2021 IECC® Essentials – Commercial Provisions

Based on the 2021 *International Energy Conservation Code®*

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GOAL & OBJECTIVES

This seminar covers the essential concepts of the 2021 *International Energy Conservation Code®* (IECC®) as it applies to the construction of new commercial buildings.

1) Identify the importance of the energy code in reducing building energy use and providing other environmental benefits
2) Explain the intent, scope and applicability of the 2021 IECC requirements for commercial building projects and how systems covered by the IECC ensure occupant safety and comfort
3) Describe the duties and rights of design professionals and code officials, and how these professions will use key topics and tables to effectively perform their duties
4) Identify essential commercial provisions in the 2021 IECC and how compliance with these by the design, plan review and inspection communities help achieve the intended benefits of the code

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INSTRUCTOR

Jerica Stacey

Director of Technical Training
International Code Council
Ammon, Idaho
Tel: 208.859.6578
jstacey@iccsafe.org

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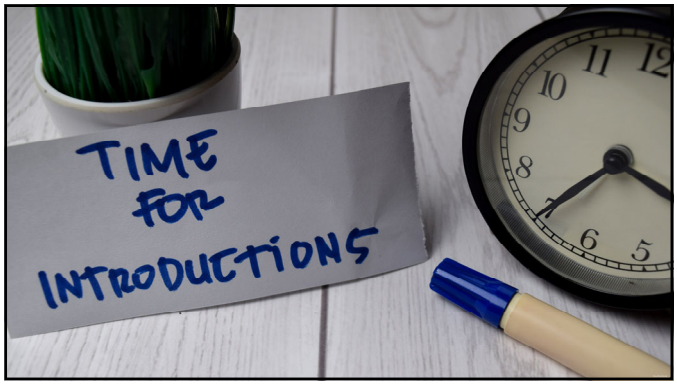

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COURSE OUTLINE

- Overview of the IECC
- Administrative Chapters
  - Chapters 1 – 3 and 6
- Commercial Energy Efficiency
  - Chapter 4
- Appendices

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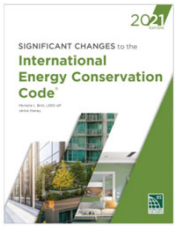

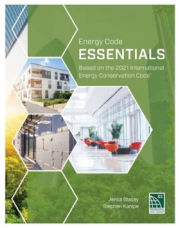

Useful Publications

Available on shop.iccsafe.org

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Overview of the IECC

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Building Codes

- Codes are minimum requirements to safeguard health, safety, and welfare of the public and occupants or users of spaces or buildings
- Adopted by governmental agencies to ensure that buildings are built in a safe manner
- People expect when entering a building to be safe from inherent dangers caused by natural or man-made disasters

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Family of I-Codes

- International Private Sewage Disposal Code
- International Property Maintenance Code
- International Zoning Code
- International Performance Code
- International Swimming Pool & Spa Code
- International Wildlife-Urban Interface Code
- International Fuel Gas Code
- International Mechanical Code
- International Green Construction Code
- International Existing Building Code
- **International Energy Conservation Code**
- International Plumbing Code
- International Fire Code
- International Building Code
- International Residential Code

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About the IECC

- The IECC regulates the design and construction of buildings for the effective use and conservation of energy over the useful life of each building
- This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective
- This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances

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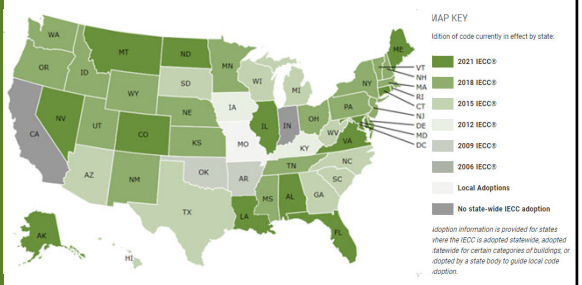
INTERNATIONAL ENERGY CONSERVATION CODE® (IECC®)

ADOPTION MAP



2024: Rhode Island; Nevada; various jurisdictions in Arizona

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How the Code is Organized

There are two separate sets of provisions

- **Commercial** and **residential** energy efficiency requirements
  - Apply to the building thermal envelope, mechanical and service water heating systems, and lighting and electrical systems
  - Additional energy efficiency requirements
- Administrative provisions and definitions specific to each commercial and residential set of regulations are also included

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TABLE OF CONTENTS

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Chapter 1: Administration and Enforcement

Commercial

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Chapter 1: Scope and Administration

- Establishes the limits of applicability of the code and describes how the code is to be applied and enforced

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Chapter 1: Scope and Administration

- Establishes the limits of applicability of the code and describes how the code is to be applied and enforced
- Establishes authority and duties of the code official appointed by the authority having jurisdiction

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Chapter 1: Scope and Administration

- Establishes the limits of applicability of the code and describes how the code is to be applied and enforced
- Establishes authority and duties of the code official appointed by the authority having jurisdiction
- Establishes the rights and privileges of the design professional, contractor and property owner

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C101.2 – Scope

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

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Commercial and Residential Buildings Defined

- **Residential:** For this code, includes one- and two-family dwellings and townhouses, as well as group R-2, R-3, and R-4 buildings three stories or less in height above grade plane
- **Commercial:** For this code, all buildings that are not included in the definition of "Residential building"

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Commercial and Residential Buildings Defined

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C102.1.1 and R102.1.1 – Above Code Programs

- Code official or other AHJ has authority to deem "above code" program as exceeding the energy efficiency required by the code
- Burden of proof to establish equivalency is on applicant

LEED FOR HOMES

U.S. GREEN BUILDING COUNCIL LEED CERTIFIED USGBC

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C102.1.1 – Above Code Programs

- For commercial buildings:
  - Requirements in Table C407.2 must be met

TABLE C407.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION*	TITLE
Envelope	
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls

partial table

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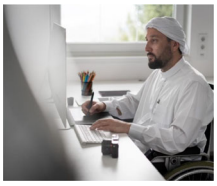
C103.1 and R103.1 – Digital Construction Documents

- Submitted in 1 or more sets
- Construction documents may be submitted in digital format



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C103.2 – Information on Construction Documents for Commercial Projects

1. Energy compliance path
2. Insulation materials and their R-values
3. Fenestration U-factors and SHGCs
4. Area-weighted U-factor and SHGC calculations
5. Mechanical systems design criteria
6. Mechanical and service water-heating systems and equipment types, sizes, and efficiencies
7. Economizer description
8. Equipment and system controls
9. Fan motor horsepower and controls
10. Duct sealing, duct and pipe insulation and location
11. Lighting fixture schedule with wattage and control narrative
12. Location of daylight zones on floor plans
13. Air barrier and air sealing details, including location of the air barrier

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C103.2 and R103.2 – Information and Construction Documents

Information can be presented in several ways

- On the drawings
- On sections and in schedules
- Through notes and callouts
- Through supplementary worksheets or calculations

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C105 and R105 – Inspections

- All construction is subject to inspection
- Construction must not be concealed without inspection approval
- A final inspection is required before occupancy
- A building must be reinspected when determined necessary by a code official

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C105.2 and R105.2 – Required Inspections

Commercial

- Footing and foundation
- Thermal envelope
- Plumbing system
- Mechanical system
- Electrical system
- Final

Residential

- Footing and foundation
- Framing and rough-in
- Plumbing rough-in
- Mechanical rough-in
- Final

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C108.1.1 and R108.1.1 – Conflicts

IECC takes precedence when the requirements of the referenced code or standard conflict with the requirements of the code

C108.3 and R108.3 – Other laws

The provisions of this code shall not be deemed to nullify any provisions of local, state, or federal law

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Chapter 2: Definitions

Commercial

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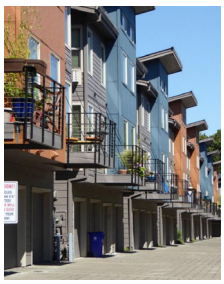
Chapter 2: Definitions



- IECC includes definitions for specific terms
- Most defined terms are *italicized* in code text
  - When definition is key to understanding a particular code provision
- Undefined terms
  - Other I-Code definitions apply
  - Common-use definitions apply

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On-site Renewable Energy and Renewable Energy Resources

- **ON-SITE RENEWABLE ENERGY.** Energy ~~derived~~ from renewable energy resources harvested at the building project site. ~~solar radiation, wind, waves, tides, landfill gas, biogas, biomass or the internal heat of the earth. The energy system providing onsite renewable energy shall be located on the project site.~~

- **RENEWABLE ENERGY RESOURCE.** Energy derived from solar radiation, wind, waves, tides, landfill gas, biogas, biomass, or extracted from hot fluid or steam heated within the earth.

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Fan Efficiencies

- New definitions related to fans introduce and support the Fan Energy Index (FEI)

- **FAN ENERGY INDEX (FEI).** The ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated in accordance with AMCA 208.

