State of Connecticut Mechanical and Energy Codes Update

Presented jointly by the
Connecticut Chapters of ASHRAE & AEE

December 11, 2025

Agenda

- Status of New England Electric Grid (ISO-NE)
- Connecticut Electric and Natural Gas Distribution Systems
- Connecticut Building Code Development & Timeline
- IMC Updates – Chapters 1 – 14
- Break
- IECC Updates – Sections 401 – 500

The information and interpretations presented in this session are solely the opinions of the speaker(s) and do not necessarily reflect the official position or policy of ASHRAE.

These presentations are not intended to be a complete and thorough analysis of any topic. Attendees are advised that they are ultimately responsible for conducting their own due diligence and for ensuring compliance with all applicable codes, standards, and regulations.

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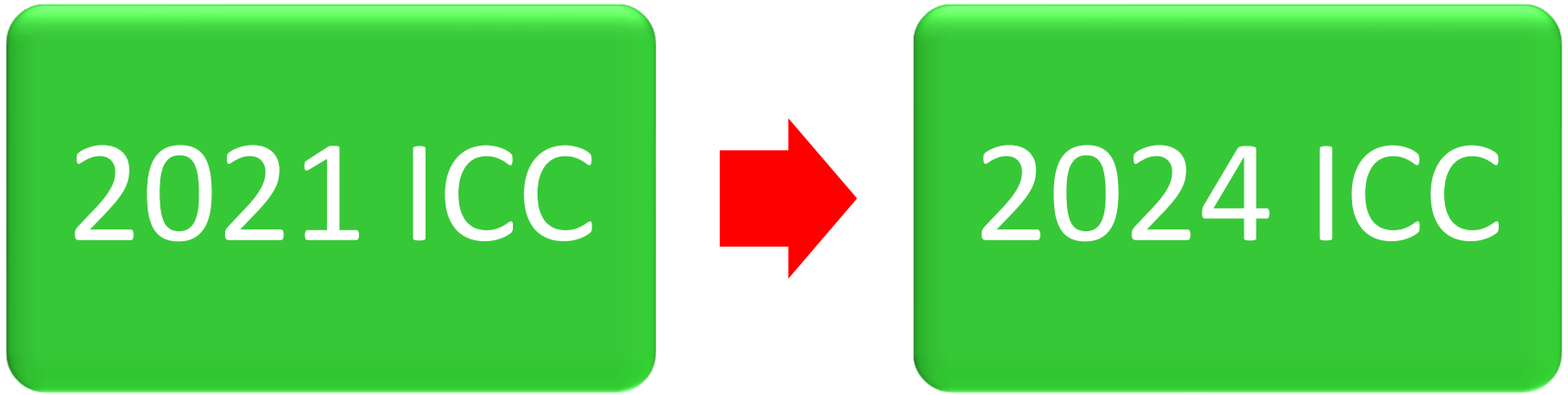
The Connecticut State Codes

- The state adopted the 2022 Connecticut State Building Code which will be based on the 2021 editions of the ICC Codes
- In November the Codes & Standards Committee sent the approved 2026 State Building Code & Fire Code to the Regulations Review Committee. On Tuesday that Committee …



The Connecticut State Codes

Building and Fire Code Adoption Process

https://portal.ct.gov/das/office-of-state-building-inspector/building-and-fire-code-adoption-process?language=en_US

State Building, Fire Safety And Fire Prevention Codes Update:

The next state building, fire safety, and fire prevention codes are expected to take effect in mid-2026.

The Code Amendment Subcommittee began meeting to discuss the proposed 2026 Connecticut state codes on January 10, 2024. For meeting dates, agendas, and meeting minutes, visit the Codes Amendment Subcommittee page

The new Connecticut state codes that will be in effect will be the:

- 2026 Connecticut State Building Code
- 2026 Connecticut State Fire Safety Code
- 2026 Connecticut State Fire Prevention Code

Click Here to view the Draft Amendments

The Connecticut State Codes

Adopted Model Codes

The following model codes are anticipated to be adopted by the 2026 Connecticut state codes:

- 2024 International Building Code (IBC) by ICC
- 2024 International Existing Building Code (IEBC) by ICC
- 2024 International Energy Conservation Code (IECC) by ICC
- 2024 International Mechanical Code (IMC) by ICC
- 2024 International Plumbing Code (IPC) by ICC
- 2024 International Residential Code (IRC) by ICC
- 2024 International Swimming Pool & Spa Code (ISPSC) by ICC
- 2023 NFPA 70 National Electrical Code (NEC) by NFPA
- 2017 ICC A117.1 Accessible and Usable Buildings and Facilities by ICC
- 2024 International Fire Code (IFC) by ICC
- 2021 NFPA 101 - Life Safety Code by the NFPA
- 2024 NFPA 1 - Fire Code by the NFPA

The model codes are viewable on their publisher's web sites:

- International Code Council (ICC) Codes
- National Fire Protection Association (NFPA) Codes

The development of Connecticut specific versions of the International Building Code (IBC), International Residential Code (IRC), International Fire Safety Code (IFC), NFPA 1 and NFPA 101, is expected once the codes are adopted.

The Connecticut State Codes

Grace Period

The new codes will apply to projects for which a permit is applied for after the effective date. If you have a project that will be significantly impacted by this change in codes, you may apply for a code modification from the Office of the State Building Inspector and the Office of the State Fire Marshal (separate applications) to allow the project to continue under the previously adopted state codes. This process, colloquially known as a grace period, will be available for approximately three months from the effective date. See the **code modification web page** for more information.

If a municipality requires separate permit applications for each portion of a project (building, electrical, plumbing, mechanical etc.), then the **primary permit** application date will determine the code applicable to all permits for the project. For example, a new house being constructed had its building permit applied for before the new code came into effect, but all associated trade permits were applied for after the new code came into effect. In this case, all permits should be reviewed under the code in effect when the building permit (the primary permit) was applied for.

Care should be taken that the scope of the primary and associated trade permits match - for example, if a development of 20 new houses is broken into four phases of five lots each and a building permit application is submitted for lots 1 through 5, the associated trade permits must also be for lots 1 through 5.

The Connecticut State Codes

Training

Once the draft codes are ready, the department will be providing free online training on the significant changes in the new codes and other related topics through its learning management system. More information and user instructions are available on the **LMS web page**.

More Information

In the meantime, if you have any questions, please e-mail the team at das.codesstandards@ct.gov and a team member will get back to you.

Anyone interested in receiving informational and update emails may request to be included by e-mailing DAS.CodesStandards@ct.gov

2021 vs. 2024 IMC Commercial Provisions

IMC Chapter 2 Definitions

[BG] AMBULATORY CARE FACILITY. *Buildings* or portions thereof used to provide medical, surgical, psychiatric, nursing or similar care on a less than 24-hour basis to persons who are rendered incapable of self-preservation by the services provided or staff has accepted responsibility for care recipients already incapable.

~~**BALANCED VENTILATION.**~~ **BALANCED VENTILATION SYSTEM.** A ventilation system that simultaneously supplies outdoor air to and exhausts air from a space, where the mechanical supply airflow rate and the mechanical exhaust airflow rate are each within 10 percent of the average of the two airflow rates. ~~Any combination of concurrently operating mechanical exhaust and mechanical supply whereby the total mechanical exhaust airflow rate is within 10 percent of the total mechanical supply airflow rate.~~

CONDENSING UNIT. A factory-made assembly of refrigeration components designed to compress and liquefy a specific refrigerant. The unit consists of one or more power-driven compressors, condensers, liquid receivers (where required) and factory-supplied accessories. ~~A specific refrigerating machine combination for a given refrigerant, consisting of one or more power-driven compressors, condensers and, where required, liquid receivers, and the regularly furnished accessories.~~

IMC Chapter 2 Definitions

DRAFTSTOP. A material, device or construction installed to restrict the movement of air within open spaces of concealed areas of *building* components such as crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and attics.

GREASE DUCT. A duct serving a Type I hood, or cooking *appliances* equipped with integral down-draft exhaust systems that produce grease, to convey grease-laden air from the hood or cooking *appliance* directly to the outdoors.

[BS] GYPSUM BOARD. A type of gypsum panel product consisting of a noncombustible core primarily of gypsum with paper surfacing.

[BS] GYPSUM WALLBOARD. A gypsum board used primarily as an interior surfacing for *building* structures.

HEAT PUMP. A *refrigeration system* or factory-made *appliance* that utilizes refrigerant to transfer heat into a space or substance. ~~A refrigeration system that extracts heat from one substance and transfers it to another portion of the same substance or to a second substance at a higher temperature for a beneficial purpose.~~

Definitions

(Add) **LIMITED-COMBUSTIBLE MATERIAL**. A material shall be considered a limited-combustible material where both of the conditions 1 and 2 below and conditions 3 or 4 below are met.

Conditions:

1. The material does not comply with the requirements for a *noncombustible material*.
2. The material, in the form in which it is used, exhibits a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg), when tested in accordance with NFPA 259, Standard Test Method for Potential Heat of Building Materials.
3. The material shall have a structural base of a *noncombustible material* with a surfacing not exceeding a thickness of 1/8 inch (3.2mm) where the surfacing exhibits a *flame spread* index not greater than 50 when tested in accordance with ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials, or ANSI/UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.
4. The material is composed of materials that, in the form and thickness used, neither exhibit a *flame spread* index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E 84 or ANSI/UL 723 and are of such composition that all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a *flame spread* index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E 84 or ANSI/UL 723.

Definitions

[A] LISTED. *Equipment,* materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of *listed equipment* or materials or periodic evaluation of services and whose listing states either that the *equipment*, material, product or service meets identified standards or has been tested and found suitable for a specified purpose. Terms that are used to identify *listed equipment*, products or materials include "listed," "certified," "classified" or other terms as determined appropriate by the listing organization.

LOWER FLAMMABLE LIMIT (REFRIGERANT) (LFL). The minimum concentration of refrigerant at which a flame is ~~that is~~ capable of propagating ~~a flame~~ through a homogeneous mixture of refrigerant and air under specific test conditions in accordance with **ASHRAE 34** .

~~**NONCOMBUSTIBLE MATERIALS.**~~ **NONCOMBUSTIBLE MATERIAL.** A material that passes **ASTM E136**. ~~Materials that, when tested in accordance with ASTM E136, have not fewer than three of four specimens tested meeting all of the following criteria:~~

[A] PEER REVIEW. An independent and objective technical review conducted by an *approved* third party.

Definitions

REFRIGERANT. The fluid used for heat transfer in a *refrigeration system* that undergoes a change of state to absorb heat. ~~A substance utilized to produce refrigeration by its expansion or vaporization.~~

REFRIGERANT DESIGNATION. The unique identifying alphanumeric value or refrigerant number assigned to an individual refrigerant and published in **ASHRAE 34**.

REFRIGERANT SAFETY GROUP CLASSIFICATION. The alphanumeric designation ~~alphabetical/numerical designation~~ that indicates both the toxicity and flammability classifications of refrigerants in accordance with **ASHRAE 34**.

~~**Flammability.** See *Flammability classification (Refrigerant)* .~~

Flammability classification (refrigerant). The alphanumeric designation used to identify the flammability of refrigerants.

Class 1. Indicates a refrigerant with no flame propagation.
Class 2. Indicates a refrigerant with low flammability.
Class 2L. Indicates a refrigerant with low flammability and low burning velocity.
Class 3. Indicates a refrigerant with high flammability.

Toxicity classification (refrigerant). An alphabetical designation used to identify the toxicity of refrigerants. Class A indicates a refrigerant with low toxicity. Class B indicates a refrigerant with high toxicity.

Definitions

~~**REFRIGERATING SYSTEM.**~~ **REFRIGERATION SYSTEM.** A combination of interconnected parts in which a refrigerant is enclosed and ~~refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant~~ is circulated for the purpose of extracting then rejecting heat.

~~**REFRIGERATION SYSTEM, MECHANICAL.** A combination of interconnected refrigeration-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat and in which a compressor is used for compressing the refrigerant vapor.~~

STEAM BATH EQUIPMENT. Includes steam bath generators, combination room and steam generator systems, and steam bath cabinets intended for high-humidity concentrated heating at elevated temperatures for personal bathing.

Chapter 3 General Regulations

301.6 Fuel gas appliances and equipment. The approval and installation of fuel gas distribution piping and *equipment*, fuel gas-fired *appliances* and fuel gas-fired *appliance* venting systems shall be in accordance with the *International Fuel Gas Code* .

(Amd) **301.6 Gas.** The *International Fuel Gas Code* is not adopted by the state of Connecticut. Any references to the *International Fuel Gas Code* within the body of this code shall be considered references to requirements of NFPA 2, *Hydrogen Technologies Code*, NFPA 54, *National Fuel Gas Code* and NFPA 58, *Liquefied Petroleum Gas Code*, as incorporated in the Connecticut State Fire Safety Code and the Connecticut State Fire Prevention Code. These requirements apply to liquid petroleum storage systems, gas piping systems extending from the point of delivery to the inlet connections of *appliances*, the installation and operation of residential and commercial gas *appliances* and related accessories as covered by this code.

Section 302 Protection of Structure

[BS] 302.3 Cutting, notching and boring in wood framing. The cutting, notching and boring of wood framing members shall comply with Section 2308.6 of the *International Building Code*. ~~Sections 302.3.1 through 302.3.1~~

[BS] 302.5 Cutting~~,~~ and notching ~~and boring~~ in cold-formed steel framing. The cutting and notching of holes in cold-formed steel framing members shall be in accordance with **AISI S240** for structural members and **AISI S220** for nonstructural members. ~~The cutting, notching and boring of steel framing members shall comply with **Sections 302.5.1** through 302.5.3.~~

Section 305 Piping Support

305.4 Interval of support. Piping shall be supported at distances not exceeding the spacing specified in **Table 305.4** or in accordance with **ANSI/MSS SP-58**.

