Energy Systems Laboratory Stringency Analysis for Commercial & Residential Over 3 Stories: 2015 vs 2021 IECC

2015 Fenestration Maximum U-factor and SHGC, Envelope Minimum R-value, and Maximum Air leakage (Table C402. 4, Table C402.1.3, C402.5.2)

	CZ1		CZ2		CZ3		CZ4	
Window U-factor	0.50		0.50		0.46		0.38	
Window SHGC	SEW	N	SEW	N	SEW	N	SEW	N
	0.25	0.33	0.25	0.33	0.25	0.33	0.40	0.53
Attic and other	R-38		R-38		R-38		R-38	
Insulation entirely above roof deck	R-20ci		R-25ci		R-25ci		R-25ci	
Wood framed Wall and other	R-20 or R-13+3.8ci		R-20 or R-13+3.8ci		R-20 or R-13+3.8ci		R-20 or R-13+3.8ci	
Floor R-value (Joist/framing)	NR		R-30		R-30		R-30	
Slab R-value (Unheated)	NR		NR		NR		R-10 for 24″ below	
Air leakage	≤0.4CFM/ft^2		≤0.4CFM/ft^2		≤ 0.4 CFM/ft^2 Vestibules		≤ 0.4 CFM/ft^2 Vestibules	

2021 Fenestration Maximum U-factor, SHGC, and Envelope Minimum R-value, and Maximum Air leakage (Table C402. 4, Table C402.1.3, C402.5.3)

	CZ1	CZ2	CZ3	CZ4
Window U-factor	0.50	0.45	0.42	0.36
Window SHGC	0.23	0.25	0.25	0.36
Attic and other	R-38	R-38	R-38	R-49
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci
Wood framed Wall and other	R-20 or R-13+R-3.8ci	R-20 or R-13+R-3.8ci	R-20 or R-13+R-3.8ci	R-20 or R-13+R3.8ci
Floor R-value (Joist/framing)	R-13	R-30	R-30	R-30
Slab R-value (Unheated)	NR	NR	R-10 for 24″ below	R-15 for 24″ below
Air leakage	≤ 0.4 CFM/ft^2	≤ 0.4 CFM/ft^2	≤ 0.4 CFM/ft^2 Vestibules	≤ 0.4 CFM/ft^2 Vestibules

Stringency Analysis:

Window U-factor:

- *For CZ1 the window U-factor in the 2021 IECC (CZ1=0.50) is as stringent as the U-factor in the 2015 IECC (CZ1=0.50)*
- *For CZ2 the window U-factor in the 2021 IECC (CZ2=0.45) is more stringent than the U-factor in the 2015 IECC (CZ1=0.50)*
- *For CZ3 the window U-factor in the 2021IECC (CZ3=0.42) is more stringent than the U-factor in the 2015 IECC (CZ3=0.46)*
- *For CZ4 the window U-factor in the 2021IECC (CZ4=0.36) is more stringent than the U-factor in the 2015 IECC (CZ4=0.38)*

Window SHGC:

- *For CZ1 the window SHGC in the 2021 IECC (CZ1=0.23) is more stringent than the SHGC in the 2015 IECC (CZ1, S, E, W=0.25, or N=0.33)*
- *For CZ2 & CZ3 the window SHGC in the 2021 IECC (CZ2 & CZ3=0.25) is as the SHGC in the 2015 IECC (CZ2, S, E, W=0.25), and is more stringent (0.36) than the SHGC in the 2015 IECC (CZ2 N=0.33).*
- *For CZ4 the window SHGC in the 2021 IECC (CZ1=0.36) is more stringent than the SHGC in the 2015 IECC (CZ1, S, E, W=0.40, or N=0.53)*

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Stringency Analysis:

Attic & Other R-value:

- *For CZ1, CZ2 & CZ3 the Attic and Other R-value in the 2021 IECC (R-38) is as stringent the Attic and Other R-value in CZ1, CZ2 & CZ3 the 2015 IECC (R-38)*
- *For CZ4 the Attic and Other R-value in the 2021 IECC (R-49) is more stringent than the ceiling R-value for CZ4 in the 2015 IECC (R-38)*

Insulation entirely above roof deck:

- *For CZ1, CZ2, CZ3 & CZ4 the Insulation entirely above the roof deck in the 2021 IECC (CZ1=R-20ci, CZ2, CZ3 & CZ4=R-25ci) is as stringent the Insulation entirely above the roof deck in the 2015 IECC.*