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Other New or Revised Definitions - Commercial

- Commercial New
  - Data center, Data center systems
  - Direct Digital Control (DDC)
  - Enthalpy recovery ratio
  - Fault detection and diagnostics (FDD) system
  - Information technology equipment
  - Internal curtain system
  - Large diameter ceiling fan
  - Testing unit enclosure area
  - Thermal distribution efficiency (TDE)
  - Vegetative roofs
  - Visible transmittable, annual

- Commercial Revised
  - General lighting
  - Green houses
  - On-site renewable energy
  - Skylights
  - Wall, above-grade

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Chapter 3: General Requirements

Commercial and Residential

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Chapter 3: General Requirements

- Includes broadly applicable requirements not found in other chapters
- Establishes climate zones for US counties and territories
  - Includes methodology for determining climate zones elsewhere
- Contains product rating, marking and installation requirements for materials
  - Insulation, windows, doors, and siding

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C301 and R301 – Climate Zones

Climate zones updated in 2021 IECC

- New Climate Zone 0
- Align with ASHRAE 169, ASHRAE Standard 90.1, 2018 IgCC
- 10% of US counties assigned new CZ

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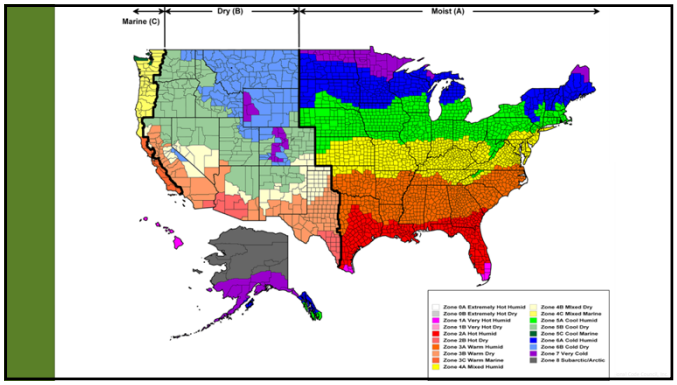

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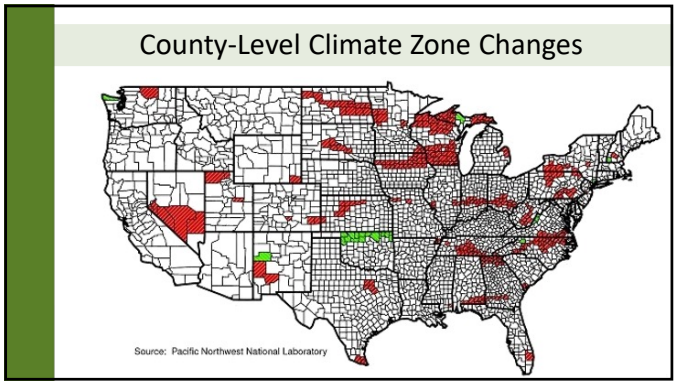
County-Level Climate Zone Changes



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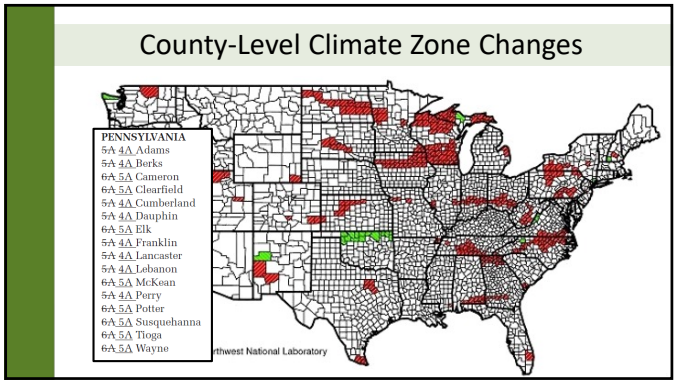
County-Level Climate Zone Changes



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C302.1 and R302.1 – Interior Design Conditions

- Interior design temperatures used for heating and cooling load calculations
  - Maximum of 72°F (22°C) for heating
  - Minimum of 75°F (24°C) for cooling

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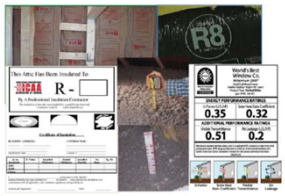
C303.1 and R303.1 – Identification

- Requires materials to be labeled on site with the rated *R-value* or *U-factor*
- Thickness of insulation must be written on markers



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C303.1.3 and R303.1.3 – Fenestration Product Rating

- "Label or Table"
- U-factors determined by an accredited, independent laboratory, and labeled and certified by the manufacturer
  - NFRC 100 for windows, doors and skylights
  - NFRC 100 or ANSI/DASMA 105 for garage doors and rolling doors, where required
- SHGCs and VT determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer

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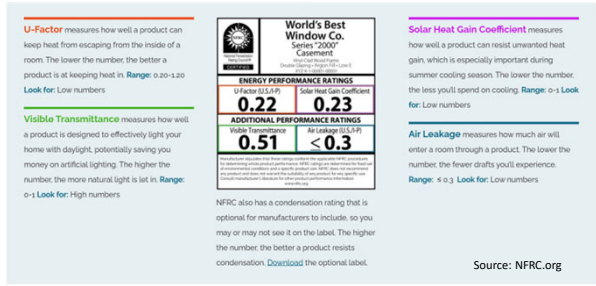
NFRC Label



Source: NFRC.org

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C303.1.3 and R303.1.3 – Fenestration Product Rating

- "Label or Table"
- Products lacking a labeled U-factor, SHGC, or VT are assigned a default U-factor from Tables C/R303.1.3(1) through C/R303.1.3(3)

TABLE R303.1.3(1)
DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT *U*-FACTORS

FRAME TYPE	WINDOW AND GLASS DOOR		SKYLIGHT	
	Single pane	Double pane	Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

TABLE R303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC AND VT

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

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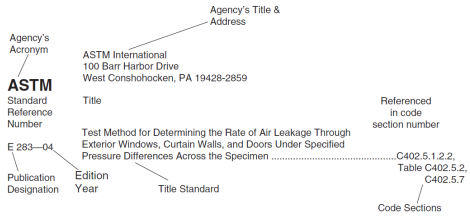
Chapter 6: Referenced Standards



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Improved Useability of the 2021 IECC

Mandatory and *Prescriptive* labels removed in favor of mandatory tables

- Total Building Performance
- Energy Rating Index

2018 IECC

C402.5 Air leakage—thermal envelope (Mandatory). The *thermal envelope* of buildings shall comply with Sections C402.5.1 through C402.5.8, 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 when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft² (2.0 L/s • m²). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

2021 IECC

C402.5 Air leakage—thermal envelope. The *building thermal envelope* shall comply with Sections C402.5.1 through Section C402.5.11.1, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.

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Improved Useability of the 2021 IECC

TABLE C407.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
	Envelope
C402.5	Air leakage—thermal envelope
	Mechanical
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commissioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

TABLE R405.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION	TITLE
	General
R401.2.3	Additional energy efficiency
R401.3	Certificate
	Building Thermal Envelope
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R405.5	Maximum fenestration U-factor and SHGC
	Mechanical
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.3.4	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
	Electrical Power and Lighting Systems
R404.1	Lighting equipment
404.2	Interior lighting controls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

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Chapter 4: Commercial Energy Efficiency

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C401.1 - Scope

- Pertains to buildings not covered by the Residential Provisions of the IECC
  - New construction
  - Existing building chapter (Chapter 5) points to Chapter 4

- Applies to buildings' sites and associated systems and equipment

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C401.2 - Application

- Commercial compliance path options
  - IECC Prescriptive Compliance
  - IECC Total Building Performance
  - ASHRAE Standard 90.1 – 2019
- Projects must comply with ONE path fully

C401.2 Application. Commercial buildings shall comply with Section C401.2.1 or C401.2.2.

C401.2.1 International Energy Conservation Code. Commercial buildings shall comply with one of the following:

1. Prescriptive Compliance. The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408. Dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.
2. Total Building Performance. The Total Building Performance option requires compliance with Section C407.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

C401.2.2 ASHRAE 90.1. Commercial buildings shall comply with the requirements of ANSI/ASHRAE/IESNA 90.1.

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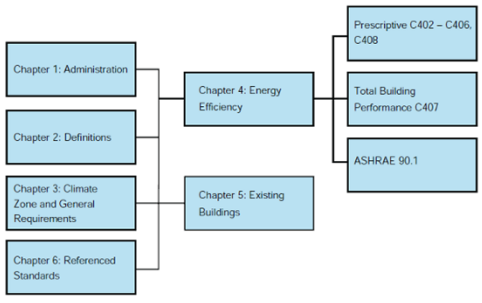
C401.2 – Application Continued



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C401.2.1 – International Energy Conservation Code

Structure of the IECC – Commercial Provisions

- C401 General
- C402 Building Envelope Requirements
- C403 Building Mechanical Systems
- C404 Service Water Heating
- C405 Electrical Power and Lighting Systems
- C406 Additional Efficiency Requirements
- C407 Total Building Performance
- C408 Maintenance Information and System Commissioning

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C401.2.2 – ASHRAE Standard 90.1

Structure of the ANSI/ASHRAE/IES Standard 90.1-2019

- Section 5 – Building Envelope
- Section 6 – Heating, Ventilation, and Air Conditioning
- Section 7 – Service Water Heating
- Section 8 – Power
- Section 9 – Lighting
- Section 10 – Other Equipment
- Section 11 – Energy Cost Budge
- Section 12 – Method Normative References
- Appendices A-I
- Annex

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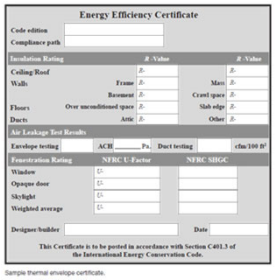
C401.3 – Thermal Envelope Certificate



Energy Efficiency Certificate

Code edition
Compliance path

Insulation Rating		R -Value		R -Value
Ceiling/Roof		R-		R-
Walls	Frame	R-	Mass	R-
	Basement	R-	Crawl space	R-
Floors	Over unconditioned space	R-	Slab edge	R-
Ducts	Attic	R-	Other	R-

Air Leakage Test Results

Envelope testing ACH ____ Pa. Duct testing cfm/100 ft²

Fenestration Rating	NFRC U-Factor	NFRC SHGC
Window	U-	
Opaque door	U-	
Skylight	U-	
Weighted average	U-	

Designer/builder Date

This Certificate is to be posted in accordance with Section C401.3 of the International Energy Conservation Code.

Sample thermal envelope certificate.

