CE-16

PART I - IECC: C101.2, C101.4.1, C202, C202 (New), C501.1, CHAPTER 6(New)

PART II - IECC: R202, R202 (New)

Proponent : Sean Denniston (sean@newbuildings.org)

2015 International Energy Conservation Code

Revise as follows:

C101.2 Scope. This code applies to *commercial* and *multifamily buildings* and the buildings' sites and associated systems and equipment.

C101.4.1 Mixed occupancy. Where a building includes ~~both~~ any combination of *multifamily*, *residential* and *commercial* occupancies, each occupancy shall be separately considered and meet the applicable provisions ~~of IECC – Commercial Provisions or IECC – Residential Provisions.~~ for each occupancy.

Add new definition as follows:

SECTION C202 DEFINITIONS

C202 GENERAL DEFINITIONS

Revise as follows:

COMMERCIAL BUILDING. For this code, all buildings that are not included in the definition of "Residential building" or "Multifamily building."

Add new definition as follows:

COMMON AREA. For this code, all portions of a multifamily building that are not *dwelling units* or *sleeping units.*

MULTIFAMILY BUILDING. For this code, all Group R-2 buidlings.

Revise as follows:

RESIDENTIAL BUILDING.
For this code, includes detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group ~~R-2,~~ R-3 and R-4 buildings three stories or less in height above grade plane.

C501.1 Scope. The provisions of this chapter shall control the *alteration*, *repair*, *addition* and change of occupancy of existing *commercial* buildings and structures.

Add new text as follows:

CHAPTER 6 MULTIFAMILY BUILDINGS.

SECTION C601 GENERAL

C601.1 Scope. The provisions in this chapter are applicable to *multifamily buildings* and their building sites.

C601.2 Application. Multifamily buildings shall comply with one of the following:

1. The requirements of ANSI/ASHRAE/IESNA 90.1, provided the *building* has four or more stories.
2. The requirements of Sections C602 through C605.
3. The requirements of Sections C602.5, C603.2, C604, C605.2, C605.3, C605.4, C605.6 and C607. The building energy cost shall be equal to or less than 85 percent of the standard reference design building.

C601.2.1 Application to replacement fenestration products. Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and SHGC in Table C602.4.

Exception: An area-weighted average of the U-factor of replacement fenestration products being installed in the building for each fenestration product category listed in Table C602.4 shall be permitted to satisfy the U-factor requirements for each fenestration product category listed in Table C602.4. Individual fenestration products from different product categories listed in Table C602.4 shall not be combined in calculating the area-weighted average U-factor.

SECTION C602 BUILDING ENVELOPE REQUIREMENTS

C602.1 General (Prescriptive). Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis, in accordance with the compliance path described in Item 2 of Section C601.2, shall comply with the following:

1. The opaque portions of the building thermal envelope shall comply with the specific insulation requirements of Section C602.2 and the thermal requirements of either the R-value-based method of Section C602.1.1; the U-, C-and F-factor-based method of Section C602.1.2; or the component performance alternative of Section C602.1.3.
2. Roof solar reflectance and thermal emittance shall comply with Section C602.3.
3. Fenestration in building envelope assemblies shall comply with Section C602.4.
4. Air leakage of building envelope assemblies shall comply with Section C602.5.

TABLE C602.1.1
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQRUIEMENTS, R-VALUE METHOD[a]

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories
Roofs																
Insulation entirely above roof deck	NA[g]	R-25ci	NA[g]	R-25ci	NA[g]	R-25ci	NA[g]	R-30ci	NA[g]	R-30ci	NA[g]	R-30ci	NA[g]	R-35ci	NA[g]	R-35ci
Metal buildings[a, b]	NA[g]	R-19 + R-11 LS	NA[g]	R-19 + R-11 LS	NA[g]	R-19 + R-11 LS	NA[g]	R-19 + R-11 LS	NA[g]	R-19 + R-11 LS	NA[g]	R-25 + R-11 LS	NA[g]	R-30 + R-11 LS	NA[g]	R-30 + R-11 LS
Steel Truss ceiling[f]	R-38 or R-30+3ci		R-49 or R-38+3ci		R-49 or R-		R-38+5ci		R-38+5ci		R-38+5ci		R-38+5ci		R-38+5ci	

	or R-26+5ci				38+3ci											
Steel Joist Ceiling[f]	R-38 in 2×4 or 2×6 or 2×8, or R-49 in any framing		R-49 in 2×4 or 2×6 or 2×8 or 2×10		R-49 in 2×4 or 2×6 or 2×8 or 2×10		R-49		R-49		R-49		R-49		R-49	
Attic and other	R-30	R-38	R-38	R-38	R-38	R-38	R-49	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-49	R-49
Walls, Above Grade																
Mass[j]	3/4	R-5.7ci[c]	4/6	R-7.6ci	8/13	R-9.5ci	8/13	R-11.4 ci	13/17	R-13.3 ci	15/20	R-15.2 ci	19/21	R-15.2 ci	19/21	R-25ci
Metal building	NA[g]	R-13 + R-6.5ci	NA[g]	R-13 + R-13ci	NA[g]	R-13 + R-13ci	NA[g]	R-13 + R-13ci	NA[g]	R-13 + R-13ci	NA[g]	R-13 + R-13ci	NA[g]	R-13+R-19.5ci	NA[g]	R-13+R-19.5ci
Metal framed, 16" OC	R13+4.2ci or R-19+2.1ci or R-21+2.8ci or R-0+11.2ci or R-15+3.8ci or R-21+3.1ci	R-13 + R-5ci	R13+4.2ci or R-19+2.1ci or R-21+2.8ci or R-0+11.2ci or R-15+3.8ci or R-21+3.1ci	R-13 + R-7.5ci	R-0+14.0ci or R-13+8.9ci or R-15+8.5ci or R-19+7.8ci or R-19+6.2ci or R-21+7.5	R-13 + R-7.5ci	R-0+14.0ci or R-13+8.9ci or R-15+8.5ci or R-19+7.8ci or R-19+6.2ci or R-21+7.5	R-13 + R-7.5ci	R-0+14.0ci or R-13+8.9ci or R-15+8.5ci or R-19+7.8ci or R-19+6.2ci or R-21+7.5	R-13 + R-7.5ci	R-13+12.7ci or R-15+12.3ci or R-19+11.6ci or R-21+11.3ci or R-25+10.9ci	R-13 + R-7.5ci	R-13+12.7ci or R-15+12.3ci or R-19+11.6ci or R-21+11.3ci or R-25+10.9ci	R-13+R-15.6 ci	R-13+12.7ci or R-15+12.3ci or R-19+11.6ci or R-21+11.3ci or R-25+10.9ci	R-13+R17.5ci
Metal framed, 24" OC	R-0+9.3ci or R-13+3.0ci or R-15+2.4ci		R-0+9.3ci or R-13+3.0ci or R-15+2.4ci		R-0+14.0ci or R-13+7.7ci or R-15+7.1ci or R-19+6.3ci or R-21+5.9ci		R-0+14.0ci or R-13+7.7ci or R-15+7.1ci or R-19+6.3ci or R-21+5.9ci		R-0+14.0ci or R-13+7.7ci or R-15+7.1ci or R-19+6.3ci or R-21+5.9ci		R-13+11.5ci or R-15+10.9ci or R-19+10.1ci or R-21+9.7ci or R-25+9.1ci		R-13+11.5ci or R-15+10.9ci or R-19+10.1ci or R-21+9.7ci or R-25+9.1ci		R-13+11.5ci or R-15+10.9ci or R-19+10.1ci or R-21+9.7ci or R-25+9.1ci	
Wood framed and other	R-13	R-13 + R-3.8ci or R-20	R-13	R-13 + R-3.8ci or R-20	R-20 or R-13+5 ci	R-13 + R-3.8ci or R-20	R-20 or R-13+5 ci	R-13 + R-3.8ci or R-20	R-20 or R-13+5 ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-20+5 or R-13+10	R-13 + R-7.5ci or R-20 + R-3.8ci	R-20+5 or R-13+10	R-13 + R-7.5ci or R-20 + R-3.8ci	R-20+5 or R-13+10	R13+R-15.6ci or R-20+R-10ci
Walls, Below Grade																
Below-grade wall[d, h]	NR	NR	NR	NR	5/13[i]	NR	10/13[i]	R-7.5ci	15/19[i]	R-7.5ci	15/19[i]	R-7.5ci	15/19[i]	R-10ci	15/19[i]	R-12.5ci
Floors																
Mass[e]	R-13	NR	R-13	R-8.3ci	R-19	R-10ci	R-19	R-10.4 ci	R-30	R-12.5 ci	R-30	R-12.5 ci	R-30	R-16.7 ci	R-30	R-16.7ci
Metal framed	R-19 in 2×6 or R-19+6ci in 2×8 or 2×10	NR	R-19 in 2×6 or R-19+6ci in 2×8 or 2×10	R-30	R-19+6ci in 2×6 or R-19+12ci in 2×8 or 2×10	R-30	R-19+6ci in 2×6 or R-19+12ci in 2×8 or 2×10	R-30	R-30	R-30	R-30	R-38	R-30	R-38	R-30	R-38