Wood framed Wall and other:

- *For CZ1, CZ2, CZ3 & CZ4 the Wood framed wall and other Insulation in the 2021 IECC (R-20 or R-13+R-3.8ci) is as stringent the Wood framed wall and other Insulation in the 2015 IECC (R-20 or R-13+R-3.8ci).*

Floor R-value (Joist/framing)

- *For CZ1 the floor R-value in the 2021 IECC (CZ1=R-13) is more stringent than the floor R-value in the 2015 IECC (CZ1=NR) and is as stringent for CZ2, CZ3 & CZ4 (R-30) as the Floor R-value in the 2015 IECC (R-30).*

Slab R-value (Unheated)

- *For CZ1 and CZ2 the slab R-value in the 2021 IECC (CZ1, CZ2=NR) is as stringent as the slab R-value in the 2015 IECC (CZ1, CZ2=NR).*
- *For CZ3 the slab R-value in the 2021 IECC (R-10 for 24" below) is more stringent than the slab R-value in the 2015 IECC (NR)*
- *For CZ4 the slab R-value in the 2021 IECC (R-15 for 24" below) is more stringent than the slab R-value in the 2015 IECC (R-10 for 24" below)*

Air leakage

- *For CZ1 and CZ2 the air leakage in the 2021 IECC (CZ1, CZ2 <= 0.4 CFM/ft2) is as stringent as the air leakage in the 2015 IECC.*
- *For CZ3 and CZ4 the air leakage in the 2021 IECC (CZ3, CZ4 <=0.4 CFM/ft2, vestibules) is as stringent as the air leakage in the 2015 IECC.*

Energy Systems Laboratory Stringency Analysis for Commercial & Residential Over 3 Stories: 2015 vs 2021 IECC

2015 Minimum Efficiency Requirements
(Table C403.2.3 (1), Table C403.2.3 (2), Table C403.2.3 (4))

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency
Air Conditioner, Air Cooled	< 65,000 Btu/h	Split System	14 SEER (1/1/2016)
Air Cooled (Heating mode) Heat Pump	< 65,000 Btu/h	Split System	8.2 HSPF (1/1/2016)
Air Cooled (Heating mode) Heat Pump	≥ 135,000 Btu/h	47°Fdb/43°Fwb outdoor air	3.2 COP
Warm-air furnaces, gas fired	< 225,000 Btu/h	–	78% AFUE or 80% E_t
	≥ 225,000 Btu/h	Maximum capacity	80% E_t

2021 Minimum Efficiency Requirements
(Table C403.3.2 (2), Table C403.3.2 (5))

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency
Air Conditioner, Air Cooled	< 66,000 Btu/h	Split System	14 SEER (before 1/1/23)
Air Cooled (Heating mode) Heat Pump	< 65,000 Btu/h	Split System	8.2 HSPF (before 1/1/23)
Air Cooled (Heating mode) Heat Pump	≥ 135,000 Btu/h	47°Fdb/43°Fwb outdoor air	3.2 COP (before 1/1/23)
Warm-air furnaces, gas fired	< 225,000 Btu/h	Maximum capacity	80% E_t (Before 1/1/2023)

Stringency Analysis:

Air-conditioner, air-cooled.

• A split-system, air-cooled unit that is less than 66,000 Btu/h, in the 2021 IECC (14 SEER before 1/1/23) is as stringent as the same system in the 2015 IECC (SEER 14, 1/1/2016).

Air-Cooled (heating mode) Heat Pump

• An air cooled, split-system, in the heating mode (Heat Pump), that is less than 65,000 Btu/h in the 2021 IECC (8.2 HSPF, 1/1/2016) is as stringent as the same system in the 2015 IECC (8.2 HSPF, 1/1/2016).

• An air cooled, split-system, in the heating mode (Heat Pump), that is equal to or greater than 135,000 Btu/h, in the 2021 IECC (3.2 COP) is as stringent as the same system in the 2015 IECC (3.2 COP).

Warm-air furnace, gas fired.

• A gas-fired, warm-air furnace that is less than 225,000 Btu/h, in the 2021 IECC (80% Et, before 1/1/2023) is as stringent as the same system in the 2015 IECC (80% Et).