- Permanent thermal envelope certificate
  - R-values of insulation
  - U-factors and SHGCs of fenestration
  - Envelope air leakage test results
- Completed by approved party
- Posted in approved location and copy included in construction files for project

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Section C402

Commercial Building Envelope

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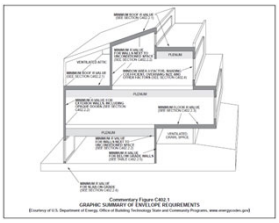
The Building Thermal Envelope

- The building thermal envelope separates conditioned space from unconditioned space
  - Contributes greatly to energy efficiency of the building
  - Increases passive survivability
  - Improves indoor air quality and occupant comfort
  - Offers moisture management
  - Improves durability leading to more resilient buildings and communities



Dark boundary line indicates the building thermal envelope

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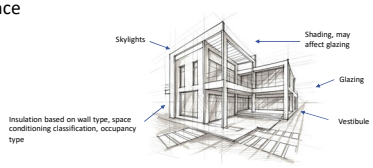
Key Building Envelope Provisions

- Insulation: roofs, ceilings, above-grade walls, below-grade walls, floors
- Roof solar reflectance and thermal emittance
- Fenestration performance: windows, doors, skylights
- Air leakage and air barriers



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Exempt: Low-energy Buildings

Some buildings exempt from building envelope requirements only

- Low energy buildings
  1. Peak design rate < 3.4 Btu/h × ft² for space conditioning purposes
  2. Do not contain conditioned space

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Exempt: Greenhouses

- Greenhouses mechanically heated or cooled
  - Exterior opaque envelope assemblies comply with insulation requirements of C402.2 and door requirements of C402.4.5
  - Interior partitions separating greenhouse from conditioned space meet insulation, door, and maximum U-factor/SHGC requirements
- Fenestration assemblies comply with Table C402.1.1.1

TABLE C402.1.1.1
FENESTRATION THERMAL ENVELOPE MAXIMUM REQUIREMENTS

COMPONENT	*U*-FACTOR (BTU/h × ft² × °F)
Skylight	0.5
Vertical fenestration	0.7

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Exempt: Equipment Buildings

Equipment buildings exempt if

1. Separate buildings with floor area not more than 1,200 ft²
2. **Intended to house electric equipment** with installed equipment power totaling not less than 7 W/ft² and **not intended for human occupancy**
3. Heating system capacity not greater than 17,000 Btu/hr and a heating thermostat setpoint that is restricted **to not more than 50°F**
4. Have an **average wall and roof U-factor** less than 0.200 in Climate Zones 1 through 5 and less than 0.120 in Climate Zones 6 through 8
5. Comply with the **roof solar reflectance and thermal emittance provisions** for Climate Zone 1

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C402.1 – General (Prescriptive Compliance)

Prescriptive compliance path
- Thermal requirements
- Specific insulation requirements
- Roof solar reflectance and thermal emittance
- Fenestration performance
- Air leakage requirements
  - Mandatory for other compliance paths as well

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C402.1 – General (Prescriptive Compliance)

Prescriptive compliance path
- Thermal requirements of either
  - R-value based method of Section C402.1.3
  - U-, C-, and F-factor-based method of Section C402.1.4
  - Component performance alternative of Section C402.1.5

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Thermal Requirement Compliance Options

1. **C402.1.3 Insulation component R-value method**
   - **R-value table**
   - **Sets the performance level (minimum R-value) for individual components**
   - **Detailed methods for determining**

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Table C402.1.3 – R-Values

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

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings[b]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-25 + R-11 + R-11 LS	R-25 + R-11 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-60	R-60	R-60	R-60
Walls, above grade																
Mass[i]	R-5.7ci	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building	R-13 + R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-17ci	R-13 + R-19.5ci	R-13 + R-19.5ci	R-13 + R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-10ci	R-13 + R-10ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-15.6ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R20 + R3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Walls, below grade																
Below-grade wall[j]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-10ci	R-7.5ci	R-10ci	R-10ci	R-15ci	R-15ci	R-15ci	R-15ci	R-15ci
Floors																
Mass[c]	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-14.6ci	R-16.7ci	R-14.6ci	R-16.7ci	R-16.7ci	R-20.9ci	R-20.9ci	R-25ci	R-25ci	
Joist/framing	R-13	R-13	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38	R-38	R-38	R-38	R-38
Slab-on-grade floors																
Unheated slabs	NR	NR	NR	NR	NR	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-20 for 24" below	R-20 for 24" below	R-20 for 48" below	R-20 for 24" below	R-20 for 48" below	R-20 for 48" below	R-25 for 48" below
Heated slabs[k]	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-10 for 24" below + R-5 full slab	R-10 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab

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2021 IECC Increases in Efficiency

- Incremental increases in efficiency for many roof, wall and floor components in CZs 4-8
- R-13 insulation for framed floors in CZs 0 and 1
- R-10 CI for unheated slabs in CZ 3 Group R
- Non-swinging opaque doors moved from R-Value to U-Factor table

Changes align IECC with ASHRAE 90.1-2016 and 2019 requirements

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CZ 4A and 4B – Roof and Floors

IECC Edition	Roofs						Floors				Slab-on-grade Floors			
	Entirely Above Roof Deck		Metal Buildings		Attic and Other		Mass		Joist/ Framing		Unheated Slabs		Heated Slabs	
	Other	Grp R	Other	Grp R	Other	Grp R	Other	Grp R	Oth	Grp R	Other	Grp R	Other	Grp R
2009	20ci	20ci	13+ 13	19	38	38	10ci	10.4ci	30	30	NR	10, 24" below	15, 24" below	15, 24" below
2012	25ci	25ci	19+ 11 LS	19+ 11 LS	38	38	10ci	10.4ci	30	30	10, 24" below	10, 24" below	15, 24" below	15, 24" below
2015	30ci	30ci	19+ 11 LS	19+ 11 LS	38	38	10ci	10.4ci	30	30	10, 24" below	10, 24" below	15, 24" below	15, 24" below
2018	30ci	30ci	19+ 11 LS	19+ 11 LS	38	38	10ci	10.4ci	30	30	10, 24" below	10, 24" below	15, 24" below + R-5 slab	15, 24" below + R-5 slab
2021	30ci	30ci	19+ 11 LS	19+ 11 LS	49	49	14.6ci	16.7ci	30	30	15, 24" below	15, 24" below	15, 24" below + R-5 slab	15, 24" below + R-5 slab

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Climate Zone 4A and 4B – Walls

IECC Edition	Above Grade								Below Grade	
	Mass		Metal Building		Metal Framed		Wood Framed and Other		Below-grade wall	
	Other	Grp R	Other	Grp R	Other	Grp R	Other	Grp R	Other	Grp R
2009	9.5ci	11.4ci	19	19	13+7.5ci	13+7.5ci	13	13+3.8ci	NR	7.5ci
2012	9.5ci	11.4ci	13+13ci	13+13ci	13+7.5ci	13+7.5ci	13+3.8ci or 20	13+3.8ci or 20	7.5ci	7.5ci
2015	9.5ci	11.4ci	13+13ci	13+13ci	13+7.5ci	13+7.5ci	13+3.8ci or 20	13+3.8ci or 20	7.5ci	7.5ci
2018	9.5ci	11.4ci	13+13ci	13+13ci	13+7.5ci	13+7.5ci	13+3.8ci or 20	13+3.8ci or 20	7.5ci	7.5ci
2021	9.5ci	11.4ci	13+13ci	13+14ci	13+7.5ci	13+7.5ci	13+3.8ci or 20	13+3.8ci or 20	7.5ci	10ci

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CZ 5 and 4C – Roof and Floors

IECC Edition	Roofs						Floors				Slab-on-grade Floors			
	Entirely Above Roof Deck		Metal Buildings		Attic and Other		Mass		Joist/ Framing		Unheated Slabs		Heated Slabs	
	Other	Grp R	Other	Grp R	Other	Grp R	Other	Grp R	Oth	Grp R	Other	Grp R	Other	Grp R
2009	20ci	20ci	13+13	19	38	38	10ci	12.5ci	30	30	NR	10, 24" below	15, 24" below	15, 24" below
2012	25ci	25ci	19 + 11 LS	19 + 11 LS	38	49	10ci	12.5ci	30	30	10, 24" below	10, 24" below	15, 36" below	15, 36" below
2015	30ci	30ci	19 + 11 LS	19 + 11 LS	38	49	10ci	12.5ci	30	30	10, 24" below	10, 24" below	15, 36" below	15, 36" below
2018	30ci	30ci	19 + 11 LS	19 + 11 LS	38	49	10ci	12.5ci	30	30	10, 24" below	10, 24" below	15, 36" Below + R-5 slab	15, 36" Below + R-5 slab
2021	30ci	30ci	19 + 11 LS	19 + 11 LS	49	49	14.6ci	16.7ci	30	30	15, 24" below	20, 24" below	15, 36" Below + R-5 slab	15, 36" Below + R-5 slab

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Climate Zone 5 and 4C – Walls

IECC Edition	Above Grade								Below Grade	
	Mass		Metal Building		Metal Framed		Wood Framed and Other		Below-grade wall	
	Other	Grp R	Other	Grp R	Other	Grp R	Other	Grp R	Other	Grp R
2009	11.4ci	13.3ci	13+5.6ci	13+5.6ci	13+7.5ci	13+7.5ci	13+3.8ci	13+3.8ci	7.5ci	7.5ci
2012	11.4ci	13.3ci	13+13ci	13+13ci	13+7.5ci	13+7.5ci	13+3.8ci or 20	13+7.5ci or 20+3.8ci	7.5ci	7.5ci
2015	11.4ci	13.3ci	13+13ci	13+13ci	13+7.5ci	13+7.5ci	13+3.8ci or 20	13+7.5ci or 20+3.8ci	7.5ci	7.5ci
2018	11.4ci	13.3ci	13+13ci	13+13ci	13+7.5ci	13+7.5ci	13+3.8ci or 20	13+7.5ci or 20+3.8ci	7.5ci	7.5ci
2021	11.4ci	13.3ci	13+14ci	13+14ci	13+10ci	13+10ci	13+7.5ci or 20 +3.8ci	13+7.5ci or 20 +3.8ci	7.5ci	10ci