(Amd) **TABLE 305.4 PIPING SUPPORT SPACING[a]**

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS pipe	4	10[c]
Aluminum pipe and tubing	10	15
Cast-iron pipe[b]	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing	8	10
CPVC pipe or tubing, 1 inch and smaller	3	10[c]
CPVC pipe or tubing, 1 1/4-inches and larger	4	10[c]
Lead pipe	Continuous	4
PB pipe or tubing	2 2/3 (32 inches)	4
PE-RT 1 inch and smaller	2 2/3 (32 inches)	10[c]
PE-RT 1 1/4 inches and larger	4	10[c]
PEX tubing 1 inch and smaller	2 2/3 (32 inches)	10[c]
PEX tubing 1 1/4 inches and larger	4	10[c]
Cross-linked polyethylene/aluminum/crosslinked polyethylene (PEX-AL-PEX) pipe smaller than 1 inch	2 2/3 (32 inches)[d]	10[c]
Cross-linked polyethylene/aluminum/crosslinked polyethylene (PEX-AL-PEX) pipe 1 inch and larger	4[d]	10[c]
Polypropylene (PP) pipe or tubing, 1 inch and smaller	2 2/3 (32 inches)[d]	10[c]
Polypropylene (PP) pipe or tubing, 1 1/4 inches and larger	4[d]	10[c]
PVC pipe	4	10[c]
Steel pipe	12	15
Steel tubing	8	10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. See Section 301.18.
b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
c. Mid-story guide.
d. The maximum horizontal or vertical spacing of PP, PP-RCT or PEX-AL-PEX pipe hangers shall be increased to manufacturer's installation requirements based on maximum operating temperature design and/or incorporation of pipe or tube supports per manufacturer requirements.

TABLE 305.4
PIPING SUPPORT SPACING[a]

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS pipe	4	10[c]
Aluminum pipe and tubing	10	15
Cast-iron pipe[b]	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing	8	10
CPVC pipe or tubing, 1 inch and smaller	3	10[c]
CPVC pipe or tubing, 1 1/4-inches and larger	4	10[c]
Lead pipe	Continuous	4
~~PB pipe or tubing~~	~~2 2/3 (32 inches)~~	~~4~~
PE-RT 1 inch and smaller	2 2/3 (32 inches)	10[c]
PE-RT 1 1/4 inches and larger	4	10[c]
PEX tubing 1 inch and smaller	2 2/3 (32 inches)	10[c]
PEX tubing 1 1/4 inches and larger	4	10[c]
Polypropylene (PP) pipe or tubing, 1 inch and smaller	2 2/3 (32 inches)	10[c]
Polypropylene (PP) pipe or tubing, 1 1/4 inches and larger	4	10[c]
PVC pipe	4	10[c]
Steel pipe	12	15
Steel tubing	8	10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. See **Section 301.18**.
b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
c. Mid-story guide.

Section 305 Piping Support

305.5 Protection against physical damage. In concealed locations where piping, other than cast-iron or steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1 1/4 inches (32 mm) ~~1 1/2 inches (38 mm)~~ from the nearest edge of the member, the pipe shall be protected by shield plates. Protective steel shield plates ~~having a minimum thickness of 0.0575 inch (1.463 mm) (No. 16 gage)~~ shall cover the area of the pipe where the member is notched or bored, and shall extend not less than 2 inches (51 mm) above sole plates and below top plates.

305.5.1 Shield plates. Shield plates shall be of steel material having a thickness of not less than 0.0575 inch (1.4605 mm) (No. 16 gage).

Section 306 Access & Service Space

306.5 Equipment or appliances on roofs or elevated structures. Where *equipment* requiring access or *appliances* are located on an elevated structure or the roof of a building such that personnel will have to climb higher than 16 feet (4877 mm) above grade to access such *equipment* or *appliances*, an interior or exterior means of access shall be provided. Such access shall not require climbing over obstructions greater than 30 inches (762 mm) in height or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33-percent slope). Such access shall not require the use of portable ladders. Where access involves climbing over parapet walls, the height shall be measured to the top of the parapet wall.

Permanent ladders installed to provide the required access shall comply with the following minimum design criteria:

1. The side railing shall extend above the parapet or roof edge or landing platform not less than 42 inches (1067 mm). ~~30 inches (762 mm)~~.
2. Ladders shall have rung spacing not less than 10 inches (254 mm) and not to exceed 14 inches (356 mm) on center. The uppermost rung shall be not greater than 24 inches (610 mm) below the upper edge of the roof hatch, roof or parapet, as applicable.
3. Ladders shall have a toe spacing not less than 7 inches (178 mm) and not more than 12 inches (305 mm) ~~6 inches (152 mm)~~ deep.
4. There shall be not less than 16 inches (406 mm) ~~18 inches (457 mm)~~ between rails.
5. Rungs shall have a diameter not less than 0.75-inch (19.1 mm) and be capable of withstanding a 300-pound (136 kg) load.

10. Access to ladders shall be provided at all times.
11. Top landing required. The ladder shall be provided with a clear and unobstructed landing on the exit side of the roof hatch, having a minimum space of 30 inches (762 mm) deep and being the same width as the hatch.

Section 307 Condensate Disposal

307.1 Fuel-burning appliances. Liquid *combustion* by-products of condensing *appliances* shall be collected and discharged to an *approved* plumbing fixture or disposal area in accordance with the manufacturer's installation instructions. Condensate piping shall be of *approved* corrosion-resistant material and shall not be smaller than the drain connection on the *appliance*. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than $^{1}/_{8}$ unit vertical in 12 units horizontal (1-percent slope).

307.1.1 Identification. The termination of concealed condensate piping shall be marked to indicate whether the piping is connected to the primary or secondary drain.

(Add) **307.1.2 Neutralization.** Liquid combustion by-products of condensing appliances shall be neutralized prior to being discharged.

Chapter 4 Ventilation

TABLE 403.3.1.1
MINIMUM VENTILATION RATES

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT² [a]	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/ PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/ FT² [a]	EXHAUST AIRFLOW RATE CFM/FT² [a]
Animal facilities				
Animal exam room (veterinary office)	20	10	0.12	—
Animal imaging (MR/ CT/PET)	20	10	0.18	0.9
Animal operating rooms	20	10	0.18	3.00
Animal postoperative recovery room	20	10	0.18	1.50
Animal preparation rooms	20	10	0.18	1.50
Animal procedure room	20	10	0.18	2.25
Animal surgery scrub	20	10	0.18	1.50
Large-animal holding room	20	10	0.18	2.25
Necropsy	20	10	0.18	2.25
Small-animal cage room (static cages)	20	10	0.18	2.25
Small-animal cage room (ventilated cages)	20	10	0.18	1.50
Correctional facilities				
Booking/waiting	50	7.5	0.06	—
Cells				
without plumbing fixtures	25	5	0.12	—
with plumbing fixtures[g]	25	5	0.12	1.0
Day room	30	5	0.06	—
Dining halls (see "Food and beverage service")	—	—	—	—
Break rooms	25	5	0.06	—
Cafeteria, fast food	100	7.5	0.18	—
Coffee stations	20	5	0.06	—
Corridors	—	—	0.06	—
Dining rooms	70	7.5	0.18	—
Kitchens (cooking)[b]	20	7.5	0.12	0.7
Occupiable storage rooms for liquids or gels	2	5	0.12	—
Hotels, motels, resorts and dormitories				
Bathrooms/ toilet—private[g]	—	—	—	25/50[f]
Bedroom/living room	10	5	0.06	—
Conference/meeting	50	5	0.06	—
Dormitory sleeping areas	20	5	0.06	—
Gambling casinos	120	7.5	0.18	—
Laundry rooms, central	10	5	0.12	—
Laundry rooms within dwelling units	10	5	0.12	—
Lobbies/prefunction	30	7.5	0.06	—
Multipurpose assembly	120	5	0.06	—
Offices				
Break rooms	50	5	0.12	—
Conference rooms	50	5	0.06	—
Main entry lobbies	10	5	0.06	—
Occupiable storage rooms for dry materials	2	5	0.06	—
Office spaces	5	5	0.06	—
Reception areas	30	5	0.06	—
Telephone/data entry	60	5	0.06	—
Outpatient healthcare facilities[i, j]				
Birthing room	15	10	0.18	—
Class 1 imaging room	5	5	0.12	—
Dental operatory[k]	20	10	0.18	—
General examination room	20	7.5	0.12	—
Other dental treatment areas	5	5	0.06	—
Physical therapy exercise area	7	20	0.18	—
Physical therapy individual room	20	10	0.06	—
Physical therapeutic pool area	—	—	0.48	—
Prosthetics and orthotics room	20	10	0.18	—
Psychiatric consultation room	20	5	0.06	—
Psychiatric examination room	20	5	0.06	—
Psychiatric group room	50	5	0.06	—
Psychiatric seclusion room	5	10	0.06	—
Speech therapy room	20	5	0.06	—
Urgent care examination room	20	7.5	0.12	—
Urgent care observation room	20	5	0.06	—
Urgent care treatment room	20	7.5	0.18	—
Urgent care triage room	20	10	0.18	—
Room with adult changing station	—	—	—	50/70[e]
Banks or lobbies	15	7.5	0.06	—
Manufacturing where hazardous materials are not used	7	10	0.18	—
Manufacturing where hazardous materials are used (excludes heavy industrial and chemical processes)	7	10	0.18	—
Meat processing[c]	10	15	—	—
Pharmacy (prep. area)	10	5	0.18	—
Photo studios	10	5	0.12	—
Sorting, packing, light assembly	7	7.5	0.12	—
Telephone closets	—	—	0.00	—

Ventilation

TABLE 403.3.2.3
MINIMUM REQUIRED LOCAL EXHAUST RATES FOR GROUP R-2, R-3 AND R-4 OCCUPANCIES

AREA TO BE EXHAUSTED	EXHAUST RATE CAPACITY
Kitchens	100 cfm intermittent or ~~25~~ 50 cfm continuous
Bathrooms and toilet rooms	50 cfm intermittent or ~~20~~ 25 cfm continuous

For SI: 1 cubic foot per minute = 0.0004719 m^3/s.

AMBULATORY CARE FACILITIES AND GROUP I-2 OCCUPANCIES

407.1 General. Mechanical ventilation for ambulatory care facilities and Group I-2 *occupancies* shall be designed and installed in accordance with this code, **ASHRAE/ASHE 170** and **NFPA 99**.

Chapter 5 Exhaust Systems

501.6 Common ducts. The discharge from exhaust fans serving separate *dwelling* or *sleeping units* shall not be connected to a common duct or shaft, except where the common duct or shaft is maintained at a negative pressure.

504.8.1 Shield plates. Shield plates shall be of steel material having a thickness of not less than 0.0575 inch (1.463 mm) (No. 16 gage).

505.3 Exhaust ducts. Domestic cooking exhaust *equipment* shall discharge to the outdoors through sheet metal ducts constructed of galvanized steel, stainless steel, aluminum or copper. Such ducts shall have smooth inner walls, shall be airtight and shall be equipped with a backdraft damper. Installations in Group I-1 and I-2 *occupancies* shall be in accordance with the *International Building Code* and Section 904.15 of the *International Fire Code* and **Section 505.7** or **505.8**.

Exhaust Systems

(Amd) **505.4 Makeup air required.** Where one or more gas, liquid or solid fuel-burning *appliances* that are neither direct-vent nor use a mechanical draft venting system are located within a *dwelling unit's* air barrier, each exhaust system capable of exhausting in excess of 400 cubic feet per minute (0.19 m^3/s) shall be mechanically or passively provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with not fewer than one damper complying with Section 505.4.2.

Exceptions:

1. Makeup air is not required for exhaust systems installed for the exclusive purpose of space cooling and intended to be operated only when windows or other air inlets are open.
2. Where all *appliances* in the house are of sealed combustion, power-vent, unvented, or electric, the exhaust hood system shall be permitted to exhaust up to 600 cubic feet per minute (0.28 m^3/s) without providing makeup air. Exhaust hood systems capable of exhausting in excess of 600 cubic feet per minute (0.28 m^3/s) shall be provided with a makeup air at a rate approximately equal to the difference between the exhaust air rate and 600 feet per minute. Such makeup air systems shall be equipped with a means of closure.

(Add) **505.4.1 Location.** Kitchen exhaust makeup air shall be discharged into the same room in which the exhaust system is located or into rooms or *duct systems* that communicate through one or more permanent openings with the room in which such exhaust system is located. Such permanent openings shall have a net cross-sectional area not less than the required area of the makeup air supply openings.

(Add) **505.4.2 Makeup air dampers.** Where makeup air is required by Section 505.4, makeup air dampers shall comply with this section. Each damper shall be a gravity damper or an electrically operated damper that automatically opens when the exhaust system operates. Dampers shall be located to allow access for inspection, service, repair and replacement without removing permanent construction or any other ducts not connected to the damper being inspected, serviced, repaired or replaced. Gravity or barometric dampers shall not be used in passive makeup air systems except where the dampers are rated to provide the design makeup airflow at a pressure differential of 0.01 in. w.c. (3 Pa) or less.

Exhaust Systems

505.7 Group I-1 occupancies. In Group I-1 *occupancies*, hood installations over domestic cooking equipment installed in accordance with Section 420.9 of the *International Building Code* shall comply with the following:

1. Range hoods shall have a minimum air flow rate of 500 cfm (14 000 L/min).
2. Mechanical ventilation shall be provided to the rooms or spaces containing the domestic cooking equipment in accordance with **Section 403.3.1**.
3. Range hood exhaust shall discharge to the outdoors.

