> 1/2$ " thick

Other exterior cladding products may comply if tested

Air Leakage of Fenestration - Section C402.5.2

Fenestration Assembly	cfm/ft ²	Test Procedure
Windows, sliding glass doors, and swinging doors	0.20	AAMA/WDMA/CSA 101/1.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	

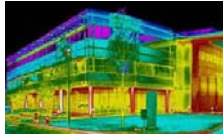
✓ **Exceptions:**

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

Concluding Thought

IECC is founded on principles intended to provide:

- adequately energy conservation – a minimum code
- provisions that do not unnecessarily increase construction costs
- provisions that do not restrict the use of new materials, products or methods of construction
- provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.



Thank You!

- Questions/comments may be addressed to me at:
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If you would like a copy of this presentation, or assistance with other IECC requirements, please email your request to one the above email addresses