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Table C402.1.3 Footnotes

a. Assembly descriptions can be found in ANSI/ASHRAE/IES 90.1 Appendix A.
b. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, 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-ft^2 °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
e. "Mass floors" shall be in accordance with Section C402.2.3.
f. "Mass walls" shall be in accordance with Section C402.2.2.
g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

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Thermal Requirement Compliance Options

1. C402.1.3 Insulation component R-value method
   - R-value table
   - Sets the performance level (minimum R-value) for individual components
   - Detailed methods for determining
2. **C402.1.4 Assembly U-factor, C-factor or F-factor-based method**
   - **U-factor table**
   - **Considers the performance of the entire assembly**
   - **Detailed methods for determining**

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Table C402.1.4 – U-Factors

TABLE C402.1.4
OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, *U*-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[c]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[d]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	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	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[e]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[e]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

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Thermal Requirement Compliance Options

1. C402.1.3 Insulation component R-value method
   - R-value table
   - Sets the performance level (minimum R-value) for individual components
   - Detailed methods for determining
2. C402.1.4 Assembly U-factor, C-factor or F-factor-based method
   - U-factor table
   - Considers the performance of the entire assembly
   - Detailed methods for determining
3. **C402.1.5 Component performance alternative**
   - **Allows for trade-offs of building envelope provisions**
   - **Overall building thermal flow (UA) must comply with code**
   - **Provides design flexibility**

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Component Performance Alternative

- Equation 4-2 Trade-Off Alternative
  - Insulation and fenestration U-factors
  - Fenestration SHGC values not traded off

$$A + B + C + D + E \leq \text{Zero}$$

A = **assembly type of the building thermal envelope**, other than slabs on grade and below-grade walls
B = **slab-on-grade** perimeter condition
C = **below-grade wall** assembly type
D = **vertical glazing area**
E = **skylight area**

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Specific Insulation Requirements

- Requirements must be met in addition to U-factor or R-value compliance
  - Roof assembly
  - Above-grade walls
  - Floors
  - Slabs-on-grade
  - Below-grade walls
  - Insulation of radiant heating systems
  - Airspaces

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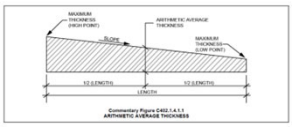
C402.1.4.1 – Roof/Ceiling Assembly (U-factor)

- Maximum roof/ ceiling assembly U-factors are specified in Table C402.1.4



- Where used as a component of a roof/ceiling assembly U-factor calculation
  - Sloped roof insulation R-value contribution to that calculation must use the average thickness in inches along with the material R-value- per-inch

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C402.2.1 – Roof Assembly (R-value)

- Minimum R-value of insulating material installed either between the roof framing or continuously on the roof assembly specified in Table C402.1.3
- Minimum thickness of above-deck roof insulation at lowest point, gutter edge, roof drain or scupper must be at least 1 inch

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Roof Assembly (U-factor and R-value)

- Insulation installed on removable ceiling tiles not included
- Continuous insulation board
  - Not less than 2 layers
  - Edge joints between each layer of insulation must be staggered

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C402.2.1.5 – Skylight Curbs

- Insulated to the level of roofs with insulation entirely above the deck or R-5, whichever is less
- Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 are exempt

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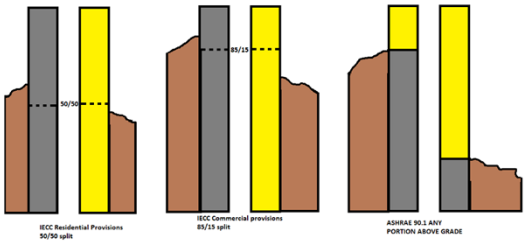
C402.2.2 – Above Grade Walls - Classification



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C402.2.2 – Above Grade Walls

- Minimum R-values included in Table C402.1.3 based on framing type, insulation position and materials
- Insulation within the cells of concrete masonry units (CMUs) not permitted to be considered when applying the R-value

- Mass walls must meet R-value or U-factor requirements and one of the following
  - Weigh at least 35lbs/ft^2 of wall surface area
  - Weigh at least 25lbs/ft^2 of wall surface area where the material weight is less than 120 pcf
  - Have a heat capacity exceeding 7 Btu/ft^2 × °F
  - Have a heat capacity exceeding 5 Btu/ft^2 × °F, where the material weight is not more than 120 pcf

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C402.2.3 – Floors

- The requirements for floor insulation are based on
  - Assembly type
  - Insulation placement
  - Cavity insulation
  - Continuous insulation
- Floor framing cavity insulation or structural slab insulation must be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs
  - Some exceptions

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C402.4 – Fenestration

- Products classified as either skylights or vertical fenestration
  - **Fenestration:** Windows that are fixed or operable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors composed of glass or other transparent or translucent glazing materials.
  - **Skylights:** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees from horizontal
- Limits to the area of each
- Maximum U-factor and SHGC requirements

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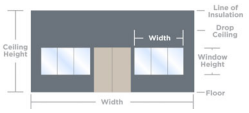
C402.4.1 – Maximum Area

- Vertical fenestration area limited to 30% of the gross above-grade wall area
  - The gross wall area excludes opaque doors and spandrel panels



- The skylight area limited to 3% of the gross roof area
- Increases to maximum area allowed where daylight responsive controls are used
  - 40% for vertical fenestration, 6% for roof area

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C402.4.3 - Maximum U-factor and SHGC

- Table C402.4 specifies maximum U-factor and SHGC requirements
- SHGC based on the operable/fixed properties of the fenestration and projection factor

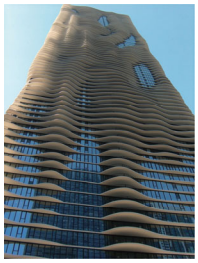

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Table C402.4 – Maximum U-factor and SHGC

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

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
Vertical fenestration																
U-factor																
Fixed fenestration	0.50		0.45		0.42		0.36		0.36		0.34		0.29		0.26	
Operable fenestration	0.62		0.60		0.54		0.45		0.45		0.42		0.36		0.32	
Entrance doors	0.83		0.77		0.68		0.63		0.63		0.63		0.63		0.63	
SHGC																
	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable
PF < 0.2	0.23	0.21	0.25	0.23	0.25	0.23	0.36	0.33	0.38	0.33	0.38	0.34	0.40	0.36	0.40	0.36
0.2 ≤ PF < 0.5	0.28	0.25	0.30	0.28	0.30	0.28	0.43	0.40	0.46	0.40	0.46	0.41	0.48	0.43	0.48	0.43
PF ≥ 0.5	0.37	0.34	0.40	0.37	0.40	0.37	0.58	0.53	0.61	0.53	0.61	0.54	0.64	0.58	0.64	0.58
Skylights																
U-factor	0.70		0.65		0.55		0.50		0.50		0.50		0.44		0.41	
SHGC	0.30		0.30		0.30		0.40		0.40		0.40		NR		NR	

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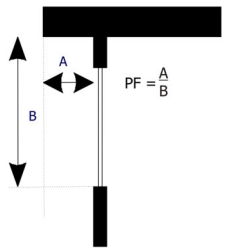
C402.4.3 - Maximum U-factor and SHGC, Projection Factor



A = depth from the leading edge of the overhang to the face of the glass

B= height from the bottom of the leading edge of the overhang to the of the windowsill

97

C402.4.3.4 – Area-weighted U-factor

- Area weighted U-factor is permitted to satisfy the U-factor requirements for each product category in Table C402.4
- Individual fenestration products from different categories may not be combined
  - For example: operable, fixed, doors, skylights

98

C402.4.5 Doors (Table C402.1.4 Footnotes)

- Opaque doors considered part of the gross area of above-grade walls
  - Opaque swinging doors must comply with U-factor requirements in Table C402.1.4
  - Opaque nonswinging doors that are horizontally hinged sectional doors with a single row of fenestration must meet assembly U-factor maximums
    - 0.440 in Climate Zones 0-6
    - 0.360 in Climate Zones 7 and 8
    - Fenestration area must be between 14% and 25% of total door area
- All other doors must comply with vertical fenestration provisions

99

TABLE C402.1.4
OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, *U*-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[f]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[g]	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322	U-0.322	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066	U-0.066	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73	F-0.73	F-0.73	F-0.73	F-0.73	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[e]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[e]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

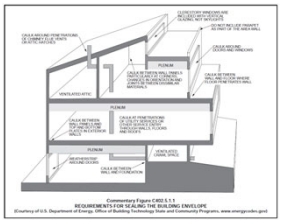
100

C402.5.1 – Air Barriers

- Continuous air barrier is required throughout the thermal envelope
  - Located on the inside or outside of thermal envelope
  - Located within the assemblies composing thermal envelope
  - Any combination of the above
  - Buildings in CZ 2B are exempt

101

C402.5.1 – Air Barriers



- Air barrier construction
  - Continuous
  - Joints and seams sealed
  - Penetrations caulked, gasketed or otherwise sealed to allow for expansion, contraction, and vibration
  - Recessed lighting fixtures must comply with C402.5.10

102

C402.5 – Air Leakage – Thermal Envelope Overview

- Dwelling unit testing required for Group R and Group I occupancies
- Building envelope testing required for occupancies other than Group R and I
- Buildings exempt from testing
  - Material or assembly
  - Performance verification

103

C402.5 – Air Leakage – Thermal Envelope

- The building thermal envelope shall comply with Sections C402.5.1 through Section C402.5.11.1, or the building thermal envelope shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.
  - Air intakes, exhaust openings, stairways, and shafts
  - Loading dock weather seals
  - Vestibules

104

C402.5 – Air Leakage – Thermal Envelope

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  - Air intakes, exhaust openings, stairways, and shafts
  - Loading dock weather seals
  - Vestibules

This language picks up Section C402.5.1.2 Air barrier compliance
- Requires testing

105

C402.5.1.2 – Air Barrier Compliance, Group R and I

- Buildings with Group R and I occupancies must be tested using the **dwelling and sleeping unit enclosure testing** method
  - Required in all CZ except 2B, 3C, and 5C
  - Building thermal envelope must be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827, or an equivalent method
  - Air leakage limited to 0.30 cfm/ft^2 of testing unit enclosure area at 50 Pa

TESTING UNIT ENCLOSURE AREA. The area sum of all the boundary surfaces that define the *dwelling unit*, *sleeping unit* or occupiable *conditioned space* including top/ceiling, bottom/floor and all side walls. This does not include interior partition walls within the *dwelling unit*, *sleeping unit*, or occupiable *conditioned space*. Wall height shall be measured from the finished floor of the *conditioned space* to the finished floor or roof/ceiling air barrier above.