Exception: A *listed* and *labeled* ductless range hood shall be permitted where a charcoal filter is provided in the hood to reduce smoke and odors.

505.8 Group I-2 occupancies. In Group I-2 *occupancies*, hood installations above domestic cooking equipment installed in accordance with Section 407.2.7 of the *International Building Code* shall comply with the following:

1. Range hoods shall have a minimum air flow rate of 500 cfm (14 000 L/min).
2. Mechanical ventilation shall be provided to the rooms or spaces containing the domestic cooking equipment in accordance with **Section 403.3.1**.
3. Range hood exhaust shall discharge to the outdoors.

Exception: A *listed* and *labeled* ductless range hood shall be permitted where a charcoal filter is provided in the hood to reduce smoke and odors.

Commercial Kitchen Hoods

506.3 ~~**Ducts serving Type I hoods**~~ **Grease duct systems.** ~~Type I exhaust ducts shall be independent of all other exhaust systems except as provided in **Section 506.3.5**. Commercial kitchen~~ Grease duct systems ~~serving Type I hoods~~ shall be designed, constructed and installed in accordance with **Sections 506.3.1** through **506.3.13.3**.

(Amd) **506.3.2.5 Grease duct test.** Prior to the use or concealment of any portion of a grease *duct* system, a leakage test shall be performed. *Ducts* shall be considered to be concealed where installed in *shafts* or covered by coatings or wraps that prevent the ductwork from being visually inspected on all sides. The test shall be performed for the entire *duct* system, including the hood-to-*duct* connection. All connections, seams and welds shall be visible during the test. The ductwork shall be permitted to be tested in sections, provided that every joint is tested. For *listed* factory-built grease *ducts*, this test shall be limited to *duct* joints assembled in the field and shall exclude factory welds. The *permit* holder shall be responsible to provide the necessary equipment and perform the grease *duct* leakage test. The leakage test shall consist of one of the following tests, or an *approved* equivalent test:

(Del) **506.3.2.5.1 Light test.** Delete section and replace with the following:

(Add) **506.3.2.5.1 Positive pressure smoke test.** The positive pressure smoke test shall be performed by sealing the entire *duct* system from the hood exhaust opening(s) to the *duct* termination. Visible smoke shall be introduced to the *duct* system. The sealed *duct* shall then be pressurized to a minimum pressure of 1.0 inch water column, but shall not exceed the positive pressure capability of the system and components under test. No smoke shall emit from any exterior surface of the *duct*.

(Add) **506.3.2.5.3 Air test**. The air test shall be performed by sealing the entire *duct* system from the hood exhaust opening(s) to the *duct* termination. The sealed *duct* system shall then be pressurized to a minimum pressure of 1.0 inch (249 Pa) water column and shall be required to hold the initial set pressure for a minimum of 20 minutes.

Grease Ducts

(Amd) **506.3.6 Grease duct clearances**. Where enclosures are not required, grease *duct* systems and exhaust equipment serving a Type I hood shall have a clearance to combustible construction of at least 18 inches (457 mm), 3 inches (76 mm) to *limited-combustible material*, and 0 inches (0 mm) to *noncombustible material*.

Exceptions:

1. Factory-built commercial kitchen grease *ducts listed* and *labeled* in accordance with UL 1978.
2. Grease *duct* systems or exhaust equipment *listed* for clearances less than those required in Section 506.3.6, shall be installed with the clearances specified by such listings.
3. Where commercial kitchen grease *ducts* are continuously covered on all sides with a *listed* and *labeled* field-applied grease *duct* enclosure material, system, product or method of construction specifically evaluated for such purpose in accordance with ASTM E2336, the required clearance shall be in accordance with the listing of such material, system, product or method.

(Add) **506.3.6.1 Clearance reduction**. The clearances required by Section 506.3.6 shall be permitted to be reduced in accordance with Section 308.

Grease Ducts

506.5 Exhaust equipment. Exhaust *equipment*, including fans and grease reservoirs, shall comply with **Sections 506.5.1** through **506.5.6** and shall be of an *approved* design or shall be *listed* for the application.

506.5.1 Exhaust fans. Exhaust fan housings serving a Type I hood shall be constructed as required for grease ducts in accordance with **Section 506.3.1**.

Exception: Fans *listed* and *labeled* in accordance with ~~UL762~~ **UL 705** .

506.5.1.1 Fan motor. Exhaust fan motors shall be located outside of the exhaust airstream.

Commercial Kitchen Hoods

COMMERCIAL KITCHEN HOODS

507.1 General. Commercial kitchen exhaust hoods shall comply with the requirements of this section. Hoods shall be Type I or II and shall be designed to capture and confine cooking vapors and residues. A Type I hood shall be installed at or above appliances in accordance with **Section 507.2**. ~~or~~ A Type II hood shall be installed at or above *appliances* in accordance with ~~**Sections 507.2 and**~~ **Section 507.3**. Where any cooking *appliance* under a single hood requires a Type I hood, a Type I hood shall be installed. Where a Type II hood is required, a Type I or Type II hood shall be installed. ~~Where a Type I hood is installed, the installation of the entire system, including the hood, ducts, exhaust *equipment* and *makeup air* system shall comply with the requirements of **Sections 506**, **507**, **508** and 509.~~

(Amd) **507.2.6 Clearances for Type I hood**. A Type I hood shall be installed with a clearance to combustibles of not less than 18 inches (457 mm), 3 inches (76 mm) to *limited-combustible material*, and 0 inches (0 mm) to *noncombustible material*.

Exceptions:

1. Clearance shall not be required from gypsum wallboard or 1/2-inch (12.7 mm) or thicker cementitious wallboard attached to noncombustible structures provided that a smooth, cleanable, nonabsorbent and *noncombustible material* is installed between the hood and the gypsum or cementitious wallboard over an area extending not less than 18 inches (457 mm) in all directions from the hood.
2. Type 1 hoods *listed* and *labeled* for clearances less than those required in Section 507.2.6 in accordance with UL 710 shall be installed with the clearances specified by such listings.

(Add) **507.2.6.1 Clearance reduction**. The clearances required by Section 506.3.6 shall be permitted to be reduced in accordance with Section 308.

Commercial Kitchens

507.1.3 Fuel-burning appliances. ~~Where vented fuel-burning *appliances* are located in the same room or space as the hood, provisions shall be made to prevent the hood system from interfering with normal operation of the *appliance* vents.~~ *Appliances* equipped with draft hoods or atmospheric burners shall not be located in the same room or space containing a Type I or Type II hood except where the *appliance* is located in a sealed enclosure equipped with a self-closing device with combustion air obtained from the outdoors or from other spaces in the *building* in accordance with **Chapter 7** or the *International Fuel Gas Code* .

Commercial Kitchen Hoods

507.3 Type II hoods. Type II hoods shall be installed above *light-duty cooking appliances,* dishwashers and *appliances* that produce heat or moisture and do not produce grease or smoke as a result of the cooking process. ~~, except where the heat and moisture loads from such *appliances* are incorporated into the HVAC system design or into the design of a separate removal system.~~ Type II hoods shall be installed above all *appliances* that produce products of *combustion* and do not produce grease or smoke as a result of the cooking process. A Type I hood shall be permitted to be installed for a required Type II hood, provided that the Type I hood installation complies with all of the requirements for a Type I hood installation. Where such a Type I hood serves only dishwashers and *appliances* that require a Type II hood, the Type I hood shall not be required to have fire suppression or grease filters. ~~Spaces containing cooking *appliances* that do not require Type II hoods shall be provided with exhaust at a rate of 0.70 cfm per square foot (0.00356 $m^3/(s \cdot m^2)$. For the purpose of determining the floor area required to be exhausted, each individual *appliance* that is not required to be installed under a Type II hood shall be considered as occupying not less than 100 square feet (9.3 m^2). Such additional square footage shall be provided with exhaust at a rate of 0.70 cfm per square foot [0.00356 $m^3/(s \cdot m^2)$].~~

507.3.4 Capacity of Type II hoods. Type II hoods shall exhaust a minimum net quantity of air determined in accordance with this section and **Sections 507.3.4.1** through **507.3.4.2**. The net quantity of *exhaust air* shall be calculated by subtracting any airflow supplied directly to a hood cavity from the total exhaust flow rate of a hood.

Commercial Kitchen Make-up Air

508.1.1 Makeup air temperature. ~~The temperature differential between *makeup air* and the air in the conditioned space shall not exceed 10°F (6°C) except where the added heating and cooling loads of the *makeup air* do not exceed the capacity of the HVAC system.~~ - HVAC systems that serve the kitchen space shall have the additional capacity necessary for the latent and sensible loads that are introduced by the *makeup air* supplied to the kitchen space, or the *makeup air* shall be conditioned by dedicated systems such that the difference in temperature between the *makeup air* supplied to the kitchen space and the design setpoint temperature in the kitchen space is not greater than 10°F (6°C).

Exception: *Makeup air* supplied to a compensating hood shall not be required to be conditioned.

Chapter 6 Duct Systems

601.5 Return air openings. Return air openings for heating, ventilation and air-conditioning systems shall comply with all of the following:

1. Openings shall not be located less than 10 feet (3048 mm) measured in any direction from an open combustion chamber or draft hood of another *appliance* located in the same room or space.
2. Return air for heating or air-conditioning systems shall not be taken from a hazardous or insanitary location or a refrigeration room as defined in this code.
3. The amount of return air taken from any room or space shall be not greater than the flow rate of supply air delivered to such room or space.
4. Return and transfer openings shall be sized in accordance with the *appliance* or *equipment* manufacturer's installation instructions, **ACCA Manual D** or the design of the *registered design professional*.
5. Return air taken from one *dwelling unit* shall not be discharged into another *dwelling unit*.
6. Taking return air from a crawl space shall not be accomplished through a direct connection to the return side of a forced air furnace. Transfer openings in the crawl space enclosure shall not be prohibited.
7. Return air for heating or air-conditioning systems shall not be taken from a ~~closet,~~ bathroom, toilet room, kitchen, garage, boiler room, furnace room or unconditioned attic.
8. Return air from a closet shall serve only the closet and shall not require a dedicated closet supply duct.
9. Return air taken from a closet smaller than 30 square feet (2.8 m^2) shall require the closet door be undercut not less than $1^1/_2$ inches (38 mm) or have either a louvered door or an air transfer grille, each with a net free area of not less than 30 square inches (19 355 mm^2).

~~8.~~ 10. Return air for heating or air-conditioning systems shall not be taken from indoor swimming pool enclosures and associated deck areas.

Plenums

602.1 General. Supply, return, exhaust, relief and *ventilation air plenums* shall be in accordance with this section. ~~limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces, mechanical *equipment* rooms and the framing cavities addressed in **Section 602.2.1**. *Plenums* shall be limited to one fire area. Air systems shall be ducted from the boundary of the fire area served directly to the air-handling *equipment*.~~ Fuel-fired *appliances* shall not be installed within a *plenum*.

602.1.1 Locations limited. *Plenums* shall be limited to uninhabited crawl spaces, above a ceiling or below the floor, attic spaces, mechanical equipment rooms and the framing cavities addressed in **Section 602.2**.

602.1.2 Limited to a fire area. *Plenums* shall be limited to one fire area. Air systems shall be ducted directly from the boundary of the fire area served to the air-handling equipment.

602.1.3 Fuel-fired appliances. Fuel-fired *appliances* shall not be installed within a *plenum*.

~~**602.2.1**~~ **602.3 Materials within plenums.** ~~Except as required by Sections 602.3.3 through 602.3.9, m~~Materials within *plenums* shall be noncombustible or shall be in compliance with the applicable requirements in **Sections 602.3.1** through **602.3.10**. ~~*listed* and *labeled* as having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723.~~

Exceptions:

1. ~~Rigid and flexible ducts and connectors shall conform to **Section 603**.~~ Materials exposed within *plenums* in one- and two-family *dwellings*.
2. ~~Duct coverings, linings, tape and connectors shall conform to **Sections 603** and **604**.~~ Combustible materials fully enclosed within one of the following:
   2.1. Continuous noncombustible raceways or enclosures.
   2.2. *Approved* gypsum board assemblies.
   2.3. Materials *listed* and *labeled* for installation within a *plenum* and *listed* for the application.
3. ~~This section shall not apply to materials exposed within *plenums* in one- and two-family *dwellings*.~~
4. ~~This section shall not apply to smoke detectors.~~
5. ~~Combustible materials fully enclosed within one of the following:~~
   ~~5.1. Continuous noncombustible raceways or enclosures.~~
   ~~5.2. *Approved* gypsum board assemblies.~~
   ~~5.3. Materials *listed* and *labeled* for installation within a *plenum* and listed for the application.~~

Plenums

602.3.1 Ducts, connectors, duct coverings, linings and tape. Rigid and flexible ducts and connectors shall conform to **Section 603**. Duct coverings, linings, tape and connectors shall conform to **Sections 603** and **604**.

602.3.2 Smoke detectors. Smoke detectors shall be *listed* and *labeled*.

602.3.10 Other combustible materials. Other combustible materials not covered by **Section 602.3** shall be *listed* and *labeled* as having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with **ASTM E84** or **UL 723**.

Duct Insulation

604.3 Coverings and linings. Duct coverings and linings, including adhesives where used, shall have a flame spread index not more than 25 and a smoke-developed index not more than 50, when tested in accordance with **ASTM E84** or **UL 723**, using the specimen preparation and mounting procedures of **ASTM E2231**. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with **ASTM C411** at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C). Coverings and linings shall be *listed* and *labeled*.