2015 Service Water Heat – Minimum Performance of Water-Heating Equipment (2015 IECC Table C404.2)

Equipment Type	Size Category	Subcategory of Rating Condition	Performance Required
Water heaters, electric	≤ 12 kW	Resistance	0.97- 0.00132V, EF
	≤ 24 amps and ≤ 250 volts	Heat Pump	0.93-0.00132V, EF
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gallons	0.67-0.0019V, EF
Instantaneous water heaters, gas	> 50,000 Btu/h and < 200,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 2 gallons	0.62-0.0019V, EF

2021 Service Water Heat – Minimum Performance of Water-Heating Equipment (2021 IECC Table C404.2)

Equipment Type	Size Category	Subcategory of Rating Condition	Performance Required
Water heaters, electric	≤ 12 kW	Resistance ≥ 20 gallons and ≤ 55 gallons	0.96-0.0003V, EF
	≤ 24 amps and ≤ 250 volts	Heat Pump ≥ 55 gallons and ≤ 120 gallons	2.057-0.00113V, EF
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gal and ≤ 55 gallons	0.675-0.0015V, EF
		> 55 gal and ≤ 100 gallons	0.8012-0.00078V, EF
Instantaneous water heaters, gas	> 50,000 Btu/h and < 200,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 2 gallons	0.82-0.0019V, EF

Stringency Analysis:

Electric Resistance Water Heaters,

- *The electric resistance water heater that draws less than 12 kW that provides 20 to 55 gallons of hot water in the 2021 IRC / IECC (EF=0.96 – 0.0003V) is more stringent than the same water heater in the 2015 IRC / IECC (EF=0.97-0.00132V).*

Heat Pump Water Heaters,

- *The heat pump water heater that draws less than 24 Amps and 250 Volts or less in the 2021 IRC / IECC (EF=2.057-0.00113V) is more stringent than the same water heater in the 2015 IRC / IECC (EF=0.93-0.00132V).*

Natural gas storage-type water heaters,

- *The natural gas storage-type water heater that is 75,000 Btu/h or less and provides more than 20 gallons but less than 55 gallons of hot water in the 2021 IRC / IECC (EF=0.675-0.0015V) is more stringent than the same water heater in the 2015 IRC / IECC (0.067-0.0019V EF).*
- *The natural gas storage-type water heater that is greater than 75,000 Btu/h and provides more than 55 gallons but less than 100 gallons of hot water in the 2021 IRC / IECC (EF=0.8012-0.00078V) is more stringent than the same water heater in the 2015 IRC / IECC (0.067-0.0019V EF).*

Instantaneous water heaters,

- *The instantaneous water heater that is greater than 50,000 Btu/h and less than 200,000 Btu/h and provides 4,000 Btu/h or more, containing 2 gallons or less of hot water in the 2021 IRC / IECC (0.82-0.0019V, EF) is more stringent than the same water heater in the 2015 IRC / IECC (0.067-0.0019V EF).*

Energy Systems Laboratory Stringency Analysis for Commercial & Residential Over 3 Stories: 2015 vs 2021 IECC

2015 New Building Compliance: To be compliant with the 2015 IECC building energy code a new Commercial Building must comply with one of the following:

- The requirements of ANSI/ASHRAE/IESNA Standard 90.1-2013;

or

(Prescriptive)

- Section C402 (Building Thermal Envelope),
- Section C403 (Mechanical Systems),
- Section C404 (Service Water Heating), and
- Section C405 (Electrical Power and Lighting). In addition, commercial buildings shall comply with Section 406 (Additional Efficiency Options), and tenant spaces shall comply with Section 406.1.1.

or

(Total Building Performance)

- Section C407 (Total Building Performance), includes compliance with mandatory provisions of:
  - Section C402.5 (Air Leakage – Thermal Envelope),
  - Section C403.2 (Mechanical Systems),
  - Section C404 (Service Water Heating),
  - Section C405.2 (Lighting and Controls),
  - Section C405.3 (Exit Signs),
  - Section C405.4 (Interior Lighting Power Requirements),
  - Section C405.6 (Electrical Energy Consumption).

and

- Section C406: Additional Efficiency Package Options. Buildings shall comply with at least one of the following:
  1. More efficient HVAC performance in accordance with Section C406.2.