106

C402.5.1.2 – Air Barrier Compliance, Group R and I

8 or less units

- Test them all
- Air leakage is the weighted average of all testing unit results, weighted by each testing unit's enclosure area

More than 8 units

- Test the greater of 7 units or 20 percent of all units
- Top floor unit, ground floor unit, unit with largest area
- For each unit that exceeds maximum air leakage rate (fails), test two more

107

C402.5.1.2 – Air Barrier Compliance, All Other Occupancies

- Buildings or portions of buildings other than Group R and I occupancies must be tested using the **building thermal envelope testing** method
  - Tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method
  - Air leakage limited to 0.40 cfm/ft^2 of building thermal envelope area at 75 Pa

108

C402.5.1.2 – Air Barrier Compliance, All Other Occupancies

Alternatively, portions of the building can be tested and measured air leakage area weighted

1. Entire envelope area of all stories that have any spaces directly under a roof
2. Entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space

109

Exceptions

- Buildings in CZ 2B, 3B, 3C and 5C
- Buildings larger than 5,000ft^2 in CZ 0B, 1, 2A, 4B and 4C
- Buildings between 5,000ft^2 and 50,000ft^2 in CZs 0A, 3A and 5B

110

C402.5.1.2 – Air Barrier Compliance, All Other Occupancies

- If the building air leakage rate exceeds 0.40 cfm/ft^2 but does not exceed 0.60 cfm/ft^2
  - Diagnostic evaluation using smoke tracer or infrared imaging while building is pressurized required along with a visual inspection of the air barrier
    - Seal leaks without destruction of existing building components
    - Submit report identifying corrective actions taken to seal leaks
  - Building is deemed to comply, no retest required

111

C402.5.1.3, C402.5.1.4, C402.5.1.5 –Materials, Assemblies, Performance Verification

Buildings that do not complete air barrier testing (exempt) must meet provisions of Section C402.5.1.3 **or** C402.5.1.4 **in addition to** Section C402.5.1.5

Select Compliance Option

- Materials
- Assemblies

Verify Performance

- Review construction documents
- Inspect air barrier
- Final commission report provided
- Deficiencies found during plan review and inspection and corrective actions

112

Other Air Leakage Provisions

- Air leakage limits for fenestration
  - Not required when building is tested
- Doors and access openings to shafts, chutes, stairways, and elevator lobbies must be sealed
- Stairway enclosures and elevator shaft vents must have dampers
- Cargo door openings and loading door openings must be equipped with weather seals
- Building entrances required to have enclosed vestibule

113

C402.5.11 – Operable Openings Interlocking

- Large, operable openings (>40ft^2) such as roll-up doors and windows must now be interlocked with the heating and cooling system

114

C402.5.11 – Operable Openings Interlocking

- Time and temperature specific
  - System adjustments within 10 minutes of opening operable opening
  - Controls raise cooling setpoint to 90°F and lower heating setpoint to 55°F
  - Controls shut off the system entirely when outdoor temperatures are below 90°F or above 55°F

115

Exceptions

- Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy
- Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official
- The first entrance doors where located in the exterior wall and are part of a vestibule system

116

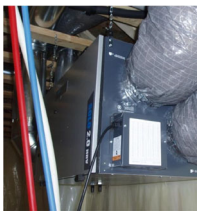
Section C403

Commercial Mechanical Systems

117

Key Mechanical System Provisions

- Heating and cooling load calculations and system design
- Equipment efficiencies and sizing
- System controls
- Economizers
- Ventilation and exhaust systems
- Fans and fan controls
- Refrigeration equipment performance
- Duct construction
- Piping insulation



118

C403.1.1 – Calculation of Heating and Cooling Loads

- HVAC design loads must be determined in accordance with ANSI/ASHRAE/ACCA Standard 183 or equivalent
- Loads must be adjusted to account for load reductions that are achieved where energy recovery systems are utilized
- Output capacity of HVAC equipment must be less than that of the smallest available equipment size that exceeds the loads calculated

119

C403.2.1 – Zone Isolation Required

- HVAC system must be divided into isolation areas if
  - Serves zone over 25,000 ft^2
  - Spans more than one floor, and
  - Designed to operate or be occupied nonsimultaneously
- Controlled independently

120

C403.2.2 – Ventilation

- Natural or mechanical ventilation must be provided in accordance with Chapter 4 of the International Mechanical Code

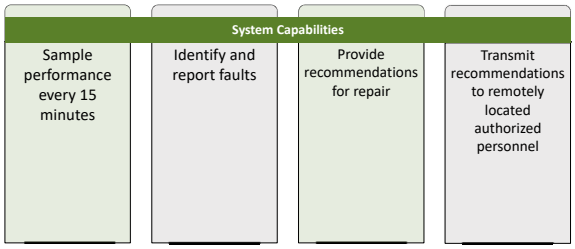
121

C403.2.3 – Fault Detection and Diagnostics

- HVAC systems serving a gross conditioned floor area of >100,000 ft^2 must include FDD system
- The system must include permanently installed sensors to measure HVAC system performance
  - **Exception:** R-1 and R-2 occupancies

122

C403.2.3 – Fault Detection and Diagnostics



123

C403.3.2 – HVAC Equipment Performance Requirements

- Equipment must meet the minimum efficiency requirements of Tables C403.3.2(1) - (16)
- HVAC equipment efficiency updated to match ASHRAE tables directly and Federal appliance manufacturing requirements
- Refrigeration efficiencies updated to match federal requirements

124

C403.3.2 – HVAC Equipment Performance Requirements

- Additional tables added for
  - DOAS units
  - Water source heat pumps
  - Variable refrigerant flow cooling and heat pumps
  - Heat pump and heat reclaim chiller packages
  - Ceiling mounted computer room air conditioners
  - Commercial refrigerators and freezers

125

Table C403.3.2(10) Partial

TABLE C403.3.2(10)
FLOOR-MOUNTED AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS—MINIMUM EFFICIENCY REQUIREMENTS[a]

EQUIPMENT TYPE	STANDARD MODEL	NET SENSIBLE COOLING CAPACITY	MINIMUM NET SENSIBLE COP	RATING CONDITIONS (ENTERING AIR dry-bulb/dew point)	TEST PROCEDURE[b]
Air cooled	Downflow	< 80,000 Btu/h	2.70	85°F/52°F (Class 2)	AHRI 1360
		≥ 80,000 Btu/h and < 295,000 Btu/h	2.58		
		≥ 295,000 Btu/h	2.38		
	Upflow—ducted	< 80,000 Btu/h	2.67		
		≥ 80,000 Btu/h and < 295,000 Btu/h	2.55		
		≥ 295,000 Btu/h	2.33		
	Upflow—nonducted	< 65,000 Btu/h	2.16	75°F/52°F (Class 1)	
		≥ 65,000 Btu/h and < 240,000 Btu/h	2.04		
		≥ 240,000 Btu/h	1.89		
	Horizontal	< 65,000 Btu/h	2.65	95°F/52°F (Class 3)	
		≥ 65,000 Btu/h and < 240,000 Btu/h	2.53		
		≥ 240,000 Btu/h	2.47		
Air cooled with fluid economizer	Downflow	< 80,000 Btu/h	2.70	85°F/52°F (Class 1)	AHRI 1360
		≥ 80,000 Btu/h and < 295,000 Btu/h	2.58		
		≥ 295,000 Btu/h	2.36		
	Upflow—ducted	< 80,000 Btu/h	2.67		
		≥ 80,000 Btu/h and < 295,000 Btu/h	2.55		
		≥ 295,000 Btu/h	2.33		
	Upflow—nonducted	< 65,000 Btu/h	2.09	75°F/52°F (Class 1)	
		≥ 65,000 Btu/h and < 240,000 Btu/h	1.99		
		≥ 240,000 Btu/h	1.81		
	Horizontal	< 65,000 Btu/h	2.65	95°F/52°F (Class 3)	
		≥ 65,000 Btu/h and < 240,000 Btu/h	2.53		
		≥ 240,000 Btu/h	2.47		

126

C403.4 – Heating and Cooling System Controls

C403.4.1
Each zone must be controlled by individual thermostatic controls

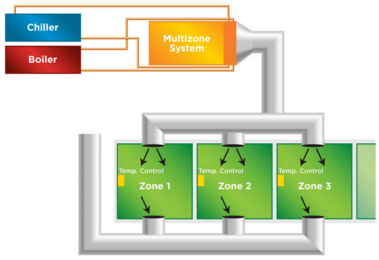
C403.4.1.2
Deadband of at least 5°F

C403.4.2
Setback controls controlled by automatic time clock or programmable system
- Down to 55°F or up to 85°F

C403.4.2.3
Automatic start and stop controls required for each HVAC system

127

Multiple Zone Systems, Section C403.6

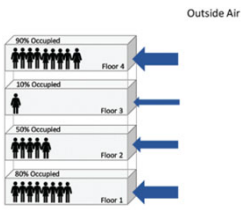


Source: www.energycodes.gov

128

C403.7.1 – Demand Control Ventilation

- Required for all single-zone systems required to comply with Sections C403.5 through C403.5.3 (economizers)
- **Required for spaces larger than 500 ft² and with an average occupant load of at 15 people or greater per 1,000 ft² of floor area**
- Served by systems with
  - Air-side economizer
  - Automatic modulating control of the outdoor air damper
  - Design outdoor airflow greater than 3,000 cfm



Note several new/modified exceptions in 2021 IECC

129

C403.7.6 – Automatic Control of HVAC Systems Serving Guestrooms

In Group R-1 buildings with more than 50 guestrooms, each guestroom must have controls

C403.7.6.1 Controls must be capable of and configured with three modes of temperature control

C403.7.6.2 Controls must be capable of and configured to automatically turn off the ventilation and exhaust fans within 20 minutes of the occupants leaving the guestroom, or isolation devices must be provided to each guestroom that are capable of automatically shutting off the supply of outdoor air to and exhaust air from the guestroom.