Wood joist/framing	R-13	NR	R-13	R-30	R-19	R-30	R-19	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30
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 48" below	R-15 for 24" below	R-10 for 48" below	R-15 for 24" below	R-10 for 48" below	R-20 for 24" below
Heated slabs[f]	R-5 for 24" below	R-7.5 for 12" below	R-5 for 24" below	R-7.5 for 24" below	R-5 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 36" below	R-15 for 48" below	R-20 for 36" below	R-15 for 48" below	R-20 for 48" below	R-15 for 48" below	R-20 for 48" below

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, LS = Liner system.

1. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.
2. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C602.1.2.
3. 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 °F.
4. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
5. "Mass floors" shall include floors weighing not less than:
6. 35 pounds per square foot of floor surface area; or
7. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
8. Insulation exceeding the height of the framing shall cover the framing.
9. Where NA is listed, a U-factor method in accordance with Sections C602.1.2 or C602.1.3 shall be used.
10. “15/19” means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. “15/19” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. “10/13” means R-10 continuous insulation on the interior or exterior of the wall or R-13 cavity insulation at the interior of the basement wall.
11. Below grade wall insulation is not required in warm-humid locations as defined by Figure C301.1 and Table C301.1.
12. The second R-value applies when more than half the insulation is on the interior of the mass wall.

C602.1.1 Insulation component R-value-based method. Building thermal envelope opaque assemblies shall meet the requirements of Sections C602.2 and C602.4 based on the climate zone specified in Chapter 3. For opaque portions of the building thermal envelope intended to comply on an insulation component R-value basis, the R-values for insulation in framing cavities, where required, and for continuous insulation, where required, shall be not less than that specified in Table C602.1.1, based on the climate zone specified in Chapter 3. The thermal resistance or R-value of the insulating material installed continuously within or on the below-grade exterior walls of the building envelope required in accordance with Table C602.1.1 shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground level, or to the level of the lowest floor of the conditioned space enclosed by the below grade wall, whichever is less. Opaque swinging doors shall comply with Table C602.1.2 and opaque roll-up or sliding doors shall comply with Table C602.1.1.

C602.1.2.1 Thermal resistance of cold-formed steel walls. U-factors of walls with cold-formed steel studs shall be permitted to be determined in accordance with Section C402.1.4.1

C602.1.2 Assembly U-factor, C-factor or F-factor-based method. Building thermal envelope opaque assemblies intended to comply on an assembly U-, C- or F-factor basis shall have a U-, C-or F-factor not greater than that specified in Table C602.1.2. The C-factor for the below-grade exterior walls of the building envelope, as required in accordance with Table C602.1.2, shall extend to a depth of 10 feet (3048 mm) below the outside finished ground level, or to the level of the lowest floor, whichever is less. Opaque swinging doors shall comply with Table C602.1.2 and opaque roll-up or sliding doors shall comply with Table C602.1.1.

TABLE C602.1.2
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQRUIEMENTS, U-FACTOR METHOD[a, b]

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories	1-3 Stories	≥ 4 Stories
Roofs																
Insulation entirely above roof deck	U-0.035	U-0.039	U-0.030	U-0.039	U-0.030	U-0.039	U-0.026	U-0.032	U-0.026	U-0.032	U-0.026	U-0.032	U-0.026	U-0.028	U-0.026	U-0.028
Metal buildings[a, b]		U-0.035		U-0.035		U-0.035		U-0.035		U-0.035		U-0.031		U-0.029		U-0.029
Attic and other		U-0.027		U-0.027		U-0.027		U-0.027		U-0.021		U-0.021		U-0.021		U-0.021
Walls, Above Grade																
Mass	U-0.197[h]	U-0.151	U-0.165[h]	U-0.123	U-0.098[h]	U-0.104	U-0.098[h]	U-0.090	U-0.082[h]	U-0.080	U-0.060[h]	U-0.071	U-0.057[h]	U-0.061	U-0.057[h]	U-0.061
Metal building	U-0.084	U-0.079	U-0.084	U-0.079	U-0.060	U-0.052	U-0.060	U-0.052	U-0.060	U-0.052	U-0.045	U-0.052	U-0.045	U-0.039	U-0.045	U-0.039
Metal framed		U-0.077		U-0.064		U-0.064		U-0.064		U-0.064		U-0.057		U-0.052		U-0.045
Wood framed and		U-0.064		U-0.064		U-0.064		U-0.064		U-0.064		U-0.051		U-0.051		U-0.036