2021 New Building Compliance: To be compliant with the 2021 IECC building energy code a new Commercial Building must comply with one of the following:

- The requirements of ANSI/ASHRAE/IESNA Standard 90.1-2019;

or

(Prescriptive)

- Section C402 (Building Envelope Requirements),
- Section C403 (Building Mechanical Systems),
- Section C404 (Service Water Heating),
- Section C405 (Electrical Power and Lighting Systems),
- Section C406 (Additional Efficiency Options) New buildings shall achieve a total of 10 credits from Table C406.1.1 through C406.1.5 (selected by weighted use by group of the building)
  1. More efficient HVAC performance in accordance with Section C406.2.
  2. Reduced lighting power density system in accordance with Section C406.3.
  3. Enhanced lighting controls in accordance with Section C406.4.
  4. On-site supply of renewable energy in accordance with Section C406.5.
  5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
  6. High-efficiency service water heating in accordance with Section C406.7 by building type.
  7. Enhanced envelope performance in accordance with Section 406.8.
  8. Reduced air infiltration in accordance with Section C406.9.

Stringency Analysis: *The compliance with ASHRAE Standard 90.1-2019, or one of the two (2) compliance paths in the 2021 IECC, Prescriptive plus the Additional Energy Efficiency [C406], or Performance plus the 85 percent requirement C407.2.2) make the 2021 IECC more stringent than the 2015 IECC.*

The 2015 IECC *has three (3) new building compliance paths:*

- *ASHRAE Standard 90.1 – Requires compliance with ANSI/ASHRAE/IESNA Standard 90.1-2013.*

or

- *Prescriptive Option – Requires compliance with Sections [C402 through C405].*
- *Total Building Performance – Requires compliance with Sections [C402 through C405] and [C407, C408].*

The 2021 IECC *has three (3) new building compliance paths:*

- *ASHRAE Standard 90.1 – Requires compliance with ANSI/ASHRAE/IESNA Standard 90.1-2019.*

or

- *Prescriptive Option – Requires compliance with Sections [C402 through C405],*

and

- *Section [C406 Additional Efficiency Options C408].*

or

- *Total Building Performance Option – requires compliance with Section [C407].*

and

- *Additional Energy Efficiency – requires compliance with Section [C407.2.2 Mandatory] and an annual energy cost that is less than or equal to 85 percent of the annual energy cost*

Equipment shall exceed all performance requirements by 10 percent. 2. Reduced lighting power density system in accordance with Section C406.3. The total interior lighting power of the building shall be determined by using 90 percent of the lighting power values in Table C405.4.2.1. 3. Enhanced digital lighting controls in accordance with Section C406.4, including: continuous dimming, individual addressing, limited to 8 fixtures on one daylight sensor, digital control to include: digital addressability, load shedding, user control, reconfigurable occupancy sensors. 4. On-site supply of renewable energy in accordance with Section C406.5 to comply with one of the following: not less than 0.5 W/ft2 of conditioned area, or not less than 3 percent of energy used for mechanical, service water heating, and lighting. 5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6, including independent ventilation system to each occupied space, include total energy recovery and HVAC system supply air temperature reset. 6. High-efficiency service water heating in accordance with Section C406.7 for building types: Group R-1 (Boarding houses), Group I-2 (Hospitals), Group A-2 (Restaurants), Group F (Laundries), Group R-2 (Buildings with residential occupancies), Group A-3 (Health clubs), Buildings with service water heating equal to 10 percent or more of the total building energy loads. Service water heating system shall have (sized to provide not less than	9. Include an energy monitoring system in accordance with Section C406.10 (where not required by C405.12). 10. Include a Fault Detection Diagnostics (FDD) systemin accordance with Section C406.11 (where not required by C403.2.3) 11. Efficient kitchen equipment in accordance with Section C406.12. • Section C406.1.1 Tenant Spaces shall comply with Section C406.1.1 through C406.1.5 to achieve a minimum number of 5 credits. or **(Total Building Performance)** • Section C407 (Total Building Performance), which includes mandatory requirements Section C407.2.1 (Table C407.2): ○ Section C402.5 (Air Leakage – Thermal Envelope), ○ Section C403.1.1 (Calculation of heating and cooling loads. ○ Section C403.1.2 (Data centers). ○ Section C403.2 (System Design). ○ Section C403.3 (Heating and Cooling equipment efficiencies). ○ Section C403.4 (Heating and cooling system controls). ○ Section C403.5.5 (Economizer system fault detection and diagnostics). ○ Section C403.7 (Ventilation and exhaust systems). ○ Section C403.8 (Fan and fan controls). ○ Section C403.9 (Large-diameter ceiling fans). ○ Section C403.11 (Refrigeration equipment performance). ○ Section C403.12 (Construction of HVAC system elements.	*of the standard reference design (renewables limited to 5% of total energy cost).*