130

C403.7.7 – Shutoff Dampers

- Outdoor air intake and exhaust openings and stairway and shaft vents must have Class I motorized dampers
  - Air leakage rate not greater than 4 cfm/ft^2 (20.3 L/s • m^2)
  - Labeled AMCA 500D

131

Exception

Nonmotorized gravity dampers can be used as an alternative to motorized dampers for exhaust and relief openings

1) In buildings less than three stories in height above grade plane
2) In buildings of any height located in Climate Zones 0, 1, 2, or 3
3) Where the design exhaust capacity is not greater than 300 cfm (142 L/s)

132

C403.8.5 – Low-capacity Ventilation Fans

- Requirements for low-capacity ventilation fans
- Applies efficiencies of ventilation fans typical of residential construction to mid-rise residential occupancies and small commercial buildings

- Except when part of listed HVAC appliance
- Except dryer exhaust, range hood main or booster fans

133

C403.8.5 – Low-capacity Ventilation Fans

TABLE C403.8.5 Low-Capacity Ventilation Fan Efficacy[a]

FAN LOCATION	AIRFLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIRFLOW RATE MAXIMUM (CFM)
HRV or ERV	Any	1.2 cfm/watt	Any
In-line fan	Any	3.8 cfm/watt	Any
Bathroom, utility room	10	2.8 cfm/watt	< 90
Bathroom, utility room	90	3.5 cfm/watt	Any

134

C403.8.9 – Large-Diameter Ceiling Fans

- Large-diameter ceiling fans, defined in C202, must be tested and labeled in accordance with AMCA 230
- Testing provisions include energy efficiency metric

135

C403.11 – Refrigeration Equipment Performance

- Updated to Federal DOE requirements
- Energy use must be verified through certification under an approved certification program
- Where certification program does not exist, the energy use must be supported by data furnished by the equipment manufacturer

136

C403.12.1 – Ducts and Plenum Insulation and Sealing

- Ductwork must be constructed in accordance with the IMC
  - Joints and seams must comply with Section 603.9 of the International Mechanical Code
- Supply and return air ducts and plenums must be insulated
- Ducts, air handlers and filter boxes must be sealed

137

C403.12.1 – Ducts and Plenum Insulation and Sealing

- Unconditioned spaces
  - Minimum R-6
- Outside building
  - Minimum R-8 in CZs 0 – 4
  - Minimum R-12 in CZs 5 – 8
- Underground beneath buildings
  - Insulated as required in this section or have an equivalent thermal distribution efficiency
- Within a building envelope assembly
  - Separated from building exterior or unconditioned or exempt spaces by a minimum R-8 in CZs 0 – 4 and R-12 in CZs 5 – 8

138

Exceptions

1. Where located within equipment.
2. Where the design temperature difference between the interior and exterior of the duct or plenum is less than 15°F (8°C)

139

C403.12.3 – Piping Insulation

- Piping serving as part of a heating or cooling system must be thermally insulated
- Piping insulation must be protected (C403.12.3.1)
- Adhesive tape not allowed

140

C403.12 – Mechanical Systems Located Outside of the Building Thermal Envelope

C403.12.1 **Heating outside a building.** Systems installed to provide heat outside a building must be radiant systems.

C403.12.2 **Snow- and ice-melt system controls.** Systems must include automatic controls configured to shut off the system based on temperature and precipitation.

C403.12.3 **Freeze protection system controls.** Systems must include automatic controls configured to shut off the systems based on temperature and fluid condition.

141

Section C404

Commercial Service Water Heating Systems

142

Key Service Water Heating Provisions

- Equipment efficiencies
- Heat traps for hot water storage tanks
- Piping insulation
- Controls
- Heated-water circulating and temperature maintenance systems
- Drain water heat recovery units
- Pools and spas

143

C404.2 – SWH Equipment Performance Efficiency

- Water-heating equipment and hot water storage tanks must meet requirements of Table C404.2
  - Includes water-heating equipment intended for use as space heating
  - Efficiency must be verified by manufacturer data or certification

144

Table C404.2 – Minimum Performance of Water-Heating Equipment, Partial

TABLE C404.2
MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[a, b]	TEST PROCEDURE
Water heaters, electric	≤ 12 kW[c]	Tabletop[f], ≥ 20 gallons and ≤ 120 gallons	0.93 – 0.00132V, EF	DOE 10 CFR Part 430
		Resistance ≥ 20 gallons and ≤ 55 gallons	0.960 – 0.0003V, EF	
		Grid-enabled[f] > 75 gallons and ≤ 120 gallons	1.061 – 0.00168V, EF	
	> 12 kW	Resistance	(0.3 + 27/V_m), %/h	ANSI Z21.10.3
	≤ 24 amps and ≤ 250 volts	Heat pump > 55 gallons and ≤ 120 gallons	2.057 – 0.00113V, EF	DOE 10 CFR Part 430
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gallons and > 55 gallons	0.675 – 0.0015V, EF	DOE 10 CFR Part 430
		> 55 gallons and ≤ 100 gallons	0.8012 – 0.00078V, EF	
	> 75,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t (Q/800 + 110$\sqrt{P}$)SL, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t (Q/800 + 110$\sqrt{P}$)SL, Btu/h	
	> 50,000 Btu/h and < 200,000 Btu/h[c]	≥ 4,000 Btu/h/gal and < 2 gal	0.82 – 0.00 19V, EF	DOE 10 CFR Part 430

145

C404.2.1 – High input SWH Systems

- High input service water-heating systems
  - Large (over 1,000,000 Btu/h) service hot water system efficiency increases from 90% to 92%
    - Capacity weighted average

Photo credit: PNNL

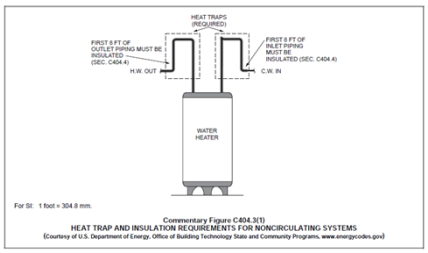
146

C404.3 – Heat Traps for Hot Water Storage Tanks

- Storage tank-type water heaters and hot water storage tanks that have **vertical water pipes** connecting to the inlet and outlet of the tank must have **integral heat traps** at those inlets and outlets
  - Pipe-configured heat traps in the piping connected to those inlets and outlets also permitted

147

C404.3 – Heat Traps for Hot Water Storage Tanks



Commentary Figure C404.3(1)
HEAT TRAP AND INSULATION REQUIREMENTS FOR NONCIRCULATING SYSTEMS
(Courtesy of U.S. Department of Energy, Office of Building Technology State and Community Programs, www.energycodes.gov)

148

C404.4 – Insulation of Piping

- The inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 8 feet of piping, whichever is less, must be insulated

TABLE C403.12.3
MINIMUM PIPE INSULATION THICKNESS (in inches)[a, c]

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu × in./(h × ft² × °F)[b]	Mean Rating Temperature, °F	< 1	1 to < 1½	1½ to < 4	4 to < 8	> 8
> 350	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251–350	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201–250	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141–200	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105–140	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40–60	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

149

C404.5, Heated Water Supply Piping

The volume of water in a hot water supply pipe is limited to reduce the amount of time it takes for hot water to reach the faucet

C404.5.1 **Maximum allowable pipe length method**
Limits the length of pipe between the source and the outlet

C404.5.2 **Maximum allowable pipe volume method**
Requires a calculation of the volume of water in the specific piping system

150

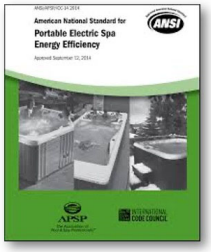
C404.8 – Energy Consumption of Pools and Permanent Spas

- Pools and permanent spas must comply with heater and time switch requirements
- Outdoor heated pools and spas must have a vapor retardant cover
  - **Exception** for pools where more than 75% of energy for heating is from a heat pump or on-site renewable energy system

151

C404.9 – Energy Consumption of Portable Spas

- The energy consumption of electric-powered portable spas controlled by the requirements of APSP 14



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Section C405

Commercial Electrical Power and Lighting Systems

153

Key Electrical Power and Lighting Provisions

- Lighting controls
- Light reduction methods
- Interior and exterior lighting power
- Automatic receptacle controls
- Energy monitoring

154

C405.1.1 – Lighting for Dwelling Units

- At least 90% of permanently installed lighting serving dwelling units
  - Must be high-efficacy (kitchen appliance lighting excluded)
  - Or comply with the daylight responsive control requirements and interior lighting power requirements

155

C405.2 – Lighting Controls

Lighting systems must have controls that comply with one of the following:

1) Lighting controls as specified in Sections C405.2.1 through C405.2.8
2) Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6
   - The LLLC luminaire must be independently capable of monitoring occupant activity and monitoring ambient lighting
   - Each control strategy must be capable of configurations as required