other																
Walls, Below Grade																
Below-grade wall[c]	U-0.360	C-1.140[e]	U-0.360	C-1.140[e]	U-0.091[i]	C-1.140[e]	U-0.059	C-0.119	U-0.050	C-0.119	U-0.050	C-0.119	U-0.050	C-0.092	U-0.050	C-0.092
Floors																
Mass[d]	U-0.064	U-0.322[e]	U-0.064	U-0.087	U-0.047	U-0.076	U-0.047	U-0.074	U-0.033	U-0.064	U-0.033	U-0.057	U-0.028	U-0.051	U-0.028	U-0.051
Joist/framing		U-0.066[e]		U-0.033		U-0.033		U-0.033		U-0.033		U-0.033		U-0.033		U-0.033
Slab-on-grade floors																
Unheated slabs	NA[g]	F-0.73[e]	NA[g]	F-0.73[e]	NA[g]	F-0.73[e]	NA[g]	F-0.54	NA[g]	F-0.54	NA[g]	F-0.52	NA[g]	F-0.40	NA[g]	F-0.40
Heated slabs[f]	NA[g]	F-0.70	NA[g]	F-0.70	NA[g]	F-0.70	NA[g]	F-0.65	NA[g]	F-0.65	NA[g]	F-0.58	NA[g]	F-0.55	NA[g]	F-0.55

For SI: 1 pound per square foot = 4.88 kg/m2, 1 pound per cubic foot = 16 kg/m.3
ci = Continuous insulation, NR = No requirement, LS = Liner system.

1. 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.
2. 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 tested design.
3. Where heated slabs are below grade, below-grade walls shall comply with the F-factor requirements for heated slabs.
4. "Mass floors" shall include floors weighing not less than:
5. 35 pounds per square foot of floor surface area; or
6. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
7. These C-, F-and U-factors are based on assemblies that are not required to contain insulation.
8. Evidence of compliance with the F-factors indicated in the table for heated slabs shall be demonstrated by the application of the unheated slab F-factors and R-values derived from ASHRAE 90.1 Appendix A.
9. Where NA is listed, a R-value method in accordance with Section C602.1.1 shall be used.
10. When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 0.17 in Climate Zone 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.
11. Basement wall U-factor of 0.360 in warm-humid locations as defined by Figure C301.1 and Table C301.1.

C602.1.3 Component performance alternative. Building envelope values and fenestration areas calculated in accordance with Section C402.1.5 utilizing the values from Table C602.1.2.

C602.2 Specific insulation requirements (Prescriptive). In addition to the requirements of Section C602.1, insulation shall meet the specific requirements of Sections C602.2.1 through C602.2.7.

C602.2.1 Multiple layers of continuous insulation board. Where two or more layers of continuous insulation board are used in a construction assembly, the continuous insulation boards shall be installed in accordance with Section C303.2. Where the continuous insulation board manufacturer's instructions do not address installation of two or more layers, the edge joints between each layer of continuous insulation boards shall be staggered.

C602.2.2 Roof assembly. The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C602.1.1 or Table C602.1.2, based on construction materials used in the roof assembly. Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less.
Exceptions:

1. Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted U-factor is equivalent to the same assembly specified in Table C402.1.4.
2. Where tapered insulation is used with insulation entirely above deck, the R-value where the insulation thickness varies 1 inch (25 mm) or less from the minimum thickness of tapered insulation shall comply with Table C602.1.1.
3. Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.

C602.2.3 Thermal resistance of above-grade walls. The R-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C602.1.1 or C602.1.2.
"Mass walls" shall include walls:

1. Weighing not less than 35 psf (170 kg/m2) of wall surface area.
2. Weighing not less than 25 psf(120 kg/m) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m3).
3. Having a heat capacity exceeding 7 Btu/ft2 •°F (144 cage/m2• K).
4. Having a heat capacity exceeding 5 Btu/ft2 •°F (103 kJ/m2 • K), where the material weight is not more than 120 pcf (1900 kg/m3).

C602.2.4 Floors. Floor framing cavity insulation or structural slab insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs.
Exceptions:

1. The floor framing cavity insulation or structural slab insulation shall be permitted to be in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies where combined with insulation that meets or exceeds the minimum R-value in Table C602.1.1 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.
2. Insulation applied to the underside of concrete floor slabs shall be permitted an airspace of not more than 1 inch (25 mm) where it turns up and is in contact with the underside of the floor under walls associated with the building thermal envelope.

C602.2.5 Slabs-on-grade perimeter insulation. The insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. Insulation extending away from the building shall be protected by pavement or by not less than of 10 inches (254 mm) of soil.
Exception: Where the slab-on-grade floor is greater than 24 inches (61 mm) below the finished exterior grade, perimeter insulation is not required.

C602.2.6 Crawl space walls. As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated in accordance with the requirements for above grade walls in Table C602.1.1 when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade

level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the International Building Code or International Residential Code, as applicable. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.

C602.2.7 Insulation of radiant heating systems. Radiant heating system panels, and their associated components that are installed in interior or exterior assemblies shall be insulated with a minimum of R-3.5 (0.62 m2/K • W) on all surfaces not facing the space being heated. Radiant heating system panels that are installed in the building thermal envelope shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the R-value of insulation required in the opaque assembly in which they are installed, or the assembly shall comply with Section C602.1.2.
Exception: Heated slabs on grade insulated in accordance with Section C602.2.5.

C602.3 Roof solar reflectance and thermal emittance. Low-sloped roofs directly above cooled conditioned spaces in Climate Zones 1, 2 and 3 shall comply with Section C402.3.

C602.4 Fenestration (Prescriptive). Fenestration shall comply with Sections C602.4.1 through C602.4.3 and Table C602.4.