2. Duct coverings added to the outside of ducts and not contained in *plenums*, including adhesives where used, shall have a flame spread index not more than 25 and a smoke-developed index not more than 450, when tested in accordance with **ASTM E84** or **UL 723**, using the specimen preparation and mounting procedures of **ASTM E2231**. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with **ASTM C411** at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C). Coverings shall be *listed* and *labeled*.

Smoke Detectors

(Amd) **606.2 Where required.** Smoke detectors shall be installed where indicated in Sections 606.2.1 to 606.2.3, inclusive.

Exception: Smoke detectors shall not be required where air distribution systems are incapable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated, or where the sole purpose of the air distribution system is to remove air from the inside of the *building* to the outside of the *building*.

Duct and Transfer openings

[BF] 607.2.4 Mechanical, electrical and plumbing controls. Mechanical, electrical and plumbing controls shall not be installed in air duct systems.

Exception: Controls shall be permitted to be installed in air duct systems only if the wiring is directly associated with the air distribution system. The wiring shall comply with the requirements of **Section 602** and the total length of such wiring shall not exceed 4 feet (1.2 m).

[BF] 607.2.4.1 Controls not permitted to be installed through dampers. Mechanical, electrical and plumbing controls shall not be installed through fire dampers, smoke dampers, combination fire/smoke dampers or ceiling radiation dampers unless otherwise permitted by the manufacturer and the listing.

Chapter 9: Specific Appliances, Fireplaces and Solid Burning Fuel

2021: 912.1 General - Electric infrared radiant heaters shall comply

2024: 912.1 General - Permanently installed electric space heaters shall be listed and labeled in accordance with UL 2021, and installed in accordance with the manufacturer’s instructions.

2021: 923.1 General. Kilns shall be listed and labeled unless otherwise approved in accordance with Section 105.2. Electric kilns shall comply with UL 499. The approval of unlisted appliances in accordance with Section 105.2 shall be based on approved engineering evaluation.

2024: 923.1 General. Kilns shall be listed and labeled unless otherwise approved in accordance with **Section 104.2.3**. Electric kilns shall comply with UL 499. The approval of unlisted appliances in accordance with Section **104.2.3** shall be based on approved engineering evaluation.

ADDED in 2024: 931.1 General. Steam bath equipment shall be listed and labeled in accordance with UL 499 and shall be installed in accordance with their listing and the manufacturer’s instructions.

Chapter 10 Boilers, Water Heaters and Pressure Vessels

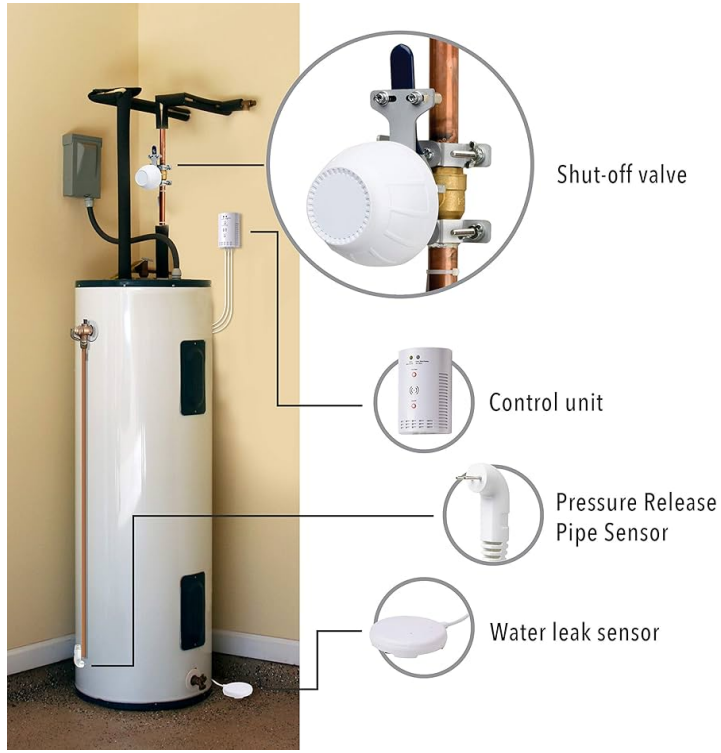
1006.6 Safety and relief valve discharge. Safety and relief valve discharge pipes shall be of rigid pipe that is approved for the temperature of the system. High-pressure-steam safety valves shall be vented to the outside of the structure. The discharge piping serving pressure relief valves, temperature relief valves and combinations of such valves shall:

2021:

7. Discharge to a termination point that is readily observable by the building occupants.

2024:

7. Discharge to a termination point that is readily visible and observable by the building occupants. **If the discharge termination point is not readily visible and observable, a leak detection monitoring device with alarm notification (and not automatic shut-off) is required.**



Chapter 10 Boilers, Water Heaters and Pressure Vessels

Added in 2024:

1002.4 Water heater pan required. Where a storage-type water heater or a hot water storage tank is installed in a location where water leakage from the tank will cause damage, the tank shall be installed in a pan constructed of one of the following:

1. Galvanized steel or aluminum of not less than 0.0236 inch (0.6 mm) in thickness.

2. Plastic of not less than 0.036 inch (0.9 mm) in thickness constructed of material having a flame spread index of not more than 25 and a smoke-developed index of not more than 450 when tested in accordance with ASTM E84 or UL 723.

3. Other approved materials.

Chapter 10 Boilers, Water Heaters and Pressure Vessels

2026 Connecticut State Building Code Amendment:

(Add) 1001.1.1 Boilers and water heaters. Boilers and water heaters shall also be governed by the regulations adopted under authority of chapter 540 of the Connecticut General Statutes.

Chapter 540 has regulations around inspection, commissioning and operation certifications. Along with fees and penalties.

Chapter 11: Refrigeration

2021: 1101.1.1 Refrigerants other than ammonia - Refrigerant piping design and installation for systems containing a refrigerant other than ammonia, including pressure vessels and pressure relief devices, shall comply with this chapter and ASHRAE 15.

2024: 1101.1.1 Refrigerants other than ammonia - Refrigeration systems using a refrigerant other than ammonia shall comply with this chapter, ASHRAE 15 and the International Fire Code. **Refrigeration systems containing carbon dioxide as the refrigerant shall also comply with IIAR CO2.**

https://iiarcondenser.org/co2-standard-provides-guidance-on-growing-segment-of-the-industry/

Chapter 11: Refrigeration

2021: 1101.7 Change in refrigerant type - The type of refrigerant in refrigeration systems having a refrigerant circuit containing more than 220 pounds (99.8 kg) of Group A1 or 30 pounds (13.6 kg) of any other group refrigerant shall not be changed without prior notification to the code official and compliance with the applicable code provisions for the new refrigerant type.

2024: 1101.7 Changing refrigerant - Changes of refrigerant in an existing system to a refrigerant with a different refrigerant designation shall be allowed only where in accordance with the following:

1. The owner or the owner's authorized agent shall be notified prior to making a change of refrigerant, and the change of refrigerant shall not be made where the owner objects to the change.

2. The change in refrigerant shall be in accordance with one of the following:

    2.1. Written instructions of the original equipment manufacturer.

    2.2. An evaluation of the system by a registered design professional or by an approved agency that validates safety and suitability of the replacement refrigerant.

    2.3. Approved by the code official.

3. Where the replacement refrigerant is classified into the same safety group, requirements that were applicable to the existing system shall continue to apply.

4. Where the replacement refrigerant is classified into a different safety group, the system shall comply with the requirements of this standard for a new installation, and the change of refrigerant shall require code official approval.

Chapter 11: Refrigeration

- 2021: 1102.2.1 Mixing - Refrigerants, including refrigerant blends, with different designations in ASHRAE 34 shall not be mixed in a system. Exception: Addition of a second refrigerant is allowed where permitted by the equipment or appliance manufacturer to improve oil return at low temperatures. The refrigerant and amount added shall be in accordance with the manufacturer's instructions.
- 2024: 1102.2.1 Mixing. Refrigerants with different refrigerant designations shall only be mixed in a system in accordance with both of the following:
- 1. The addition of a second refrigerant is allowed by the equipment manufacturer and is in accordance with the manufacturer's written instructions.
- **2. The resulting mixture does not change the refrigerant safety group.**

TABLE 1103.1—REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

CHEMICAL REFRIGERANT	FORMULAS	CHEMICAL NAME OF BLENDS	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							(F) DEGREES OF HAZARD[a]
				RCL			LFL			OEL	
				lb/MCf	ppm	g/m^3	lb/MCf	ppm	g/m^3	ppm	
R-11[c]	CCl_3F	trichlorofluoromethane	A1	0.39	1,100	6.1	—	—	—	1,000	2-0-0[b]
R-12[c]	CCl_2F_2	dichlorodifluoromethane	A1	5.6	18,000	90	—	—	—	1,000	2-0-0[b]
R-13[c]	$CClF_3$	chlorotrifluoromethane	A1	—	—	—	—	—	—	1,000	2-0-0[b]
R-13B1[c]	$CBrF_3$	bromotrifluoromethane	A1	—	—	—	—	—	—	1,000	2-0-0[b]
R-13I1	CF_3I	trifluoroiodomethane	A1	1.0	2,000	16	—	—	—	500	—
R-14	CF_4	tetrafluoromethane (carbon tetrafluoride)	A1	25	110,000	400	—	—	—	1,000	2-0-0[b]
R-22	$CHClF_2$	chlorodifluoromethane	A1	13	59,000	210	—	—	—	1,000	2-0-0[b]
R-23	CHF_3	trifluoromethane (fluoroform)	A1	7.3	41,000	120	—	—	—	1,000	2-0-0[b]
R-30	CH_2Cl_2	dichloromethane (methylene chloride)	B1	—	—	—	—	—	—	—	—
R-31	CH_2ClF	chlorofluoromethane	—	—	—	—	—	—	—	—	—
R-32	CH_2F_2	difluoromethane (methylene fluoride)	A2L	4.8	36,000	77	19.1	144,000	306	1,000	1-4-0
R-40	CH_3Cl	chloromethane (methyl chloride)	B2	—	—	—	—	—	—	—	—
R-41	CH_3F	fluoromethane (methyl fluoride)	—	—	—	—	—	—	—	—	—
R-50	CH_4	methane	A3	—	—	—	—	50,000	—	1,000	—
R-113[c]	CCl_2FCClF_2	1,1,2-trichloro-1,2,2-trifluoroethane	A1	1.2	2,600	20	—	—	—	1,000	2-0-0[b]
R-114[c]	$CClF_2CClF_2$	1,2-dichloro-1,1,2,2-tetrafluoroethane	A1	8.7	20,000	140	—	—	—	1,000	2-0-0[b]
R-115	$CClF_2CF_3$	chloropentafluoroethane	A1	47	120,000	760	—	—	—	1,000	—
R-116	CF_3CF_3	hexafluoroethane	A1	34	97,000	550	—	—	—	1,000	1-0-0
R-123	$CHCl_2CF_3$	2,2-dichloro-1,1,1-trifluoroethane	B1	3.5	9,100	57	—	—	—	50	2-0-0[b]
R-124	$CHClFCF_3$	2-chloro-1,1,1,2-tetrafluoroethane	A1	3.5	10,000	56	—	—	—	1,000	2-0-0[b]
R-125	CHF_2CF_3	pentafluoroethane	A1	23	75,000	370	—	—	—	1,000	2-0-0[b]
R-134a	CH_2FCF_3	1,1,1,2-tetrafluoroethane	A1	13	50,000	210	—	—	—	1,000	2-0-0[b]
R-141b	CH_3CCl_2F	1,1-dichloro-1-fluoroethane	—	0.78	2,600	12	17.8	60,000	287	500	2-1-0
R-142b	CH_3CClF_2	1-chloro-1, 1-difluoroethane	A2	5.1	20,000	82	20.4	80,000	329	1,000	2-4-0
R-143a	CH_3CF_3	1,1,1-trifluoroethane	A2L	4.4	21,000	70	17.5	82,000	282	1,000	2-0-0[b]
R-152a	CH_3CHF_2	1,1-difluoroethane	A2	2.0	12,000	32	8.1	48,000	130	1,000	1-4-0
R-170	CH_3CH_3	ethane	A3	0.54	7,000	8.6	2.4	31,000	38	1,000	2-4-0
R-E170	CH_3OCH_3	Methoxymethane (dimethyl ether)	A3	1.0	8,500	16	4.0	34,000	64	1,000	—
R-218	$CF_3CF_2CF_3$	octafluoropropane	A1	43	90,000	690	—	—	—	1,000	2-0-0[b]
R-227ea	CF_3CHFCF_3	1,1,1,2,3,3,3-heptafluoropropane	A1	36	84,000	580	—	—	—	1,000	—