156

Exceptions

- Lighting controls are not required for emergency and security areas

157

C405.2.1.1 – Occupant Sensor Control Function

- Required in 12 space types
  - Classrooms, conference rooms, copy rooms, restrooms, enclosed offices, open plan office areas, etc.
- Turn off lights within 20 minutes of occupants leaving space
- Manual controls
- Some spaces have more specific occupant sensor control requirements

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C405.2.1.2 – Occupant Sensor Controls in Warehouse Storage Areas

- Manual control
- Lighting in aisleway must be independent
- Occupancy sensor or time-switch control required
- Occupant sensors reduce lighting to 50% or less of full power within 20 minutes of occupants leaving controlled area

159

C405.2.2 – Time Switch Controls

- Each area not provided with occupant sensor controls must have time-switch controls

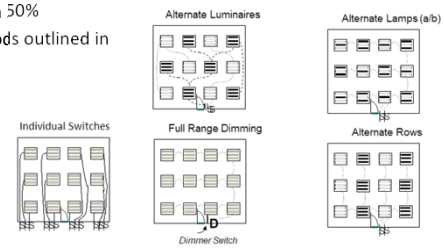
Minimum 7-day clock	Capable of being set for 7 different day types/week	Incorporate holiday "shutoff" feature

Program backup capabilities to prevent loss of program and time setting for ≥ 10 hours if power is interrupted	Override switch should include • Manual control • Control lighting to remain on < 2 hrs • Control lighting for an area < 5,000ft²

160

C405.2.3 – Light-reduction Controls

- Reduce the lighting load by not less than 50%
- Three methods outlined in code



161

C405.2.4 – Daylight-responsive Controls

- Required to control the general lighting within daylight zones in
  - Spaces with a total of more than 150 watts of general lighting within primary sidelit or toplit daylight zones
  - Spaces with a total of more than 300 watts of general lighting within sidelit daylight zones

162

C405.2.4.2 – Sidelit Daylight Zone

- Sidelit daylight zone is the floor area adjacent to vertical fenestration

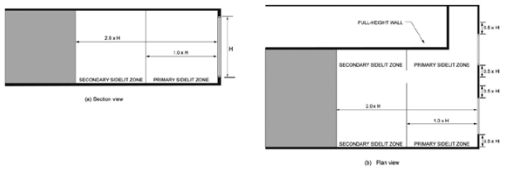
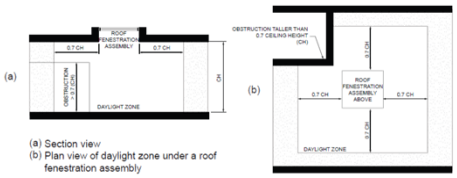


FIGURE C405.2.4.2(1)
PRIMARY AND SECONDARY SIDELIT DAYLIGHT ZONES

163

C405.2.4.3 – Toplit Daylight Zone

- Toplit daylight zone is the floor area underneath a roof fenestration assembly



(a) Section view
(b) Plan view of daylight zone under a roof fenestration assembly

FIGURE C405.2.4.3
TOPLIT DAYLIGHT ZONE

164

C405.2.5 – Specific Application

- Select lighting must be controlled by an occupant sensor or a time-switch and a manual control

- Luminaires for which additional lighting power is claimed
- Display and accent
- Lighting in display cases
- Supplemental task lighting
- Lighting equipment that is for sale or demonstration in lighting education
- Display lighting for exhibits in galleries, museums and monuments

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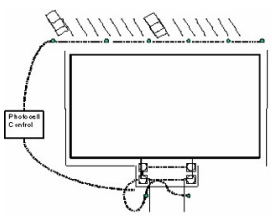
C405.2.7 – Exterior Lighting Controls

- Daylight shutoff
- Building façade and landscape lighting
- Lighting setback
- Time-switch control functions



166

C405.2.8 – Parking Garage Lighting

- Occupant sensor or time-switch control required
- Lighting power of luminaires automatically reduced by at least 30% when there is no activity within a lighting zone for 20 minutes
- Lighting zones not larger than 3,600ft^2
- Perimeter daylight responsive controls

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C405.3 – Interior Lighting Power Requirements

A building complies with this section where its total connected interior lighting power is less than the interior lighting power allowance.

- The installed lighting power is the sum of the watts of all interior lighting equipment
  - 20 exceptions
- Two options to determine lighting power allowance
  - Building area method
  - Space-by-space method
    - Includes additional interior lighting power

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Steps to Determine if a Building Complies with Interior Lighting Power Allowances

1. Determine the interior lighting power budget for the entire building or space
2. Verify the total connected power in watts for the proposed lighting using the construction documents
3. Compare and assess compliance
   - **Reminder:** proposed total connected lighting power must be less than or equal to the interior lighting power budget for the building to comply

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Table C405.3.2(1) Interior Lighting Power Allowances: Building Area Method, Partial

TABLE C405.3.2(1)—continued
INTERIOR LIGHTING POWER ALLOWANCES:
BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (watts/ft²)
Parking garage	0.18
Penitentiary	0.69
Performing arts theater	0.84
Police station	0.66
Post office	0.65
Religious building	0.67
Retail	0.84
School/university	0.72
Sports arena	0.76
Town hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

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Table C405.3.2(2) Interior Lighting Power Allowances: Space-by-Space Method, Partial

TABLE C405.3.2(2)
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	0.48
Greater than 40 feet in height	0.60
Audience seating area	
In an auditorium	0.61
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.67
In a performing arts theater	1.16
In a religious building	0.72
In a sports arena	0.33
Otherwise	0.33
Banking activity area	0.61
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.89
Otherwise	0.71

171

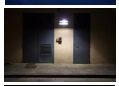
C405.4 – Lighting for Plant Growth

- At least 95% of permanently installed luminaires used for plant growth and maintenance
  - Have a photon efficiency of not less than 1.6 µmol/J
    - Defined in accordance with ANSI/ASABE S640

172

C405.5 – Exterior Lighting Power Requirements

- The total connected exterior lighting power must be less than the exterior lighting power allowance
  - The total exterior connected lighting power is the total maximum rated wattage of all lighting that is powered through the energy service for the building
    - 14 Exceptions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C405.5 – Exterior Lighting Power Requirements

- Exterior lighting power allowance is calculated
  - Use the lighting zone from Table C405.5.2(1)
  - Determine applicable area type from Table C405.5.2(1)
  - Multiply the total area/length of each area type by the value in the table to determine lighting power allowed for each area
  - Sum the base allowance and the watts from each area type

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Table C405.5.2(1) Exterior Lighting Zones

TABLE C405.5.2(1)
EXTERIOR LIGHTING ZONES

LIGHTING ZONE	DESCRIPTION
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed-use areas
3	All other areas not classified as lighting zone 1, 2 or 4
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

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Table C405.5.2(2) Lighting Power Allowances for Building Exteriors

TABLE C405.5.2(2)
LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

	LIGHTING ZONES			
	Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance	350 W	400 W	500 W	900 W
Uncovered Parking Areas				
Parking areas and drives	0.03 W/ft²	0.04 W/ft²	0.06 W/ft²	0.08 W/ft²
Building Grounds				
Walkways and ramps less than 10 feet wide	0.50 W/linear foot	0.50 W/linear foot	0.60 W/linear foot	0.70 W/linear foot
Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas	0.10 W/ft²	0.10 W/ft²	0.11 W/ft²	0.14 W/ft²
Dining areas	0.65 W/ft²	0.65 W/ft²	0.75 W/ft²	0.95 W/ft²
Stairways	0.60 W/ft²	0.70 W/ft²	0.70 W/ft²	0.70 W/ft²
Pedestrian tunnels	0.12 W/ft²	0.12 W/ft²	0.14 W/ft²	0.21 W/ft²
Landscaping	0.03 W/ft²	0.04 W/ft²	0.04 W/ft²	0.04 W/ft²
Building Entrances and Exits				
Pedestrian and vehicular entrances and exits	14 W/linear foot of opening	14 W/linear foot of opening	21 W/linear foot of opening	21 W/linear foot of opening
Entry canopies	0.20 W/ft²	0.25 W/ft²	0.40 W/ft²	0.40 W/ft²
Loading docks	0.35 W/ft²	0.35 W/ft²	0.35 W/ft²	0.35 W/ft²
Sales Canopies				
Free-standing and attached	0.40 W/ft²	0.40 W/ft²	0.60 W/ft²	0.70 W/ft²
Outdoor Sales				
Open areas (including vehicle sales lots)	0.20 W/ft²	0.20 W/ft²	0.35 W/ft²	0.50 W/ft²
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	7 W/linear foot	7 W/linear foot	21 W/linear foot

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Table C405.5.2(3) Individual Lighting Power Allowances for Building Exteriors

TABLE C405.5.2(3)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

	LIGHTING ZONES			
	Zone 1	Zone 2	Zone 3	Zone 4
Building facades	No allowance	0.075 W/ft² of gross above-grade wall area	0.113 W/ft² of gross above-grade wall area	0.15 W/ft² of gross above-grade wall area
Automated teller machines (ATM) and night depositories	135 W per location plus 45 W per additional ATM per location			
Uncovered entrances and gate-house inspection stations at guarded facilities	0.50 W/ft² of area			
Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.35 W/ft² of area			
Drive-up windows and doors	200 W per drive through			
Parking near 24-hour retail entrances.	400 W per main entry			

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C405.9 – Vertical and Horizontal Transportation Systems and Equipment

C405.9.1 **Elevator cabs**
- Luminaires - not less than 35 lumens per watt
- Ventilation fans not more than 0.33 watts/cfm

C405.9.2 **Escalators and moving walks**
- ASME A17.1/CSA B44
- Automatic controls that reduce speed as permitted in accordance with ASME A17.1/CSA B44 and applicable local code

C405.9.3 **Energy recovery**
- Escalators must be designed to recover electrical energy when resisting overspeed in the down direction

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AMENDMENT

C405.11 – Automatic Receptable Control

- At least 50% of covered receptacles and 25% of branch circuit feeders to be on automatically controlled receptacles
- Multiple control options
- All controlled receptacles must be permanently marked per NFPA 70