TABLE C602.4
BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

CLIMATE ZONE	1			2			3			4 EXCEPT MARINE			5 AND MARINE 4			6			7			
	1-3 Stories	≥ 4 Stories		1-3 Stories	≥ 4 Stories		1-3 Stories	≥ 4 Stories		1-3 Stories	≥ 4 Stories		1-3 Stories	≥ 4 Stories		1-3 Stories	≥ 4 Stories		1-3 Stories	≥ 4 Stories		1-3 Stories
Vertical Fenestration																						
U-factor																						
Fixed fenestration	0.50	0.50		0.40	0.50		0.35	0.46		0.35	0.38		0.32	0.38		0.32	0.36		0.32	0.29		0.32
Operable fenestration	0.50	0.65		0.40	0.65		0.35	0.60		0.35	0.45		0.32	0.45		0.32	0.43		0.32	0.37		0.32
Entrance doors	0.50	1.10		0.40	0.83		0.35	0.77		0.35	0.77		0.32	0.77		0.32	0.77		0.32	0.77		0.32
SHGC																						
Orientationa	**All**	**SEW**	**N**	**All**	**SEW**	**N**	**All**	**SEW**	**N**	**All**	**SEW**	**N**	**All**	**SEW**	**N**	All	**SEW**	**N**	**All**	**SEW**	**N**	**All**
PF < 0.2	0.25	0.25	0.33	0.25	0.25	0.33	0.25	0.25	0.33	0.40	0.40	0.53	NR	0.40	0.53	NR	0.40	0.53	NR	0.45	NR	NR
0.2 ≤ PF < 0.5	0.25	0.30	0.37	0.25	0.30	0.37	0.25	0.30	0.37	0.40	0.48	0.58	NR	0.48	0.58	NR	0.48	0.58	NR	NR	NR	NR
PF ≥ 0.5	0.25	0.40	0.40	0.25	0.40	0.40	0.25	0.40	0.40	0.40	0.64	0.64	NR	0.64	0.64	NR	0.64	0.64	NR	NR	NR	NR
Opaque Doors																						
Swinging	0.50	U-0.61		0.4	U-0.61		0.35	U-0.61		0.35	U-0.61		0.32	U-0.37		0.32	U-0.37		0.32	U-0.37		0.32
Skylights																						
U-factor	0.75	0.75		0.65	0.65		0.55	0.55		0.55	0.5		0.55	0.5		0.55	0.5		0.55	0.5		0.55
SHGC	0.25[b]	0.35		0.25[b]	0.35		0.25[b, c]	0.35		0.40[c]	0.40		NR	0.40		NR	0.40		NR	NR		NR

NR = No requirement, PF = Projection factor.

3. "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.
4. Skylights may be excluded from glazed fenestration SHGC requirements in climate zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.
5. There are no SHGC requirements in the Marine Zone.

C602.4.1 Maximum vertical fenestration area. The vertical fenestration area (not including opaque doors and opaque spandrel panels) shall not be greater than 30 percent of the gross above-grade wall area. The skylight area shall not be greater than 3 percent of the gross roof area.

C602.4.2 Minimum skylight fenestration area. Enclosed *common area* spaces greater than 2,500 square feet (232 m2) in floor area, directly under a roof, with not less than 75 percent of the ceiling area with a ceiling height greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, storage space, gymnasium/exercise center, or workshop shall comply with Section C402.4.2.

C602.4.3 Maximum U-factor and SHGC. The maximum U-factor and solar heat gain coefficient (SHGC) for fenestration shall be as specified in Table C402.4.
The window projection factor shall be determined in accordance with Section C402.4.3.

C602.4.3.1 Increased skylight SHGC. In Climate Zones 1 through 6, skylights shall be permitted a maximum SHGC of 0.60 where located above daylight zones provided with daylight responsive controls.

C602.4.3.2 Increased skylight U-factor. Where skylights are installed above daylight zones provided with daylight responsive controls, a maximum U-factor of 0.9 shall be permitted in Climate Zones 1 through 3 and a maximum U-factor of 0.75 shall be permitted in Climate Zones 4 through 8.

C602.4.3.3 Dynamic glazing. Where dynamic glazing is intended to satisfy the SHGC and VT requirements of Table C602.4, the ratio of the higher to lower labeled SHGC shall be greater than or equal to 2.4, and the dynamic glazing shall be automatically controlled to modulate the amount of solar gain into the space in multiple steps. Dynamic glazing shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall not be permitted.
Exception: Dynamic glazing is not required to comply with this section where both the lower and higher labeled SHGC already comply with the requirements of Table C402.4.

C602.4.3.4 Area-weighted U-factor.
An area-weighted average shall be permitted to satisfy the U-factor requirements for each fenestration product category listed in Table C402.4. Individual fenestration products from different fenestration product categories listed in Table C402.4 shall not be combined in calculating area-weighted average U-factor.

C602.5 Air leakage-thermal envelope (Mandatory). The building thermal envelope shall be constructed to limit air leakage in accordance with this section.

C602.5.1 Verification. *Multifamily buildings* with four or more stories shall comply with Section C402.5. All other *multifamily buildings* shall comply with one of the following:

1. The requirements of Sections C602.5.2 through C602.5.6.
2. The building thermal envelope shall have an air leakage rate of not greater than 0.40 cfm/ft2 (0.2 L/s • m2) when tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official when the tested. The *building* shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

C602.5.2 Building thermal envelope.
The building thermal envelope shall comply with Sections C602.5.2.1 and C602.5.2.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

C602.5.2.1 Installation. The components of the building thermal envelope as listed in Table C602.5.2.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table C602.5.2.1, as applicable to the method of construction. Where required by the code official, an approved third party shall inspect all components and verify compliance.

TABLE C602.5.2.1
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between window/door jambs and framing, and skylights and framing shall be sealed.	
Rim joists	Rim joists shall include the air barrier.	Rim joists shall be insulated.
Floors (including above garage and cantilevered floors)	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extends from the bottom to the top of all perimeter floor framing members.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a	Where provided instead of floor insulation, insulation shall be

	Class I vapor retarder with overlapping joints taped.	permanently attached to the crawlspace walls.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.	-
Narrow cavities	-	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	-
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.
Plumbing and wiring	-	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.	-
HVAC register boots	HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.	-
Concealed sprinklers	When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	-

1. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

C602.5.2.2 Testing. The building or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour in Climate Zones 1 and 2, and three air changes per hour in Climate Zones 3 through 8. Testing shall be conducted in accordance with ASTM E 779 or ASTM E 1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the code official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weather stripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, if installed at the time of the test, shall be open.
4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open.

C602.5.3 Fireplaces.

New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces listed and labeled in accordance with UL 127, the doors shall be tested and listed for the fireplace. Where using tight-fitting doors on masonry fireplaces, the doors shall be listed and labeled in accordance with UL 907.

C602.5.4 Fenestration air leakage.

Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.2 cfm per square foot (1.5 L/s/m2), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m2), when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and listed and labeled by the manufacturer.

Exception: Site-built windows, skylights and doors.

C602.5.5 Rooms containing fuel-burning appliances. In Climate Zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room, isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Tables C602.1.1 or C602.1.2 and C602.4, where the walls, floors and ceilings shall meet not less than the basement wall R-value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section C603. The combustion air duct shall be insulated where it passes through conditioned space to a minimum of R-8.

Exceptions:

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
2. Fireplaces and stoves complying with Section C602.5.3 and Section R1006 of the International Residential Code.

C602.5.6 Recessed lighting. Recessed luminaires installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and labeled as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

SECTION C603 BUILDING MECHANICAL SYSTEMS

C603.1 General. Single-zone mechanical systems and equipment serving the heating, cooling or ventilating needs of individual *dwelling units* or *sleeping units* shall comply with this section. All mechanical equipment serving the heating, cooling or ventilating needs of other portions of the building shall comply with Section C403.