TABLE 1103.1—REFRIGERANT CLASSIFICATION, AMOUNT AND OEL—continued

CHEMICAL REFRIGERANT	FORMULAS	CHEMICAL NAME OF BLENDS	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							(F) DEGREES OF HAZARD[a]
				RCL			LFL			OEL	
				lb/MCf	ppm	g/m^3	lb/MCf	ppm	g/m^3	ppm	
R-236fa	$CF_3CH_2CF_3$	1,1,1,3,3,3-hexafluoropropane	A1	21	55,000	340	—	—	—	1,000	2-0-0[b]
R-245fa	$CHF_2CH_2CF_3$	1,1,1,3,3-pentafluoropropane	B1	12	34,000	190				300	2-0-0[b]
R-290	$CH_3CH_2CH_3$	propane	A3	0.59	5,300	9.5	2.4	21,000	38	1,000	2-4-0
R-C318	$-(CF_2)_4-$	octafluorocyclobutane	A1	41	80,000	650	—	—	—	1,000	—
R-400[c]	zeotrope	R-12/114 (50.0/50.0)	A1	10	28,000	160	—	—	—	1,000	2-0-0[b]
R-400[c]	zeotrope	R-12/114 (60.0/40.0)	A1	11	30,000	170	—	—	—	1,000	—
R-401A	zeotrope	R-22/152a/124 (53.0/13.0/34.0)	A1	6.6	27,000	110	—	—	—	1,000	2-0-0[b]
R-401B	zeotrope	R-22/152a/124 (61.0/11.0/28.0)	A1	7.2	30,000	120	—	—	—	1,000	2-0-0[b]
R-401C	zeotrope	R-22/152a/124 (33.0/15.0/52.0)	A1	5.2	20,000	84	—	—	—	1,000	2-0-0[b]
R-402A	zeotrope	R-125/290/22 (60.0/2.0/38.0)	A1	17	66,000	270	—	—	—	1,000	2-0-0[b]
R-402B	zeotrope	R-125/290/22 (38.0/2.0/60.0)	A1	15	63,000	240	—	—	—	1,000	2-0-0[b]
R-403A	zeotrope	R-290/22/218 (5.0/75.0/20.0)	A2	7.6	33,000	120	—	—	—	1,000	2-0-0[b]
R-403B	zeotrope	R-290/22/218 (5.0/56.0/39.0)	A1	18	68,000	290	—	—	—	1,000	2-0-0[b]
R-404A	zeotrope	R-125/143a/134a (44.0/52.0/4.0)	A1	31	130,000	500	—	—	—	1,000	2-0-0[b]
R-405A	zeotrope	R-22/152a/142b/C318 (45.0/7.0/5.5/42.5)	—	16	57,000	260	—	—	—	1,000	—
R-406A	zeotrope	R-22/600a/142b (55.0/4.0/41.0)	A2	4.7	21,000	75	18.8	82,000	301.9	1,000	—
R-407A	zeotrope	R-32/125/134a (20.0/40.0/40.0)	A1	19	83,000	300	—	—	—	1,000	2-0-0[b]
R-407B	zeotrope	R-32/125/134a (10.0/70.0/20.0)	A1	21	79,000	330	—	—	—	1,000	2-0-0[b]
R-407C	zeotrope	R-32/125/134a (23.0/25.0/52.0)	A1	18	81,000	290	—	—	—	1,000	2-0-0[b]
R-407D	zeotrope	R-32/125/134a (15.0/15.0/70.0)	A1	16	68,000	250	—	—	—	1,000	2-0-0[b]
R-407E	zeotrope	R-32/125/134a (25.0/15.0/60.0)	A1	17	80,000	280	—	—	—	1,000	2-0-0[b]
R-407F	zeotrope	R-32/125/134a (30.0/30.0/40.0)	A1	20	95,000	320	—	—	—	1,000	—
R-407G	zeotrope	R-32/125/134a (2.5/2.5/95.0)	A1	13	52,000	210	—	—	—	1,000	—
R-407H	zeotrope	R-32/125/134a (32.5/15.0/52.5)	A1	19	92,000	300	—	—	—	1,000	—
R-407I	zeotrope	R-32/125/124a (19.5/8.5/72.0)	A1	16	71,100	250	—	—	—	1,000	—
R-408A	zeotrope	R-125/143a/22 (7.0/46.0/47.0)	A1	21	94,000	330	—	—	—	1,000	2-0-0
R-409A	zeotrope	R-22/124/142b (60.0/25.0/15.0)	A1	7.1	29,000	110	—	—	—	1,000	2-0-0[b]
R-409B	zeotrope	R-22/124/142b (65.0/25.0/10.0)	A1	7.3	30,000	120	—	—	—	1,000	2-0-0[b]
R-410A	zeotrope	R-32/125 (50.0/50.0)	A1	26	140,000	420	—	—	—	1,000	2-0-0[b]
R-410B	zeotrope	R-32/125 (45.0/55.0)	A1	27	140,000	430	—	—	—	1,000	2-0-0[b]
R-411A	zeotrope	R-127/22/152a (1.5/87.5/11.0)	A2	2.9	14,000	46	11.6	55,000	185.6	970	—

TABLE 1103.1—REFRIGERANT CLASSIFICATION, AMOUNT AND OEL—continued

CHEMICAL REFRIGERANT	FORMULAS	CHEMICAL NAME OF BLENDS	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							(F) DEGREES OF HAZARD[a]
				RCL			LFL			OEL	
				lb/MCf	ppm	g/m^3	lb/MCf	ppm	g/m^3	ppm	
R-431A	zeotrope	R-290/152a (71.0/29.0)	A3	0.68	5,500	11	2.7	22,000	38.6	1,000	—
R-432A	zeotrope	R-1270/E170 (80.0/20.0)	A3	0.13	1,200	2.1	2.4	22,000	39.2	550	—
R-433A	zeotrope	R-1270/290 (30.0/70.0)	A3	0.34	3,100	5.5	2.4	20,000	32.4	750	—
R-433B	zeotrope	R-1270/290 (5.0-95.0)	A3	0.39	3,500	6.3	2.0	18,000	32.1	950	—
R-433C	zeotrope	R-1270/290 (25.0-75.0)	A3	0.41	3,700	6.5	2.0	18,000	83.8	790	—
R-434A	zeotrope	R-125/143a/600a (63.2/18.0/16.0/2.8)	A1	20	73,000	320	—	—	—	1,000	—
R-435A	zeotrope	R-E170/152a (80.0/20.0)	A3	1.1	8,500	17	4.3	34,000	68.2	1,000	—
R-436A	zeotrope	R-290/600a (56.0/44.0)	A3	0.50	4,000	8.1	2.0	16,000	32.3	1,000	—
R-436B	zeotrope	R-290/600a (52.0/48.0)	A3	0.51	4,000	8.2	2.0	16,000	32.7	1,000	—
R-436C	zeotrope	R-290/600a (95.0/5.0)	A3	0.57	5,000	9.1	2.3	20,000	36.5	1,000	—
R-437A	zeotrope	R-125/134a/600/601 (19.5/78.5/1.4/0.6)	A1	5.1	19,000	82	—	—	—	990	—
R-438A	zeotrope	R-32/125/134a/600/601a (8.5/45.0/44.2/1.7/0.6)	A1	4.9	20,000	79	—	—	—	990	—
R-439A	zeotrope	R-32/125/600a (50.0/47.0/3.0)	A2	4.7	26,000	76	18.9	104,000	303.3	1,000	—
R-440A	zeotrope	R-290/134a/152a (0.6/1.6/97.8)	A2	1.9	12,000	31	7.8	46,000	124.7	1,000	—
R-441A	zeotrope	R-170/290/600a/600 (3.1/54.8/6.0/36.1)	A3	0.39	3,200	6.3	2.0	16,000	31.7	1,000	—
R-442A	zeotrope	R-32/125/134a/152a/227ea (31.0/31.0/30.0/3.0/5.0)	A1	21	100,000	330	—	—	—	1,000	—
R-443A	zeotrope	R-1270/290/600a (55.0/40.0/5.0)	A3	0.19	1,700	3.1	2.2	20,000	35.6	640	—
R-444A	zeotrope	R-32/152a/1234ze(E) (12.0/5.0/83.0)	A2L	5.1	21,000	81	19.9	82,000	324.8	850	—
R-444B	zeotrope	R-32/152a/1234ze(E) (41.5/10.0/48.5)	A2L	4.3	23,000	69	17.3	93,000	277.3	930	—
R-445A	zeotrope	R-744/134a/1234ze(E) (6.0/9.0/85.0)	A2L	4.2	16,000	67	2.7	63,000	347.4	930	—
R-446A	zeotrope	R-32/1234ze(E)/600 (68.0/29.0/3.0)	A2L	2.5	16,000	39	13.5	62,000	217.4	960	—
R-447A	zeotrope	R-32/125/1234ze(E) (68.0/3.5/28.5)	A2L	2.6	16,000	42	18.9	65,000	303.5	960	—
R-447B	zeotrope	R-32/125/1234ze(E) (68.0/8.0/24.0)	A2L	2.6	16,000	42	20.6	121,000	312.7	970	—
R-448A	zeotrope	R-32/125/1234yf/134a/1234ze(E) (26.0/26.0/20.0/21.0/7.0)	A1	24	110,000	390	—	—	—	860	—
R-449A	zeotrope	R-32/125/1234yf/134a (24.3/24.7/25.3/25.7)	A1	23	100,000	370	—	—	—	840	—
R-449B	zeotrope	R-32/125/1234yf/134a (25.2/24.3/23.2/27.3)	A1	23	100,000	370	—	—	—	850	—
R-449C	zeotrope	R-32/125/1234yf/134a (20.0/20.0/31.0/29.0)	A1	23	98,000	360	—	—	—	800	—

TABLE 1103.1—REFRIGERANT CLASSIFICATION, AMOUNT AND OEL—continued

CHEMICAL REFRIGERANT	FORMULAS	CHEMICAL NAME OF BLENDS	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							(F) DEGREES OF HAZARD[a]
				RCL			LFL			OEL	
				lb/MCf	ppm	g/m³	lb/MCf	ppm	g/m³	ppm	
R-450A	zeotrope	R-134a/1234ze(E) (42.0/58.0)	A1	20	72,000	320	—	—	—	880	—
R-451A	zeotrope	R-1234yf/134a (89.8/10.2)	A2L	5.0	18,000	81	20.3	70,000	326.6	530	—
R-451B	zeotrope	R-1234yf/134a (88.8/11.2)	A2L	5.0	18,000	81	20.3	70,000	326.6	530	—
R-452A	zeotrope	R-32/125/1234yf (11.0/59.0/30.0)	A1	27	100,000	440	—	—	—	790	—
R-452B	zeotrope	R-32/125/1234yf (67.0/7.0/26.0)	A2L	4.8	30,000	77	19.3	119,000	310.5	870	—
R-452C	zeotrope	R-32/125/1234yf (12.5/61.0/26.5)	A1	27	100,000	430	—	—	—	810	—
R-453A	zeotrope	R-32/125/134a/227ea/600/601a (20.0/20.0/53.8/5.0/0.6/0.6)	A1	7.8	34,000	120	—	—	—	1,000	—
R-454A	zeotrope	R-32/1234yf (35.0/65.0)	A2L	3.2	16,000	52	18.3	63,000	293.9	690	—
R-454B	zeotrope	R-32/1234yf (68.9/31.1)	A2L	3.1	19,000	49	22.0	77,000	352.6	850	—
R-454C	zeotrope	R-32/1234yf (21.5/78.5)	A2L	4.4	19,000	71	18,0	62,000	289.5	620	—
R-455A	zeotrope	R-744/32/1234yf (3.0/21.5/75.5)	A2L	4.9	22,000	79	26.9	118,000	432.1	650	—
R-456A	zeotrope	R-32/134a/1234ze(E) (6.0/45.0/49.0)	A1	20	77,000	320	—	—	—	900	—
R-457A	zeotrope	R-32/1234yf/152a (18.0/70.0/12.0)	A2L	3.4	15,000	54	13.5	60,000	216.3	650	—
R-457B	zeotrope	R-32/1234yf/152a (35.0/55.0/10.0)	A2L	3.7	19,000	59	14.9	76,000	239	730	—
R-458A	zeotrope	R-32/125/134a/227ea/236fa (20.5/4.0/61.4/13.5/0.6)	A1	18	76,000	280	—	—	—	1,000	—
R-459A	zeotrope	R-32/1234yf/1234ze(E) (68.0/26.0/6.0)	A2L	4.3	27,000	69	17.4	107,000	278.7	870	—
R-459B	zeotrope	R-32/1234yf/1234ze(E) (21.0/69.0/10.0)	A2L	30	25,000	92	23.3	99,000	373.5	640	—
R-460A	zeotrope	R-32/125/134a/1234ze(E) (12.0/52.0/14.0/22.0)	A1	24	92,000	380	—	—	—	950	—
R-460B	zeotrope	R-32/125/134a/1234ze(E) (28.0/25.0/20.0/27.0)	A1	25	120,000	400	—	—	—	950	—
R-460C	zeotrope	R-32/125/134a/1234ze(E) (2.5/2.5/46.0/49.0)	A1	20	73,000	310	—	—	—	900	—
R-461A	zeotrope	R-125/143a/134a/227ea/600a (55.0/5.0/32.0/5.0/3.0)	A1	17	61,000	270	—	—	—	1,000	—
R-462A	zeotrope	R-32/125/143a/134a/600 (9.0/42.0/2.0/44.0/3.0)	A2	3.9	16,000	62	16.6	105,000	265.8	1,000	—
R-463A	zeotrope	R-744/32/125/1234yf/134a (6.0/36.0/30.0/14.0/14.0)	A1	19	98,000	300	—	—	—	990	—
R-464A	zeotrope	R-32/125/1234ze(E)/227ea (27.0/27.0/40.0/6.0)	A1	27	120,000	430	—	—	—	930	—