- PA amendment changes “shall” to “may”

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C405.12 – Energy Monitoring

- Applies to new buildings 25,000 ft^2 or larger
- Must be equipped to measure, monitor, record and report energy consumption data
- **Exception:** R-2 occupancies and individual tenant spaces if the space has its own utility services and meters and has less than 5,000 ft^2

TABLE C405.12.2
ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

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Section C406

Commercial Additional Efficiency Requirements

182

C406 – Additional Efficiency Requirements Overview

Required for prescriptive compliance

- Revised structure of C406
  - Points-based
  - 10 points (credits) required, where 1 point is equivalent to 0.25% energy savings
  - Equity of efficiency options across climate zones
- Expanded options
  - 11 options total, 3 new

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C406.1 – Additional Efficiency Credit: New Buildings

- Must achieve 10 credits from Tables C406.1(1) through C406.1(5)
  - 10 credits = 2.5% cost savings
- Tables based on use group of the building and climate zone
  - Office (Group B)
  - Multifamily (R) & Institutional (I)
  - Schools (E)
  - Retail (M)
  - Other
- Multiple use groups, each use group weighted by floor area to determine weighted average building credit

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C406.1 – Additional Efficiency Credit: Tenant Spaces

- Must achieve 5 credits when selected from these options
  - More efficient HVAC
  - Reduced lighting power
  - Enhanced lighting controls
  - DOAS
  - High-efficiency service water heating
  - Energy monitoring system
- Tenant spaces deemed to comply if entire building uses these credits
  - On-site renewable energy
  - Enhanced envelope
  - Reduced air infiltration

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C406.1 – Additional Efficiency Credit Options

1. More efficient HVAC performance
2. Reduced lighting power
3. Enhanced lighting controls
4. On-site supply of renewable energy
5. Dedicated outdoor air systems
6. High-efficiency service water heating
7. Enhanced envelope performance
8. Reduced air infiltration
9. *Energy monitoring system*
10. *Fault detection and diagnostics*
11. *Efficient kitchen equipment*

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C406.2 – More Efficient HVAC Equipment Performance

- 5% heating efficiency improvement
- 5% cooling efficiency improvement
- 10% heating efficiency improvement
- 10% cooling efficiency improvement
- More than 10% cooling efficiency improvement (use equation)

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Credits for Group B Occupancies

TABLE C406.1(1)
ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

SECTION	CLIMATE ZONE															
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3

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Credits for Group R & I Occupancies

TABLE C406.1(2)
ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

SECTION	CLIMATE ZONE															
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced air infiltration	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy																	

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Section C407

Commercial Total Building Performance

190

C407 – Total Building Performance

- The Total Building Performance Method allows trade-offs among the building envelope, mechanical systems, and lighting systems in commercial buildings

191

C407.2 – Mandatory Requirements

- Must meet requirements of Table C407.2
- Must have an annual energy cost **less than or equal to 80 percent of the standard reference design**
  - Standard reference design walls to be the same as proposed

TABLE C407.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
	Envelope
C402.5	Air leakage—thermal envelope
	Mechanical
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commissioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

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Table C407.4.1(1) Specifications for the Standard Reference & Proposed Designs, Partial

TABLE C407.4.1(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed

193

C407.3 - Documentation

- Documentation verifying that the methods and accuracy of compliance software tools conform to the provisions of this section must be provided to the code official
- Compliance report
  1) Address of building
  2) Inspection checklist
  3) Name of individual completing the compliance report
  4) Name and version of software tool
- Additional documentation may be required
- Calculation software tools have required capabilities

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Section C408

Commercial Maintenance Information and System Commissioning

195

Section C408 – Maintenance Information and System Commissioning

- This section covers maintenance information and the commissioning of, and the functional testing requirements for, building systems
- Verification that the building has been built and is operating as designed
  - C408.2 Mechanical systems commissioning and completion requirements
  - C408.3 Lighting system functional testing

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C408.2 – Mechanical Systems and Service Water-heating Systems Commissioning and Completion Requirements

- Prior to passing the final mechanical inspection, the registered design professional must provide evidence of mechanical systems commissioning and completion

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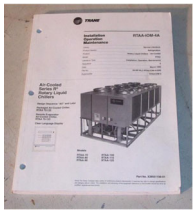
C408.2.1 – Commissioning Plan

- A commissioning plan must be developed by a registered design professional or approved agency



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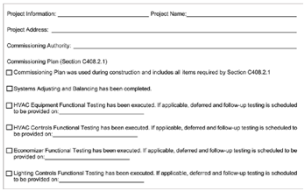
C408.2.4 – Preliminary Commissioning Report

- Completed and certified by the registered design professional or approved agency



Project Information: _____ Project Name: _____

Project Address: _____

Commissioning Authority: _____

Commissioning Plan (Section C408.2.1)

☐ Commissioning Plan was used during construction and includes all items required by Section C408.2.1

☐ Systems Adjusting and Balancing has been completed.

☐ HVAC Equipment Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on _____

☐ HVAC Controls Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on _____

☐ Economizer Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on _____

☐ Lighting Controls Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on _____

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C408.2.5 – Documentation Requirements

- System balancing report
- Final commissioning report
  - Results of functional performance tests
  - Disposition of deficiencies found during testing, including details of corrective measures used or proposed
  - Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance

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C408.3 – Functional Testing of Lighting Controls

Testing that will ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition

C408.3.1.1 Occupant sensor controls

C408.3.1.2 Time-switch controls

C408.3.1.3 Daylight responsive controls

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Commercial Appendices

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Appendix CA – Board of Appeals

- Appendix CA provides guidance for establishing a board of appeals, including criteria for membership and instruction for developing rules and procedures
- Consistent with other I-Codes

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Appendix CB – Solar-Ready Zone

- Appendix CB is intended to encourage the installation of renewable energy systems by preparing buildings for the future installation of solar energy equipment, piping and wiring

204

Appendix CC – Zero Energy Commercial Building Provisions

- Appendix CC provides a model for states and jurisdictions to require renewable energy systems capable of achieving net zero carbon
- Applies to new buildings
- Based on Architecture 2030

205

Appendix CC - Zero Energy Commercial Building Provisions

Supplemental definitions

- Adjusted off-site renewable energy
- Building energy
- Energy Utilization Intensity (EUI)
- Off-site renewable energy system
- On-site renewable energy system
- Renewable energy system
- Semi heated space
- Zero Energy Performance Index (ZEPI PB/EE)

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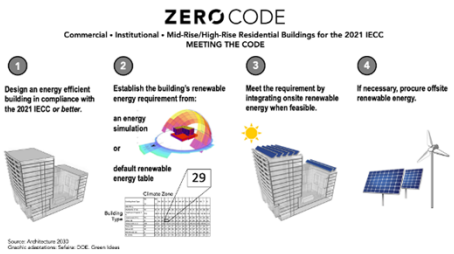
Appendix CC – Zero Energy Commercial Building Provisions



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CC103.1 Renewable Energy

On-site renewable energy systems shall be installed, or off-site renewable energy shall be procured to offset the building energy as calculated in Equation CC-1.

$RE_{onsite} + RE_{offsite} \geq E_{building}$

Where:

Re_{onsite} = Annual site energy production from on-site renewable energy systems

$Re_{offsite}$ = Adjusted annual site energy productions from off-sire renewable energy systems that may be credited against building energy use

$E_{building}$ = Building energy use without consideration of renewable energy systems

- If complying with the Prescriptive Compliance option, building energy is determined:
  gross conditioned floor area + gross semiheated floor area of the proposed building × EUI from Table CC103.1
- If complying with Total Building Performance or ASHRAE 90.1, building energy is determined from energy simulations

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Table CC103.1 Energy Utilization Intensity

TABLE CC103.1
ENERGY UTILIZATION INTENSITY FOR BUILDING TYPES AND CLIMATES (kBtu/ft² – yr)

BUILDING AREA TYPE	CLIMATE ZONE																
	0A/1A	0B/1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
	kBtu/ft² – yr																
Healthcare/hospital (I-2)	119	120	119	113	116	109	106	116	109	106	118	110	105	126	116	131	142
Hotel/motel (R-1)	73	76	73	68	70	67	65	69	66	65	71	68	65	77	72	81	89
Multiple-family (R-2)	43	45	41	41	43	42	36	45	43	41	47	46	41	53	48	53	59
Office (B)	31	32	30	29	29	28	25	28	27	25	29	28	25	33	30	32	36
Restaurant (A-2)	389	426	411	408	444	420	395	483	437	457	531	484	484	589	538	644	750
Retail (M)	46	50	45	46	44	44	37	48	44	44	52	50	46	60	52	64	77
School (E)	42	46	42	40	40	39	36	39	40	40	39	43	37	44	40	45	54
Warehouse (S)	9	12	9	11	12	11	10	17	13	14	23	17	15	32	23	32	32
All others	55	58	54	53	53	51	48	54	52	51	57	54	50	63	57	65	73

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CC103.3.1 – Qualifying Off-Site Procurement Methods

1. **Community renewables:** an off-site renewable energy system for which the owner has purchased or leased renewable energy capacity along with other subscribers.
2. **Renewable energy investment fund:** an entity that installs renewable energy capacity on behalf of the owner.
3. **Virtual power purchase agreement:** a power purchase agreement for off-site renewable energy where the owner agrees to purchase renewable energy output at a fixed price schedule.
4. **Direct ownership:** an off-site renewable energy system owned by the building project owner.
5. **Direct access to wholesale market:** an agreement between the owner and a renewable energy developer to purchase renewable energy.
6. **Green retail tariffs:** a program by the retail electricity provider to provide 100-percent renewable energy to the owner.
7. **Unbundled Renewable Energy Certificates (RECs):** certificates purchased by the owner representing the environmental benefits of renewable energy generation that are sold separately from the electric power.

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Please complete a course evaluation

iccsafe.org/eval

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