C603.2 Equipment sizing and efficiency rating. Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies. New or replacement heating and cooling equipment shall meet the minimum efficiency requirements of Tables C403.2.3(1), C403.2.3(2), C403.2.3(3), C403.2.3(4), C403.2.3(5), C403.2.3(6), C403.2.3(7), C403.2.3(8) and C403.2.3(9) when tested and rated in accordance with the applicable test procedure.

C603.3 Controls. At least one thermostat shall be provided for each separate heating and cooling system.

C603.3.1 Programmable thermostat. The thermostat controlling the primary heating or cooling system of the *dwelling unit* or *sleeping unit* shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed by the manufacturer with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).

C603.3.2 Heat pump supplementary heat (Mandatory). Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

C603.3.3 Hot water boiler outdoor temperature setback. Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.

C603.4 Mechanical ventilation. The building shall be provided with ventilation that meets the requirements of the *International Residential Code* or *International Mechanical Code*, as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

C603.4.1 Mechanical ventilation system fan efficiency. Mechanical ventilation system fans shall meet the efficacy requirements of Table C603.4.1.

Exception: Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an electronically commutated motor.

TABLE C603.4.1
Mechanical Ventilation System fan Efficiency

FAN LOCATION	AIR FLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIR FLOW RATE MAXIMUM (CFM)
Range hoods	Any	2.8 cfm/watt	Any
In-line fan	Any	2.8 cfm/watt	Any
Bathroom, utility room	10	1.4 cfm/watt	<90
Bathroom, utility room	90	2.8 cfm/watt	Any

For SI: 1 cfm = 28.3 L/min.

C603.5 Ducts. Ducts and air handlers shall be in accordance with Sections C603.5.1 through C603.5.5.

C603.5.1 Insulation. Supply and return ducts in attics shall be insulated to a minimum of R-8 where 3 inches (76 mm) in diameter and greater and R-6 where less than 3 inches (76 mm) in diameter. Supply and return ducts in other portions of the building shall be insulated to a minimum of R-6 where 3 inches (76 mm) in diameter or greater and R-4.2 where less than 3 inches (76 mm) in diameter.

Exception: Ducts or portions thereof located completely inside the building thermal envelope.

C603.5.2 Sealing. Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with either the International Mechanical Code or International Residential Code, as applicable.

Exceptions:

1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.
2. For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams, and locking-type joints and seams of other than the snap-lock and button-lock types.

C603.5.2.1 Sealed air handler. Air handlers shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193.

C603.5.3 Duct testing. Ducts shall be pressure tested to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. All registers shall be taped or otherwise sealed during the test.
2. Post construction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

Exception: A duct air leakage test shall not be required where the ducts and air handlers are located entirely within the building thermal envelope.

A written report of the results of the test shall be signed by the party conducting the test and provided to the code official.

C603.5.4 Duct leakage. The total leakage of the ducts, where measured in accordance with Section C603.5.3, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m2) of conditioned floor area where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3 cubic feet per minute (85 L/min) per 100 square feet (9.29 m2) of conditioned floor area.
2. Post construction test: Total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m2) of conditioned floor area.

C603.5.5 Building cavities. Building framing cavities shall not be used as ducts or plenums.

C603.6 Mechanical system piping insulation. Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) shall be insulated to a minimum of R-3.

C603.6.1 Protection of piping insulation. Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.

SECTION C604 WATER HEATING

C604.1 General. The equipment, piping, controls and storage for hot water systems shall comply with the requirements of with Sections C404.2 through C404.8 and Section C404.11.

C604.2 Pools and Permanent Spas. The energy consumption of pools and permanent spas shall be in accordance with Sections C404.9.1 through C404.9.3 and APSP-15.

C604.3 Energy consumption of portable spas. The energy consumption of electric-powered portable spas shall be shall be in accordance with Section C404.10.

SECTION C605 ELECTRICAL POWER AND LIGHTING SYSTEMS

C605.1 General. The lighting system controls, maximum lighting power for interior and exterior applications and electrical energy consumption of *dwelling units and sleeping units* shall comply with this section. The lighting system controls, maximum lighting power for interior and exterior applications and electrical energy consumption of all other parts of the *building* shall comply with Section C405.

C605.2 Lighting equipment. Not less than 75 percent of the lamps in permanently installed lighting fixtures shall be *high-efficacy lamps* or not less than 75 percent of the permanently installed lighting fixtures shall contain only *high-efficacy lamps*.

Exception: Low-voltage lighting.

SECTION C606 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

C606.1 Requirements. Buildings shall comply with at least one of the following:

1. More efficient HVAC performance in accordance with C406.2.
2. On-site supply of renewable energy in accordance with Section C406.5.
3. High-efficiency service water heating in accordance with Section C406.7.
4. Reduced lighting power in accordance with Section C606.2.
5. Enhanced envelope performance in accordance with Section C606.3.
6. Reduced air infiltration in accordance with Section C606.4

Exception: *Multifamily buildings* that have three or fewer stories.

C606.2 Reduced lighting power density. The total interior lighting power (watts) of the *common areas* shall be determined by using 90 percent of the interior lighting power allowance calculated by the Space-by-Space Method in Section C405.4.2. Additionally, ninety-five percent (95%) of the lamps in permanently installed light fixtures in *dwelling units* and *sleeping units* shall be lamps with a minimum efficacy of:

1. 90 lumens per watt for lamps over 40 watts;
2. 60 lumens per watt for lamps over 15 watts to 40 watts;
3. 45 lumens per watt for lamps over 5 watts to 15 watts and
4. 30 lumens per watt for lamps 5 watts or less.

C606.3 Enhanced Envelope Performance. The total UA of the *building thermal envelope* shall be no greater than eighty-five percent (85%) of the total UA of the *building thermal envelope* allowed in accordance with Section C602.1.4.

C606.4 Reduced Air Infiltration. Air infiltration shall be verified by whole building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air leakage rate of the building envelope shall not exceed 0.25 cfm/ft2 (2.0 L/s•m2) under a pressure differential of 0.3 in. water (75 Pa), with the calculated surface area being the sum of the above and below grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

C606.4.1 Large buildings. Buildings having over 250,000 ft2 (25,000 m2) of conditioned floor area shall be permitted to conduct air infiltration testing on representative above grade sections of the building provided tested areas total at least 25% of the conditioned floor area.

SECTION C607 TOTAL BUILDING PERFORMANCE

C607.1 Scope. This section establishes criteria for compliance using total building performance.

C607.2 Mandatory requirements. Compliance with this section requires that the criteria of Sections C602.5, C603.2, C604 and C605 be met.

C607.3 Requirements. Buildings shall comply with one of the following:

1. Section C407, provided the *building* has four or more stories.
2. Section R405, provided the *building* has three or fewer stories.
3. Section R406, provided the *building* has three or fewer stories.