TABLE 1103.1—REFRIGERANT CLASSIFICATION, AMOUNT AND OEL—continued

CHEMICAL REFRIGERANT	FORMULAS	CHEMICAL NAME OF BLENDS	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							(F) DEGREES OF HAZARD[a]
				RCL			LFL			OEL	
				lb/MCf	ppm	g/m³	lb/MCf	ppm	g/m³	ppm	
R-465A	zeotrope	R-32/290/1234yf (21.0/7.9/71.1)	A 2	2.5	12,000	40	10.0	98,000	160.9	660	—
R-466A	zeotrope	R-32/125/13I1 (49.0/11.5/39.5)	A1	6.2	30,000	99	—	—	—	860	—
R-467A	zeotrope	R-32/125/134a/600a (22.0/5.0/72.4/0.6)	A2L	6.7	31,000	110	—	—	—	1,000	—
R-468A	zeotrope	R-1132a/32/1234yf (3.5/21.5/75.0)	A2L	4.1	18,000	66	—	—	—	610	—
R-469A	zeotrope	R-744/R-32/R-125 (35.0/32.5/32.5)	A1	8	53,000	—	—	—	—	1,600	—
R-470A	zeotrope	R-744/32/125/134a/1234ze(E)/227ea (10.0/17.0/19.0/7.0/44.0/3.0)	A1	17	77,000	270	—	—	—	1,100	—
R-470B	zeotrope	R-744/32/125/134a/1234ze(E)/227ea (10.0/17.0/19.0/7.0/44.0/3.0)	A1	16	72,000	270	—	—	—	1,100	—
R-471A	zeotrope	R-1234ze(E)/227ea/1336mzz(E) (78.7/4.3/17.0)	A1	9.7	31,000	160	—	—	—	710	—
R-472A	zeotrope	R-744/32/134a (69.0/12.0/19.0)	A1	4.5	35,000	72	—	—	—	2,700	—
R-500[a]	azeotrope	R-12/152a (73.8/26.2)	A1	7.4	29,000	120	—	—	—	1,000	2-0-0[b]
R-501[c]	azeotrope	R-22/12 (75.0/25.0)	A1	13	54,000	210	—	—	—	1,000	—
R-502[d]	azeotrope	R-22/115 (48.8/51.2)	A1	21	73,000	330	—	—	—	1,000	2-0-0[b]
R-503[d]	azeotrope	R-23/13 (40.1/59.9)	—	—	—	—	—	—	—	1,000	2-0-0[b]
R-504[c]	azeotrope	R-32/115 (48.2/51.8)	—	28	140,000	450	—	—	—	1,000	—
R-507A	azeotrope	R-125/143a (50.0/50.0)	A1	32	130,000	510	—	—	—	1,000	2-0-0[b]
R-508A	azeotrope	R-23/116 (39.0/61.0)	A1	14	55,000	220	—	—	—	1,000	2-0-0[b]
R-508B	azeotrope	R-23/116 (46.0/54.0)	A1	13	52,000	200	—	—	—	1,000	2-0-0[b]
R-509A	azeotrope	R-22/218 (44.0/56.0)	A1	24	75,000	380	—	—	—	1,000	2-0-0[b]
R-510A	azeotrope	R-E170/600a (88.0/12.0)	A3	0.87	7,300	14	3.5	29,000	56.1	1,000	—
R-511A	azeotrope	R-290/E170 (95.0/5.0)	A3	0.59	5,300	9.5	2.4	21,000	38.0	1,000	—
R-512A	azeotrope	R-134a/152a (5.0/95.0)	A2	1.9	11,000	31	7.7	45,000	123.9	1,000	—
R-513A	azeotrope	R-1234yf/134a (56.0/44.0)	A1	20	72,000	320	—	—	—	650	—
R-513B	azeotrope	R-1234yf/134a (58.5/41.5)	A1	21	74,000	330	—	—	—	640	—
R-514A	azeotrope	R-1336mzz(S)/1130(E) (74.7/25.3)	B1	0.86	2,400	14	—	—	—	320	—
R-515A	azeotrope	R-1234ze(E)/227ea (88.0/12.0)	A1	19	63,000	300	—	—	—	810	—
R-515B	azeotrope	R-1234ze(E)/227ea (91.1/8.9)	A1	18	61,000	290	—	—	—	810	—
R-516A	azeotrope	R-1234yf/134a/152a (77.5/8.5/14.0)	A2	3.2	13,000	5 2	13.1	50,000	210.1	590	—
R-600	$CH_3CH_2CH_2CH_3$	butane	A3	0.15	1,000	2.4	3.0	20,000	48	1,000	1-4-0

TABLE 1103.1—REFRIGERANT CLASSIFICATION, AMOUNT AND OEL—continued

CHEMICAL REFRIGERANT	FORMULAS	CHEMICAL NAME OF BLENDS	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							(F) DEGREES OF HAZARD[a]
				RCL			LFL			OEL	
				lb/MCf	ppm	g/m³	lb/MCf	ppm	g/m³	ppm	
R-600a	$CH(CH_3)_2CH_3$	2-methylpropane (isobutane)	A3	0.59	4,000	9.5	2.4	16,000	38	1,000	2-4-0
R-601	$CH_3CH_2CH_2CH_2CH_3$	pentane	A3	0.18	1,000	2.9	2.2	12,000	35	600	—
R-601a	$(CH_3)_2CHCH_2CH_3$	2-methylbutane (isopentane)	A3	0.18	1,000	2.9	2.4	13,000	38	600	—
R-610	$CH_3CH_2OCH_2CH_3$	ethoxyethane (ethyl ether)	—	—	—	—	—	—	—	400	—
R-611	$HCOOCH_3$	methyl formate	B2	—	—	—		—	—	100	—
R-717	NH_3	ammonia	B2L	0.014	320	0.22	7.2	167,000	116	25	3-3-0[c]
R-718	H_2O	water	A1	—	—	—	—	—	—	—	0-0-0
R-744	CO_2	carbon dioxide	A1	4.5	40,000	72	—	—	—	5,000	2-0-0[b]
R-1130(E)	CHCl=CHCl	trans-1,2-dichloroethene	B2	0.25	1,000	4	16	65,000	258	200	—
R-1132a	$CF_2=CH_2$	1,1-difluoroethylene	A2	2.0	13,000	33	8.1	50,000	131	500	—
R-1150	$CH_2=CH_2$	ethene (ethylene)	A3	—	—	—	2.2	31,000	36	200	1-4-2
R-1224yd(Z)	$CF_3CF=CHCl$	(Z)-1-chloro-2,3,3,3-tetrafluoroethylene	A1	23	60,000	370	—	—	—	1,000	—
R-1233zd(E)	$CF_3CH=CHCl$	trans-1-chloro-3,3,3-trifluoro-1-propene	A1	5.3	16,000	85	—	—	—	800	—
R-1234yf	$CF_3CF=CH_2$	2,3,3,3-tetrafluoro-1-propene	A2L	4.5	16,000	75	18.0	62,000	289	500	—
R-1234ze(E)	$CF_3CH=CFH$	trans-1,3,3,3-tetrafluoro-1 -propene	A2L	4.7	16,000	76	18.8	65,000	303	800	—
R-1270	$CH_3CH=CH_2$	Propene (propylene)	A3	0.1	1,000	1.7	—	—	—	500	1-4-1
R-1336mzz(E)	$CF_3CHCHCF_3$	trans 1,1,1,4,4,4-hexafluoro-2- butene	A1	3.0	7,200	48	—	—	—	400	—
R-1336mzz(Z)	$CF_3CHCHCF_3$	cis-1,1,1,4,4,4-hexaflouro-2-butene	A1	5.2	13,000	84	—	—	—	500	—

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.0283 m^3.

a. Degrees of hazard are for health, fire, and reactivity, respectively, in accordance with NFPA 704.

b. Reduction to 1-0-0 is allowed if analysis satisfactory to the code official shows that the maximum concentration for a rupture or full loss of refrigerant charge would not exceed the IDLH, considering both the refrigerant quantity and room volume.

c. Class I ozone depleting substance; prohibited for new installations.

d. Occupational Exposure Limit based on the OSHA PEL, ACGIH TLV-TWA, the TERA WEEL or consistent value on a time-weighed average (TWA) basis (unless noted C for ceiling) for an 8 hr/d and 40 hr/wk.

Chapter 11: Refrigeration

2024: 1106.3 Class 2 and 3 refrigerants - Where refrigerants of Groups A2, A3, B2 and B3 are used, the machinery room shall conform to the Class I, Division 2, hazardous location classification requirements of NFPA 70. **(Exception removed)**

1106.4 Group A2L and B2L refrigerants - Machinery rooms for Group A2L and B2L refrigerants shall comply with Sections 1106.4.1 through 1106.4.3.

1106.4.1 Elevated temperatures - Open flame-producing devices or continuously operating hot surfaces over 1290°F (700°C) shall not be permanently installed in the room.

1106.4.2 Refrigerant detector - In addition to the requirements of Section 1105.3, refrigerant detectors shall signal an alarm and activate the ventilation system in accordance with the response time specified in Table 1106.4.2.

TABLE 1106.4.2

TABLE 1106.4.2—GROUP A2L and B2L DETECTOR ACTIVATION

ACTIVATION LEVEL	MAXIMUM RESPONSE TIME (seconds)	ASHRAE 15 VENTILATION (seconds)	ALARM RESET	ALARM TYPE
Less than or equal to the OEL in Table 1103.1	300	1	Automatic	Trouble
Less than or equal to the refrigerant concentration level in Table 1103.1	15	2	Manual	Emergency

1106.4.3 Mechanical ventilation - The machinery room shall have a mechanical ventilation system complying with ASHRAE 15.

Chapter 11: Refrigeration

2024:

1106.5 Remote controls - Remote control of the mechanical equipment and appliances located in the machinery room shall comply with Sections 1106.5.1 and 1106.5.2.

1106.5.1 Refrigeration system emergency shutoff - A clearly identified switch of the break-glass type or with an approved tamper-resistant cover shall provide off-only control of refrigerant compressors, refrigerant pumps, and normally closed, automatic refrigerant valves located in the machinery room. Additionally, this equipment shall be automatically shut off whenever the refrigerant vapor concentration in the machinery room exceeds the vapor detector’s upper detection limit or 25 percent of the LEL, whichever is lower.

1106.5.2 Ventilation system - A clearly identified switch of the break-glass type or with an approved tamper-resistant cover shall provide on-only control of the machinery room ventilation fans.

1106.6 Emergency signs and labels - Refrigeration units and systems shall be provided with approved emergency signs, charts, and labels in accordance with the International Fire Code.

Chapter 11: Refrigeration

2024:

1109.2.2 Refrigerant pipe enclosure - Refrigerant piping shall be protected by locating it within the building elements or within protective enclosures. Exception: Piping protection within the building elements or protective enclosure shall not be required in any of the following locations:

1. Where installed without ready access or located more than 7 feet 3 inches (2210 mm) above the finished floor.

2. Where located within 6 feet (1829 mm) of the refrigerant unit or appliance.

3. Where located in a machinery room complying with Section 1105.

Added: 4. Outside the building:

4.1. Where protected from damage from the weather, including but not limited to hail, ice and snow loads.

4.2. Where protected from damage within the expected foot or traffic path.

4.3. Where installed underground not less than 8 inches (200 mm) below finished grade and protected against corrosion.

Chapter 11: Refrigeration

2026 Connecticut State Building Code Amendment:

(Amd) 1109.2.5 Refrigerant pipe shafts. Refrigerant piping that penetrates two or more floor/ceiling assemblies shall be enclosed in a fire-resistance-rated shaft enclosure. The fire-resistance-rated shaft enclosure shall comply with Section 713 of the International Building Code portion of the Connecticut State Building Code. Exceptions:

1. Refrigeration systems using R-718 refrigerant (water).

2. Piping in a direct refrigeration system where the refrigerant quantity does not exceed the limits of Table 1103.1 for the smallest occupied space through which the piping passes.

3. Piping located on the exterior of the building where vented to the outdoors.

2024 IMC: 1109.2.5 Refrigerant pipe shafts - Refrigerant piping that penetrates two or more floor/ceiling assemblies shall be enclosed in a fire-resistance-rated shaft enclosure. The fire-resistance-rated shaft enclosure shall comply with Section 713 of the International Building Code. Exceptions:

1. Refrigeration systems using R-718 refrigerant (water).

2. Piping in a direct refrigeration system using ~~**Group A1 refrigerant**~~ where the refrigerant quantity does not exceed the limits of Table 1103.1 for the smallest occupied space through which the piping passes.

3. Piping located on the exterior of the building where vented to the outdoors.

TABLE 1103.1—REFRIGERANT CLASSIFICATION, AMOUNT AND OEL											
CHEMICAL REFRIGERANT	FORMULAS	CHEMICAL NAME OF BLENDS	REFRIGERANT SAFETY GROUP CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE							(F) DEGREES OF HAZARD[a]
				RCL			LFL			OEL	
				lb/MCf	ppm	g/m³	lb/MCf	ppm	g/m³	ppm	
R-32	CH_2F_2	difluoromethane (methylene fluoride)	A2L	4.8	36,000	77	19.1	144,000	306	1,000	1-4-0
R-454B	zeotrope	R-32/1234yf (68.9/31.1)	A2L	3.1	19,000	49	22.0	77,000	352.6	850	—
R-410A	zeotrope	R-32/125 (50.0/50.0)	A1	26	140,000	420	—	—	—	1,000	2-0-0[b]

Example: You have a 14 ton VRF system with 25.8lb of refrigerant between the condensing unit and the branch box. The piping from the condensing unit passes through a room that is 4ft x 6ft x8ft.

25.8 lb / (4x6x8) cf = 0.134lb/MCf.

Although the RCL allowed has dropped between the A1 and A2L refrigerants, you can see the limits will not be met unless you have a very large system and a very small room (closet) that the piping runs through to not comply with exception 2.

In this example 595lb of R-454b refrigerant would be required to not comply with exception 2.

Chapter 11: Refrigeration

2024:

1109.3 Installation requirements for Group A2L**, A2, A3**, B2L**, B2 or B3** refrigerant - Piping systems using Group A2L, A2, A3, B2L, B2 or B3 refrigerant shall comply with the requirements of Sections 1109.3.1 and 1109.3.2.