60 percent) waste heat recovery or solar water heating. and • Section C408 System Commissioning.	○ Section C403.13 (Mechanical system located outside the building thermal envelope). ○ Section C404 (Service water heating). ○ Section C405 (Electrical power and lighting systems). ○ Section C408 (Maintenance information and system commissioning). and ○ Section C407.2.2 An annual energy cost that is less than or equal to 85 percent of the annual energy cost of the standard reference design (renewables limited to 5% of total energy cost). Purchased renewables must be the same in standard and proposed design. and • Section C408 (Maintenance Information and System Commissioning)	

2015 IECC	**2021 IECC**	*The 2021 IECC is as stringent than the 2015 IECC.*
• C402.5: Air leakage- thermal envelope (mandatory). The thermal envelope of a building shall comply with: ○ Section C402.5.1 (Air barriers). ○ Section C402.5.2 (Assemblies). ○ Section C402.5.3 (Rooms containing fuel-burning appliances). ○ Section C402.5.4 (Doors and access openings to shafts, chutes, stairways and elevator lobbies). ○ Section C402.5.5 (Air intakes, exhaust openings, stairways, and shafts). ○ Section C402.5.6 (Loading dock weather seals). ○ Section C402.5.7 (Vestibules) ○ Section C402.5.8 (Recessed lighting) or the building thermal envelope shall be 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 (and deemed to comply with the provisions of this section).	• C402.5.2 – The building thermal envelope shall comply with ○ Section C402.5.1 (Air barriers). ○ Section C402.5.2 (Dwelling and sleeping unit enclosure testing). ○ Section C402.5.3 (Building thermal envelope testing). ○ Section C402.5.4 (Air leakage and fenestration). ○ Section C402.5.5 (Rooms containing fuel-burning appliances). ○ Section C402.5.6 (Doors and access openings to shafts, chutes, stairways and elevator lobbies). ○ Section C402.5.7 (Air intakes, exhaust openings, stairways and shafts). ○ Section C402.8 (Loading dock weather seals). ○ Section C402.9 (Vestibules). ○ Section C402.10 (Recessed lighting). ○ Section C402.5.11 (Operable openings interlocking). or the building thermal envelope shall be tested in accordance with: • Section C402.5.2 (Dwelling or sleeping unit enclosure testing) or	

	• Section C402.5.3 (Building thermal envelope testing). Tested buildings must also comply with: ○ Section C402.5.7 (Air intakes, exhaust openings, stairways and shafts), ○ C402.5.8 (Loading dock weather seals), and ○ C402.5.9 (Vestibules).	
• C403.2.1: System sizing shall be accordance with ANSI/ASHRAE/ACCA Standard 183-2007 or by approved equivalent computational procedure.	• C403.1.1: System Sizing shall be accordance with ANSI/ASHRAE/ACCA Standard 183-2007 (RA 2020) or by approved equivalent computational procedure.	*The 2021 IECC is as stringent than the 2015 IECC.*
• C403.2.9: Duct insulation: Supply and return air ducts and plenums shall be installed with a minimum of R-6 insulation where located in unconditioned spaces and where located outside the building with a minimum of R-8 insulation in Climate Zone 1- 4.	• C403.12.1: Duct insulation: Supply and return air ducts and plenums shall be installed with a minimum of R-6 insulation where located in unconditioned spaces and where located outside the building with a minimum of R-8 insulation in Climate Zone 0- 4.	*The 2021 IECC is as stringent than the 2015 IECC.*
• C403.2.9.1: Duct construction. Ductwork shall be constructed and erected in accordance with the International Mechanical Code.	• C403.12.2.3: Ductwork shall be constructed and erected in accordance with the International Mechanical Code.	*The 2021 IECC is as stringent than the 2015 IECC.*
• C405.2.3: Daylight-responsive controls. Daylighting controls complying with Section C405.2.3.1 (Daylight responsive control function) to control electric lights within daylight zones.	• C405.2.4: Daylight-responsive controls. Daylight-responsive controls. Daylighting controls complying with Section C405.2.4.1 (Daylight responsive control function) shall be provided to control the general lighting within daylight zones.	*The 2021 IECC is as stringent than the 2015 IECC.*
• C405.4.2: Lighting (office, LPD 0.82 w/ft^2) (Tal C405.4.2(1)).	• C405.3.2: Lighting (office, LPD 0.64 w/ft^2) (Table C405.3.2(1)).	*The 2021 IECC is more stringent than the 2015 IECC.*