SECTION C608 EXISTING MULTIFAMILY BUILDINGS

C608.1 Scope. The *alteration, repair, addition* and *change of occupancy* of existing *multifamily buildings* and structures shall be in accordance with Sections C501, C504 and C505 and this section.

C608.2 Additions. Additions to an existing building, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code. Additions shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this code if the addition alone complies or if the existing building and addition comply with this code as a single building.
Additions complying with ANSI/ASHRAE/IESNA 90.1.need not comply with Sections C602, C603, C604 and C605.

C608.2.1 Vertical fenestration. New vertical fenestration area that results in a total building fenestration area less than or equal to that specified in Section C602.4.1 shall comply with Section C602.4. Additions that result in a total building vertical fenestration area exceeding that specified in Section C402.4.1 shall comply with Section C607.

C608.2.2 Skylight area. New skylight area that results in a total building fenestration area less than or equal to that specified in Section C602.4.2 shall comply with Section C602.4. Additions that result in a total building skylight area exceeding that specified in Section C602.4.2 shall comply with Section C607.

C608.2.3 Building mechanical systems. New mechanical systems and equipment that are part of the addition and serve the building heating, cooling and ventilation needs shall comply with Section C603.

Exception: Where ducts from an existing heating and cooling system are extended to an addition, duct systems with less than 40 linear feet (12.19 m) in unconditioned spaces shall not be required to be tested in accordance with Section C603.5.3.

C608.2.4 Service water-heating systems. New service water-heating equipment, controls and service water heating piping shall comply with Section C604.

C608.2.5 Pools and permanently installed spas. New pools and permanently installed spas shall comply with Section C604.2.

C608.2.6 Lighting power and systems. New lighting systems that are installed as part of the addition shall comply with Section C605.

C608.2.6.1 Interior lighting power. The total interior lighting power for the addition shall comply with Sections C405.4.2 and C605.2 for the addition alone, or the existing building and the addition shall comply as a single building.

C608.2.6.2 Exterior lighting power. The total exterior lighting power for the addition shall comply with Sections C405.5.1 and C605.2 for the addition alone, or the existing building and the addition shall comply as a single building.

C608.3 Alterations. Alterations to any building or structure shall comply with the requirements of the code for new construction. Alterations shall be such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the alteration. Alterations to an existing building, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this code. Alterations shall not create an unsafe or hazardous condition or overload existing building systems.
Alterations complying with ANSI/ASHRAE/IESNA 90.1. need not comply with Sections C602, C603, C604 and C605.

Exception: The following alterations need not comply with the requirements for new construction, provided the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.
2. Surface-applied window film installed on existing single-pane fenestration assemblies reducing solar heat gain, provided the code does not require the glazing or fenestration to be replaced.
3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. Roof recover.
6. Air barriers shall not be required for roof recover and roof replacement where the alterations or renovations to the building do not include alterations, renovations or repairs to the remainder of the building envelope.

C608.3.1 Change in space conditioning. Any nonconditioned or low-energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.

C608.3.2 Building envelope. New building envelope assemblies that are part of the alteration shall comply with Sections C602.1 through C602.5.

C608.3.2.1 Roof replacement. Roof replacements shall comply with Table C602.1.1 or Table C602.1.2 where the existing roof assembly is part of the building thermal envelope and contains insulation entirely above the roof deck.

C608.3.2.2 Vertical fenestration. The addition of vertical fenestration that results in a total building fenestration area less than or equal to that specified in Section C602.4.1 shall comply with Section C602.4. Alterations that result in a total building vertical fenestration area exceeding that specified in Section C402.4.1 shall comply with Section C607.

C608.3.2.3 Skylight area. The addition of skylight area that results in a total building skylight area less than or equal to that specified in Section C602.4.2 shall comply with Section C602.4. Alterations that result in a total building skylight area exceeding that specified in Section C402.4.2 shall comply with Section C607.

C608.3.3 Heating and cooling systems. New heating, cooling and duct systems that are part of the alteration shall comply with Sections C603.
Exception: Where ducts from an existing heating and cooling system are extended, duct systems with less than 40 linear feet (12.19 m) in unconditioned spaces shall not be required to be tested in accordance with Section C603.5.3.

C608.3.4 Service hot water systems. New service hot water systems that are part of the alteration shall comply with Section C604.

C608.3.5 Lighting systems. New lighting systems that are part of the alteration shall comply with Section C605.
Exception. Alterations that replace less than 10 percent of the luminaires in a space, provided that such alterations do not increase the installed interior lighting power.

GENERAL DEFINITIONS

Revise as follows:

COMMERCIAL BUILDING. For this code, all buildings that are not included in the definition of "Residential building" or "Multifamily building."

Add new definition as follows:

COMMON AREA. For this code, all portions of a multifamily building that is not a dwelling unit or sleeping unit.

MULTIFAMILY BUILDING. For this code, all Group R-2 buildings.

Revise as follows:

RESIDENTIAL BUILDING. For this code, includes detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group ~~R-2,~~ R-3 and R-4 buildings three stories or less in height above grade plane.

Reason: Multifamily poses a conundrum for energy regulation. Generally, these buildings are constructed and renovated like commercial buildings, but used like residential buildings. As a result, the regulation of multifamily buildings has been split between the residential and the commercial codes. Multifamily buildings that are four stories and higher are considered high-rise and regulated by the commercial chapter of the International Energy Conservation Code (IECC). However, with their residential usage patterns and loads, they don't truly fit a commercial code with its focus on commercial loads and usage patterns. Multifamily buildings that are three stories or lower are regulated by the residential chapter of the IECC. However, with their larger size and higher occupant density, these low-rise multifamily buildings don't truly fit in a residential energy code with its focus on single family homes.
The result is energy regulation that does not adequately serve the multifamily market:

- Regulation by two different energy codes complicates both code compliance and code enforcement.
- Neither the Commercial nor the Residential code was crafted to address the unique characteristics of the multifamily building type.
- Advancing the energy code for multifamily is hindered by the necessity of pursuing changes simultaneously in two different codes, both of which are dominated by issues of building types other than multifamily.
- The presence of two different code baselines has made it very difficult to create above-code energy standards and efficiency programs that apply to all multifamily buildings.

This proposal will solve these problems by creating a single set of requirements for all multifamily buildings and placing them in a dedicated chapter of the IECC. The proposal is the result of an extensive analysis of the existing code language and requirements and a broad-reaching stakeholder engagement process.

New Buildings Institute, with the assistance of the Britt Makela Group, did a side-by side analysis of all of the code provisions that apply to multifamily buildings from the commercial and residential sections of the IECC. This analysis revealed the similarities and differences between the provisions of the two sections as well as where one section covers a topic and another doesn't.