1109.3.1 Protection against physical damage - In addition to the requirements of Section 305.5, aluminum, copper and steel tube used for Group A2, A3, B2 and B3 refrigerants and located in concealed locations where tubing is installed in studs, joists, rafters or similar member spaces, and located less than **1 1/4** inches (32 mm) from the nearest edge of the member, shall be continuously protected by shield plates. Protective steel shield plates shall cover the area of the tube plus the area extending not less than 2 inches (51 mm) beyond both sides of the tube.

1109.3.1.1 Shield plates - Shield plates shall be of steel material having a thickness of not less than 0.0575 inch (1.46 mm) (No.16 gage). **(Paragraph previously apart of 1109.3.1)**

1109.7 Condensate Control - removed.

Chapter 11: Refrigeration

2024:

1110.4 Factory test procedure. Factory tests shall be performed with dry nitrogen or other nonflammable, nonreactive, dried gas. Oxygen, air or mixtures containing them shall not be used. The means used to build up the test pressure shall have either a pressure limiting device or a pressure-reducing device and a gauge on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the refrigeration system's components. Exceptions:

1. Mixtures of dry nitrogen, inert gases or a combination of them with Class 1 refrigerant in concentrations of a refrigerant weight fraction (mass fraction) not exceeding 5 percent shall be permitted for tests.

2. Mixtures of dry nitrogen, inert gases or a combination of them with Class 2L, Class 2 and Class 3 refrigerants in concentrations not exceeding the lower of a refrigerant weight fraction (mass fraction) of 5 percent or 25 percent of the LFL shall be permitted for tests.

3. Compressed air without added refrigerants shall be permitted for tests, provided that the refrigeration system is subsequently evacuated to less than 1,000 microns (0.1333 kPa) before charging with refrigerant. The required evacuation level is atmospheric pressure for refrigeration systems using R-718 (water) or R-744 (carbon dioxide) as the refrigerant.

4. Systems erected on the premises using Group A1 refrigerant and with copper tubing not exceeding 0.62 of an inch (15.7mm) outside diameter shall be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at not less than 68°F (20°C).

Chapter 11: Refrigeration

2024:

1110.5 Test apparatus. The means used to pressurize the refrigerant piping system shall have on its outlet side a test pressure measuring device and either a pressure-limiting device or a pressure-reducing device. The test pressure measuring device shall have an accuracy of ±3 percent or less of the test pressure and shall have a resolution of 5 percent or less of the test pressure.

1110.6 Piping system strength test. Refrigeration system components and refrigerant piping shall be tested in accordance with ASME B31.5 or this section. Separate tests for isolated portions of the system are permitted, provided that all required portions are tested at least once. Pressurize with test gas for a minimum of 10 minutes to not less than the lower of (a) the lowest design pressure for any system component or (b) the lowest value of set pressure for any pressure relief devices in the system. The design pressures for determination of test pressure shall be the pressure identified on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. A passing test result shall have no rupture or structural failure of any system component or refrigerant piping. Refrigerant piping and tubing greater than 3/4 inch (19 mm) in diameter shall be tested in accordance with ASHRAE 15.

1110.7 Contractor or engineer declaration. The installing contractor or registered design professional of record shall issue a certificate of test to the code official for all refrigeration systems containing 55 pounds (25 kg) or more of refrigerant. The certificate shall give the test date, name of the refrigerant, test medium and the field test pressure applied to the high-pressure side and the low-pressure side of the refrigeration system. The certification of test shall be signed by the installing contractor or registered design professional and shall be made part of the public record.

Chapter 12: Hydronic Piping

TABLE 1202.4—HYDRONIC PIPE	
MATERIAL	**STANDARD (see Chapter 15)**
Acrylonitrile butadiene styrene (ABS) plastic pipe	ASTM F2806
Chlorinated polyvinyl chloride (CPVC) plastic pipe	ASTM D2846; ASTM F441; ASTM F442
Chlorinated polyvinyl chloride/aluminum/chlorinated polyvinyl chloride (CPVC/AL/CPVC)	ASTM F2855
Copper or copper-alloy pipe	ASTM B42; ASTM B43; ASTM B302
Copper or copper-alloy tube (Type K, L or M)	ASTM B75; ASTM B88; ASTM B135; ASTM B251
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe	ASTM F1281; CSA CAN/CSA-B-137.10
Cross-linked polyethylene (PEX) tubing	ASTM F876; ASTM F3253; CSA B137.5
Ductile iron pipe	AWWA C115/A21.15; AWWA C151/A21.51
Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe	ASTM F1282; CSA B137.9
Polypropylene (PP) plastic pipe	ASTM F2389
Polyvinyl chloride (PVC) plastic pipe	ASTM D1785; ASTM D2241
Raised temperature polyethylene (PE-RT)	ASTM F2623; ASTM F2769; CSA B137.18
Stainless steel pipe	ASTM A269; ASTM A312; ASTM A778
Stainless steel tubing	ASTM A269; ASTM A312; ASTM A778
Steel pipe	ASTM A53; ASTM A106
Steel tubing	ASTM A254

2024: Lead piping removed & stainless steel piping added.
Added: 1203.13 Stainless steel pipe. Joints between stainless steel pipe or fittings shall be mechanical joints that are made with an approved elastomeric seal, or shall be threaded or welded joints conforming to Section 1203.3.
Added: 1203.14 Stainless steel tubing. Joints between stainless steel tubing or fittings shall be mechanical or welded joints conforming to Section 1203.3.

Chapter 12: Hydronic Piping

2024: 1205.1 Where required - Shutoff valves shall be installed in hydronic piping systems in the locations indicated in Sections 1205.1.1 through 1205.1.6. Access shall be provided to all full-open valves and shutoff valves. (added)

1209.6 Radiant tubing placement - Hydronic tubing to be embedded for the purpose of radiant heating or cooling shall be installed in accordance with the manufacturer's instructions and with the tube layout and spacing in accordance with the system design. Individual tubing circuit lengths shall be installed with a variance of not more than ±10 percent from the design.
1209.6.1 Radiant tubing circuit length- The maximum circuit length of radiant tubing from a supply and return manifold shall not exceed the lengths specified by the system design or, in the absence of manufacturer's specifications, the lengths specified in Table 1209.6.1.

TABLE 1209.6.1—MAXIMUM CIRCUIT LENGTH OF RADIANT TUBING FROM A SUPPLY-AND-RETURN MANIFOLD ARRANGEMENT

NOMINAL TUBE SIZE	MAXIMUM CIRCUIT LENGTH (feet)
1/4	125
5/16	200
3/8	250
1/2	300
5/8	400
3/4	500
1	750

For SI: 1 foot = 304.8 mm.

Chapter 12: Hydronic Piping

2024:

1209.6.2 Radiant tubing circuit tags - Each individual radiant tubing circuit shall have a tag or label securely affixed to each manifold outlet to indicate the length of each circuit and the areas served.

1209.6.3 Radiant tubing drawings - The radiant tubing drawings and design report shall be provided to the building owner or the designated representative of the building owner.

1209.7 Snow- and ice-melt tubing placement - Hydronic tubing to be embedded for the purpose of snow and ice melt systems shall be installed in accordance with the manufacturer's installation instructions and with the tube layout and spacing in accordance with the system design.

1209.7.1 Snow and ice melt tubing circuit length. The maximum circuit length of snow and ice melt tubing from a supply and return manifold shall not exceed the lengths specified by the system design or, in the absence of manufacturer's specifications, the lengths specified in Table 1209.7.1. Individual tubing circuit lengths shall be installed with a variance of not more than ±10 percent from the design.

1209.7.2 Snow and ice melt tubing drawings. The snow and ice melt tubing drawings and design report shall be provided to the building owner or the designated representative of the building owner.

TABLE 1209.7.1—MAXIMUM CIRCUIT LENGTH OF SNOW- AND ICE-MELT TUBING FROM A SUPPLY-AND-RETURN MANIFOLD ARRANGEMENT

NOMINAL TUBE SIZE	MAXIMUM CIRCUIT LENGTH (feet)
1/2	140
5/8	250
3/4	325
1	475

For SI: 1 foot = 304.8 mm.

Chapter 13: Fuel Oil Piping and Storage

No significant changes

2026 Connecticut State Building Code Amendment:

(Amd) 1301.1 Scope. This chapter and the Connecticut Fire Safety Code and Connecticut Fire Prevention Code shall govern the design, installation, construction and repair of fuel oil storage and piping systems. The storage of fuel oil and flammable and combustible liquids shall be in accordance with the Connecticut Fire Safety Code and Connecticut Fire Prevention Code.

Chapter 14: Solar Thermal Systems

No significant changes

IECC
Commercial Provisions
2021 vs 2024

Brief Overview Chapters 1 through 3

- Chapter 1 - C105.2 Construction Documents – new requirements
  - Air Barrier and air sealing details
  - Thermal Bridges identified
  - Locations/Routing of raceways or cable for on-site electrical renewable energy
    - Reserve space for inverters, metering equipment and energy storage systems (ESS)
    - Rated capacity of planned ESS
- Chapter 2 - New Definitions
  - **APPROVED**
  - **BEST EFFICIENCY POINT (BEP**
  - **CHI-FACTOR (x^2-FACTOR)**
  - **CLEAN WATER PUMP**
  - **DEDICATED OUTDOOR AIR SYSTEM (DOAS) & DX DOAS**
  - **DEHUMIDIFIER – Both DX & Dessicant**
  - **DEMAND CONTROL KITCHEN VENTILATION (DCKV)**
  - **DEMAND RESPONSE SIGNAL & DEMAND RESPONSIVE CONTROL**
  - **ENERGY RECOVERY, SERIES & ENERGY RECOVERY, SERIES RATIO (SERR)**

Brief Overview Sections 1 through 3

- New Definitions (continued)
  - **FAN SYSTEM – Complex, Exhaust or Relief, Return, Single-Cabinet, Transfer, Airflow**
  - **FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT**
  - **GREEN RETAIL TARIFF**
  - **HIGH-CAPACITY GAS-FIRED WATER HEATER**
  - **HVAC TOTAL SYSTEM PERFORMANCE RATIO (HVAC TSPR)**
  - **INTEGRATED HVAC SYSTEM**
  - **PSI-FACTOR (Ψ-FACTOR)**
  - **PUMP ENERGY INDEX (PEI)**
  - **RENEWABLE ENERGY CERTIFICATE (REC) & RENEWABLE ENERGY INVESTMENT FUND (REIF)**
  - **SENSIBLE ENERGY RECOVERY RATIO**
  - **SIMULATED BUILDING PERFORMANCE**
  - **SUBSTANTIAL IMPROVEMENT**
  - **THERMAL BLOCK & THERMAL BRIDGE**

Section C402 – Building Thermal Envelope

- C402: Building Thermal Envelope Requirements
  - Multiple Changes Stressing Calculation Methods for Area Weighted Averaging for
    - Above/Below Grade Walls
    - Fenestration
    - Roof (inc. Tapered Roof Insulation) (C402.1.2.1.1)
    - Mechanical Penetrations > 1% of wall area (C402.1.2.1.8)
  - New Opaque Wall R Values (Table C402.1.3)
    - Metal Framed (new wall type)
      - R-0 + R12.6 ci
      - R-13 + R-10 ci
      - R-20 + R-9 ci
    - Wood Framed
      - R-0 + R-16 ci
      - R-13 + R-7.5 ci
      - R-20 + R-3.8 ci
      - R-27

Section C402 – Building Thermal Envelope

- C402: Building Thermal Envelope Requirements
  - Multiple Changes Stressing Calculation Methods for Area Weighted Averaging for
    - Above/Below Grade Walls
    - Fenestration
    - Roof (inc. Tapered Roof Insulation) (C402.1.2.1.1)
    - Mechanical Penetrations > 1% of wall area (C402.1.2.1.8)
  - New Opaque Wall R Values (Table C402.1.3)
    - Metal Framed (new wall type)
    - Footnotes:

h. The first value is cavity insulation; the second value is continuous insulation. Therefore, "R-0 + R-12ci" means R-12 continuous insulation and no cavity insulation; "R-13 + R-3.8ci" means R-13 cavity insulation and R-3.8 continuous insu-lation; "R-20" means R-20 cavity insulation and no continuous insulation. R-13, R-20 and R-27 cavity insulation, as used in this table, apply to a nominal 4-inch, 6-inch and 8-inch-deep wood or cold-formed steel stud cavities, respectively.

i. Where the required R-value in Table C402.1.3 is met by using continuous insulation such that cavity insulation is not required, the R-value is applicable to any wall framing spacing.

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
Insulation entirely above roof deck	R-30ci	R-30ci
Metal buildings[b]	R-19 + R-11 LS	R-19 + R-11 LS
Attic and other	R-49	R-49
ıde		
Mass[f]	R-11.4ci	R-13.3ci
Metal building	R-13 + R-14ci	R-13 + R-14ci
Metal framed[h, i]	R-0 + R-15.2ci or R-13 + R-10ci or R-20 + R-9ci	R-0 + R-15.2ci or R-13 + R-10ci or R-20 + R-9ci
Wood framed and other[h, i]	R-0 + R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 + R-16ci or R-13 + R-7.5ci or R-20 + R-3.8ci or R-27
de		
Below-grade wall[d]	R-7.5ci	R-10ci
Mass[e]	R-14.6ci	R-16.7ci
Joist/framing	R-30	R-30
ors		
Unheated slabs	R-15 for 24" below	R-20 for 24" below
Heated slabs[g]	R-15 for 36" below + R 5 full slab	R-15 for 36" below + R 5 full slab

Section C402 – Building Thermal Envelope

C402.1.2.1.6 Cold-formed steel assemblies. *U*-factors for *building thermal envelopes* containing cold-formed steel-framed ceilings and walls shall be permitted to be determined in accordance with AISI S250 as modified herein.