NBI recruited a Technical Advisory Group of experts in multifamily housing, codes and energy efficiency to help advise the process. Over the course of multiple conference calls, the group helped identify the key issues facing the effort to create a single set of requirements for multifamily buildings, and provided feedback on the emerging proposal language. This group included Louis Starr of the Northwest Energy Efficiency Alliance, Don Surrena and Craig Drumheller of the National Association of Home Builders, Darren Port of the Northeast Energy Efficiency Partnership, Bing Liu, Todd Taylor and Jian Zhang of the Pacific Northwest National Laboratory, Jay Bhakta of Southern California Edison, Kosol Kiatreungwattana of the National Renewable Energy Laboratory, Doug King of King Sustainability, Eric Makela of the CADMUS Group, Jim Meyers of Southwest Energy Efficiency Project, Ron Nickson of the National Multifamily Homes Council, Thomas Culp of Birch Point Consulting, Nehemiah Stone of Stone Energy Associates, Matthew Root of CLEAResult, Jim Edelson of NBI, David Cohan of the US Department of Energy and Eric Foley of Earth Advantage (the involvement of the above individuals and organizations should not be taken as support for the proposal or inclusion as co-proponents).

NBI also engaged other groups and individuals outside of the TAG on dedicated topics such as envelope requirements, infiltration, energy rating systems and usability for code officials.

Finally, NBI promoted and hosted a national webinar with nearly 100 attendees to inform a wide array of stakeholders in order to inform them about the effort, explain the proposal in its current draft at the time and to solicit additional feedback.

The entire process was informed by an energy analysis performed by the Pacific Northwest National Lab. The lab compared energy impact of the residential and commercial provisions using a set of standard multifamily building prototypes: a two-story breezeway eight-plex, a 4 story mid-rise and a 10 story high-rise. Each prototype was modeled using the commercial code provisions and the residential code provisions and the results compared. This comparison demonstrates the gap in energy outcomes that exists between the two sets of provisions. It also was used to help identify the regulation differences that have the greatest energy impact.

The table below shows the impact of moving from one code to the other. In all cases, the other code was less stringent than the native code. In the case of low-rise multifamily, this is largely because for the two-story low-rise prototype, the enhanced lighting option was chosen to meet the additional efficiency requirements from Section C406. This option was chosen since it would be the least costly; however, it is the least costly because it requires this prototype to do almost nothing. For context, when a 3-story version of the 4-story midrise building was created, switching to the commercial code resulted in greater efficiency. In this case, the additional efficiency option made a larger impact and the difference in infiltration requirements made a larger difference in part due to increased height and stack effect.

Image 1452

The result of this analysis shows that the two sets of energy requirements in the code result in significantly and inconsistently different energy outcomes in multifamily buildings. This fact emphasizes the importance of this effort to bring coherence to the multifamily market.

One issue in particular, the difference in the infiltration requirements between the commercial and residential sections, represents such a significant difference between the codes that it was modeled separately. Each prototype was modeled using its native code and then only the infiltration requirement from the other code was substituted for comparison. The results of this analysis demonstrates how it would not be possible to move to a single infiltration standard for infiltration without having a significant impact on stringency.

Image 1469

Once the proposal was substantially complete, the provisions of the proposal were compared back against the commercial and residential requirements. The results of this analysis shows that the proposal had absolutely no impact on

the 10-story high-rise and 4-story mid-rise prototypes currently subject to commercial code. The proposal had a very small impact (.1% on average) on the low-rise prototype had due to the extension of commercial outdoor lighting requirements to low-rise multifamily projects.

Image 1427

If this proposal is adopted, the IECC will be improved substantially for its use with multifamily buildings:

- Both code compliance and code enforcement will be less complicated and therefore less costly
- The energy code will more directly address multifamily buildings
- A single code baseline will make it easier to create an above-code standard for Green standards, utility programs and recognition programs above-code standards, Green Standards, utility incentive programs, and other recognition efforts
- Over time, the multifamily section of the code can be tuned to better address the issues particular to multifamily buildings
- Multifamily code issues will no longer complicate the development of the Residential and Commercial codes

The result is a proposal that gathers all multifamily provisions into a single chapter in the commercial section of the IECC. The commercial section was chosen since, in general, multifamily buildings are built more like commercial buildings. The proposal was developed in line with a handful of principles developed largely through the input of the broad body of stakeholders:

- **Leverage existing code language:** Existing code language was used almost exclusively. This minimizes the disruption of the structural change for code users and code officials since most of the language will be familiar. It also focuses the nature of the proposal on restructuring.
- **Avoid stringency changes:** The proposal is intended to primarily be a structural change. It was crafted to keep minimize any impact on stringency, either to increase or decrease it. In some places, this means maintaining the high- and low-rise split where the requirements of the residential and commercial sections of the code are very different.
- **Maximize Usability:** As the proposal makes extensive use of existing code language, there are two competing usability issues. References to existing sections in the commercial and residential sections of the code has the advantage of reducing code length and minimizing the chance of code language divergence in parallel requirements but has the disadvantage of necessitating a lot of flipping back and forth between parts of the code book by the code user and code official. Replication of existing code sections in the new multifamily chapter has the advantage of clarity and minimizing the need to move around the code book but has the disadvantage of increasing code length, creating greater likelihood of language divergence in parallel requirements and burdening the chapter with code requirements that only apply to a small percentage of multifamily buildings (eg, requirements for complex HVAC systems will only apply to the small percentage of multifamily projects that have complex HVAC systems, most multifamily projects have simple HVAC systems and users only need to use the much smaller set of requirements that apply to those systems).

To balance these competing usability needs, the proposal uses references when requirements align with commercial requirements since the commercial energy chapter is in the same part of the code and those requirements only apply to a small part of multifamily projects (the non-dwelling unit and non-sleeping unit areas) of small percentage of multifamily projects. Where requirements align with requirements from the residential section, that code language was duplicated in the new multifamily chapter. These requirements are often the primary requirements for multifamily projects and locating the language in the multifamily chapter eliminates the need for code users and officials to frequently flip to a whole other part of the code.

Following those principles, the following goes into detail about some specific parts of the proposal.

Definitions:

The proposal creates a new definition for "multifamily building" and modifies the existing definitions for "residential building" and "commercial building" to remove multifamily buildings from them. The definition for multifamily building leverages the occupancy designation R-2 that already exists in the IBC. This defines what is most often considered "multifamily" construction as it encompasses apartment buildings. It also excludes hotels and motels as well as institutional housing arrangements like prisons and long-term care facilities as these have usages and usage patterns that are less residential in character and less like what most people think of as multifamily. The definitions are modified in both the residential and commercial sections of the code.

C101.2 Scope:

Since the proposal removes multifamily buildings from the definitions of commercial and residential buildings, the scope of the commercial section is also modified to include the newly defined multifamily building. No change is needed for the residential scoping section since it depends on the definition of "residential building" and the modification is made there.

C101.4.1 Mixed occupancy.

The mixed occupancy section is also modified to include multifamily buildings. This is vitally importance as commercial/multifamily is the dominant mixed occupancy type.

C601:

The rest of the language largely mirrors the same language and structure of the commercial energy chapter, using the same section order and divisions as much as possible. The application section (C601.2) defines the ASHRAE 90.1 alternative compliance option (but limits that option to multifamily buildings four stories and taller since that is 90.1's scope), a prescriptive compliance option and a performance compliance option.

C602:

C602 includes the envelope requirements. Much of the envelope language was very similar between the commercial and residential sections. There are two areas of significant difference between the two sections: insulation/window requirements and infiltration requirements. The envelope tables in both the commercial and residential sections are the result of prolonged debate and compromise. To simply pick a single set of requirements for the multifamily chapter would result in a change of stringency in many situations – sometimes more stringent, sometimes less – and would circumvent that process of compromise. Therefore, the envelope requirements in the proposal preserve the split between high and low rise multifamily. Both high and low rise will be subject to the same requirements that they were in the 2015 IECC. However, both sets of requirements are gathered in a single table (rather than two), so that if that process of debate and compromise can come to a single set of requirements that are appropriate for all multifamily buildings, the structure of the section will be able to accommodate it without significant change.

The other significant difference between the commercial and residential sections is the infiltration requirements. Infiltration testing is required in the residential section, but is a compliance alternative in the commercial. Further, both the metrics and testing pressures are different for the two chapters. The commercial uses a metric based on the surface area of the envelope and residential uses a metric based on volume. When the two requirements were applied to the set of prototypes used in the analysis, PNNL found significantly different energy outcomes. Additionally, it is currently a hot debate topic over which metric is superior. Therefore, it would be impossible to come to a single set of requirements for infiltration without creating a significant change in requirements for at least part of the multifamily market. For this reason, the proposal maintains the high- low-rise split here as well. Hopefully, a single set of requirements can be developed in the future. When that happens the structure created by the proposal will be able to easily accept it.

The infiltration section in the proposal is structured so that multifamily projects that are four or more stories are directed to the commercial infiltration requirements. For multifamily projects with 3 or fewer projects, the proposal reproduces the infiltration requirements from the residential section. Low-rise multifamily projects have been given the additional option of meeting the commercial testing requirements instead of the residential testing requirements. Although PNNL's analysis found that the commercial testing requirements are most stringent, this is only an option so it does not increase the stringency for low-rise multifamily projects. The option is being included to offer simplified testing for mixed use, low-rise multifamily projects so that the entire project can be tested with a single testing protocol.

The 30% window to wall ratio limit is preserved from the commercial section because it is an essential part of the energy performance of high-rise multifamily, but low-rise multifamily projects rarely include that much glass. The market reality allows the requirement to be retained for the high-rise market segment and added to the low-rse market segment without really creating an impact on stringency.

C603:

The mechanical section takes an approach meant to both preserve the simplicity of the approach in the residential section but still adequately address the complex systems that can be found in larger multifamily buildings. The requirements for single-zone systems that serve dwelling units and sleeping units are reproduced from the residential system. These simple systems will, therefore, have simple requirements. More complex systems and systems that serve the parts of the building other than dwelling units and sleeping units are required to meet the mechanical system requirements of the commercial chapter by reference. This way, more complex systems, and systems serving common areas, which are more like commercial spaces in character, are adequately covered without requiring simple, residential style systems in dwelling units and sleeping units to comply with the more complex set of requirements or for users to have to parse through them.

C604:

The water heating requirements in the commercial chapter adequately cover both simple tanked systems and more complex central systems and is substantively the same as the residential requirements. This section therefore is largely a reference to the commercial chapter. There is specific language for spas and pools since the commercial language is somewhat incomplete and the residential language makes specific reference to singe family homes. This section also provides the structure so that future, multifamily-specific requirements can be accommodated.

C605:

The lighting requirements follow the same approach as the HVAC requirements. The section defines the requirements for dwelling units and sleeping units and those requirements are drawn from the residential section. Lighting in the non-dwelling unit non-sleeping unit areas of the building, with their more commercial character, are subject to the commercial chapter requirements by reference. The high-efficacy lamp requirements in the proposal are reproduced from the residential chapter.

C606:

Section 406 is an important part of the energy savings of the commercial section. However, only three of the six options offered in Section C406 apply well to multifamily. In order to address this, the proposal adds three more options to the three options that work for multifamily in C406. The options for more efficiency HVAC performance, onsite renewable energy and high efficiency water heating are included as references to section C406. The three additional options are reduced lighting power, enhanced envelope performance and reduced air infiltration. These three options are derived largely from new language going into the Washington State code for section C406. Because the additional efficiency options would represent a change in stringency for low-rise multifamily, the proposal exempts multifamily projects that are three stories or less, maintaining the stringency level for low-rise multifamily.

C607:

Section provides the total building performance compliance alternative for the chapter. The existing software and energy rating tools that enable modeled performance-based compliance or energy rating system-based performance in the existing commercial and residential sections have been crafted to serve those code baselines. Residential modeling software and energy rating systems are not set up to serve high-rise multifamily projects. And the modeling software that serves the commercial section and high-rise multifamily projects is much more complicated and costly than the tools available for the typically smaller low-rise projects. Because of the importance of these tools, a new approach just for a unified multifamily project cannot be created at this time.

Therefore, the section preserves the high- and low-rise split in multifamily and directs projects to the residential and commercial "Total Building Performance" options already in the code. However, many people in the multifamily market feel that multifamily project types are not served well by the existing tools. This structure easily accommodates the later addition of total building performance models that have been created to serve the multifamily market. And by eliminating the split in that market, the proposal also makes it easier for dedicated multifamily tools to be created since those tools would only have to deal with a single code baseline instead of two.

C608:

For the 2015 IECC, a whole new chapter for existing buildings was created. The way that chapter is created, parts of it are very specific to commercial buildings. The additions and alterations sections are filled with specific references to the energy requirements of chapter 4. With this proposal, those requirements would no longer apply to multifamily buildings. Adding the references to make the existing chapter 5 work for both commercial and multifamily buildings would significantly complicate that chapter.

Therefore, the proposal leverages the portions of chapter 5 that are not commercial building specific – C501 General, C504 Repairs and C505 Change of Occupancy. It then creates new versions of the Additions and Alterations sections that have been crafted to work with the new multifamily requirements.

Section 501.1

The scope of Chapter 5 was also modified to make it applied specifically to commercial buildings and not all buildings regulated by the commercial section.

Cost Impact: Will not increase the cost of construction
As this proposal almost exclusively restructures the requirements of the code without changing them, there will be no increase in cost for projects. Project cost may actually go down in some cases as the proposal improves the usability of the code for multifamily building projects, which should reduce the amount of time that must be dedicated to code compliance.

CE-16 : C501.1-DENNISTON12705