1. Where the steel-framed wall contains no *cavity insulation*, and uses *continuous insulation* to satisfy the *U-factor* maximum, the steel-framed wall member spacing is permitted to be installed at any on-center spacing.
2. Where the steel-framed wall contains framing at 24 inches (610 mm) on center with a 23 percent framing factor or framing at 16 inches (406 mm) on center with a 25 percent framing factor, the next lower framing member spacing input values shall be used when calculating using AISI S250.
3. Where the steel-framed wall contains less than 23 percent framing factors, the AISI S250 shall be used without any modifications.
4. Where the steel-framed wall contains other than standard C-shape framing members, the AISI S250 calculation option for other than standard C-shape framing is permitted to be used.

C402.1.2.1.7 Spandrel panels. *U-factors* of opaque assemblies within *fenestration* framing systems shall be determined in accordance with the default values in Table C402.1.2.1.7, ASTM C1363 or ANSI/NFRC 100.

TABLE C402.1.2.1.7—EFFECTIVE *U*-FACTORS FOR SPANDREL PANELS[a]

RATED *R*-VALUE OF INSULATION BETWEEN FRAMING MEMBERS		R-4	R-7	R-10	R-15	R-20	R-25	R-30
Frame Type	**Spandrel Panel**	**Default *U*-Factor**						
Aluminum without thermal break[b]	Single glass pane, stone, or metal panel	0.285	0.259	0.247	0.236	0.230	0.226	0.224
	Double glazing with no low-e coatings	0.273	0.254	0.244	0.234	0.229	0.226	0.223
	Triple glazing or double glazing with low-e glass	0.263	0.249	0.241	0.233	0.228	0.225	0.223
Aluminum with thermal break[c]	Single glass pane, stone, or metal panel	0.243	0.212	0.197	0.184	0.176	0.172	0.169
	Double glazing with no low-e coatings	0.228	0.205	0.193	0.182	0.175	0.171	0.168
	Triple glazing or double glazing with low-e glass	0.217	0.199	0.189	0.180	0.174	0.170	0.167
Structural glazing[d]	Single glass pane, stone, or metal panel	0.217	0.180	0.161	0.145	0.136	0.130	0.126
	Double glazing with no low-e coatings	0.199	0.172	0.157	0.143	0.135	0.129	0.126
	Triple glazing or double glazing with low-e glass	0.186	0.165	0.152	0.140	0.133	0.128	0.125
No framing or insulation is continuous[e]	Single glass pane, stone, or metal panel	0.160	0.108	0.082	0.058	0.045	0.037	0.031
	Double glazing with no low-e coatings	0.147	0.102	0.078	0.056	0.044	0.036	0.030
	Triple glazing or double glazing with low-e glass	0.139	0.098	0.076	0.055	0.043	0.035	0.030

a. Extrapolation outside of the table shall not be permitted. Assemblies with distance between framing less than 30 inches, or not included in the default table, shall have a *U*-factor determined by testing in compliance with ASTM C1363 or modeling in compliance with ANSI/NFRC 100. Spandrel panel assemblies in the table do not include metal backpans. For designs with metal backpans, multiply the *U*-factor by 1.2.
b. This frame type shall be used for systems that do not contain a nonmetallic element separating the metal exposed to the exterior from the metal exposed to the interior condition.
c. This frame type shall be used for systems where a nonmetallic element separates the metal exposed to the exterior from the metal that is exposed to the interior condition.
d. This frame type shall be used for systems that have no exposed mullion on the exterior.
e. This frame type shall be used for systems where there is no framing or the insulation is continuous and uninterrupted between framing.

Section C402 – Building Thermal Envelope

- C402.1.4 Component Performance Method
  - Alternative compliance method using Equation 4-1

Equation 4-1 $A_p + B_p + C_p + T_p \leq A_T + B_T + C_T + T_T - V_r - V_s$

where:

A_p = Sum of the (area × *U*-factor) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies.

B_p = Sum of the (length × *F*-factor) for each proposed slab-on-grade edge condition.

C_p = Sum of the (area × *C*-factor) for each proposed below-grade wall assembly.

T_p = Sum of the (ψLP) and (χNP) values for each type of thermal bridge condition of the building thermal envelope as identified in Section C402.7 in the proposed building. For the purposes of this section, the (ψLP) and (χNP) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu × in/h × ft² × °F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_p shall be assigned as zero.

ψLP = Psi-factor × length of the thermal bridge elements in the proposed building thermal envelope.

χNP = Chi-factor × number of the thermal bridge point elements other than fasteners, ties or brackets in the proposed building thermal envelope.

A_T = Sum of the (area × *U*-factor permitted by Tables C402.1.2 and C402.5) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies.

B_T = Sum of the (length × *F*-factor permitted by Table C402.1.2) for each proposed slab-on-grade edge condition.

C_T = Sum of the (area × *C*-factor permitted by Table C402.1.2) for each proposed below-grade wall assembly.

T_T = Sum of the (ψLT) and (χNT) values for each type of thermal bridge condition in the proposed building thermal envelope as identified in Section C402.7 with values specified as "compliant" in Table C402.1.4. For the purposes of this section, the (ψLT) and (χNT) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu × in/h × ft² × °F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_T shall be assigned as zero.

ψLT = (Psi-factor specified as "compliant" in Table C402.1.4) × length of the thermal bridge elements in the proposed building thermal envelope.

χNT = (Chi-factor specified as "compliant" in Table C402.1.4) × number of the thermal bridge point elements other than fasteners, ties or brackets in the proposed building thermal envelope.

P_r = Maximum vertical fenestration area allowable by Section C402.5.1, C402.5.1.1 or C402.5.1.2.

Q_r = Proposed vertical fenestration area.

$R_r = Q_r - P_r$, but not less than zero (excess vertical fenestration area).

S_r = Area-weighted average *U*-factor permitted by Table C402.5 of all vertical fenestration assemblies.

T_r = Area-weighted average *U*-factor permitted by Table C402.1.2 of all exterior opaque wall assemblies.

$U_r = S_r - T_r$ (excess *U*-factor for excess vertical fenestration area).

$V_r = R_r \times U_r$ (excess $U \times A$ due to excess vertical fenestration area).

P_s = Maximum skylight area allowable by Section C402.1.2.

Q_s = Actual skylight area.

$R_s = Q_s - P_s$, but not less than zero (excess skylight area).

S_s = Area-weighted average *U*-factor permitted by Table C402.5 of all skylights.

T_s = Area-weighted average *U*-factor permitted by Table C402.1.2 of all opaque roof assemblies.

$U_s = S_s - T_s$ (excess *U*-factor for excess skylight area).

$V_s = R_s \times U_s$ (excess $U \times A$ due to excess skylight area).

A proposed psi- or *chi-factor* for each thermal bridge shall comply with one of the following, as applicable:

1. Where the proposed mitigation of a thermal bridge is compliant with the requirements of Section C402.7, the "compliant" values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
2. Where a thermal bridge is not mitigated in a manner at least equivalent to Section C402.7, the "noncompliant" values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
3. Where the proposed mitigation of a thermal bridge provides a psi- or chi-factor less than the "compliant" values in Table C402.1.4, the proposed psi- or chi-factor shall be determined by thermal analysis, testing or other approved sources.

TABLE C402.1.4—PSI- and CHI-FACTORS TO DETERMINE THERMAL BRIDGES FOR THE COMPONENT PERFORMANCE METHOD

THERMAL BRIDGE PER SECTION C402.7	THERMAL BRIDGE COMPLIANT WITH SECTION C402.7		THERMAL BRIDGE NONCOMPLIANT WITH SECTION C402.7	
	Psi-Factor (Btu/h × ft × °F)	Chi-Factor (Btu/h × °F)	Psi-Factor (Btu/h × ft × °F)	Chi-Factor (Btu/h × °F)
C402.7.1 Balconies and floor decks	0.2	N/A	0.5	N/A
C402.7.2 Cladding supports	0.2	N/A	0.3	N/A
C402.7.3 Structural beams and columns	N/A	1.0 carbon steel 0.3 concrete	N/A	2.0 carbon steel 1.0 concrete
C402.7.4 Vertical fenestration	0.15	N/A	0.3	N/A
C402.7.5 Parapets	0.2	N/A	0.4	N/A

For SI: 1 W/m × K = 0.578 Btu/h × ft × °F, 1 W/K = 1.9 Btu/h × °F.
N/A = Not Applicable.

Section C402 – Building Thermal Envelope

- C402.2 Specific insulation and installation requirements
  - C402.2.1, 402.2.2, 402.2.3, 402.2.4, 402.2.
    - Insulation Installation requirements: Install insulation between framing and stagger joints of continuous insulation
  - C402.2.7 Airspaces:

C402.2.7 Airspaces. Where the *R-value* of an airspace is used for compliance in accordance with Section C402.1, the airspace shall be enclosed in a cavity bounded on all sides by building components and constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where one of the following conditions occur:

1. The enclosed airspace is unventilated.
2. The enclosed airspace is bounded on at least one side by an anchored masonry veneer, constructed in accordance with Chapter 14 of the *International Building Code* and vented by veneer weep holes located only at the bottom of the airspace and spaced not less than 15 inches (381 mm) on center with top of the cavity airspace closed.

  - C402.5 Fenestration:
    - Fixed Fenestration for Climate Zone 5 U Factor = 0.34 (was .36)

Section C402 – Building Thermal Envelope

- C402.6 Air Leakage – New Documentation Requirements

C402.6 Air leakage—building thermal envelope. The *building thermal envelope* shall comply with Sections C402.6.1 through C402.6.7.

C402.6.1 Air barriers. A continuous *air barrier* shall be provided throughout the *building thermal envelope*. The *air barrier* is permitted to be located at any combination of inside, outside or within the *building thermal envelope*. The *air barrier* shall comply with Sections C402.6.1.1 and C402.6.1.2. The *air leakage* performance of the *air barrier* shall be verified in accordance with Section C402.6.2.

Exception: *Air barriers* are not required in buildings located in *Climate Zone* 2B.

C402.6.1.1 Air barrier design and documentation requirements. Design of the continuous *air barrier* shall be documented as follows:

1. Components comprising the continuous *air barrier* and their position within each *building thermal envelope* assembly shall be identified.
2. Joints, interconnections and penetrations of the continuous *air barrier* components shall be detailed.
3. The continuity of the *air barrier* building element assemblies that enclose *conditioned space* or provide a boundary between *conditioned space* and unconditioned space shall be identified.
4. Documentation of the continuous *air barrier* shall detail methods of sealing the *air barrier,* such as wrapping, caulking, gasketing, taping or other *approved* methods at the following locations:
    - 4.1. Joints around *fenestration* and door frames.
    - 4.2. Joints between walls and floors; between walls at building corners; between walls and roofs, including parapets and copings; where *above-grade walls* meet foundations; and at similar intersections.
    - 4.3. Penetrations or attachments through the continuous *air barrier*.
    - 4.4. Building assemblies used as *ducts* or plenums.
    - 4.5. Changes in continuous *air barrier* materials and assemblies.
5. Identify where testing will or will not be performed in accordance with Section C402.6.2. Where testing will not be performed, a plan for field inspections required by Section C402.6.2.3 shall be provided that includes the following:
    - 5.1. A schedule for periodic inspection.
    - 5.2. The continuous *air barrier* scope of work.
    - 5.3. A list of critical inspection items.
    - 5.4. Inspection documentation requirements.
    - 5.5. Provisions for corrective actions where needed.

Section C402 – Building Thermal Envelope

- C402.6.2 Air Leakage Compliance (new)

C402.6.2 Air leakage compliance. *Air leakage* of the *building thermal envelope* shall be tested by an *approved* third party in accordance with Section C402.6.2.1. The measured *air leakage* shall not be greater than 0.35 cubic feet per minute per square foot (1.8 L/s x m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa) with the calculated *building thermal envelope* surface area being the sum of the above- and below-grade *building thermal envelope*.

Exceptions:

1. Where the measured *air leakage* rate is greater than 0.35 cfm/ft^2 (1.8 L/s × m^2) but is not greater than 0.45 cfm/ft^2 (2.3 L/s × m^2), the *approved* third party shall perform a diagnostic evaluation using a smoke tracer or infrared imaging. The evaluation shall be conducted while the building is pressurized or depressurized along with a visual inspection of the *air barrier* in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging existing building components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the *code official* and the *building* owner. Where the measured *air leakage* rate is greater than 0.45 cfm/ft^2 (2.3 L/s × m^2), corrective actions must be made to the *building* and an additional test completed for which the results are 0.45 cfm/ft^2 (2.3 L/s × m^2) or less.
2. Buildings in Climate Zone 2B.
3. Buildings larger than 25,000 square feet (2323 m^2) floor area in Climate Zones 0 through 4, other than Group I and R occupancies, that comply with Section C402.6.2.3.
4. As an alternative, *buildings* or portions of *buildings* containing Group I-1 and R-2 occupancies shall be permitted to be tested by an *approved* third party in accordance with Section C402.6.2.2. The reported *air leakage* of the *building thermal envelope* shall not be greater than 0.27 cfm/ft^2 (1.4 L/s × m^2) of the *testing unit enclosure area* at a pressure differential of 0.2 inch water gauge (50 Pa).

Section C402 – Building Thermal Envelope

- C406.2.1 Whole Building Thermal Envelope Testing

C402.6.2.1 Whole building test method and reporting. The *building thermal envelope* shall be tested by an *approved* third party in accordance with ASTM E3158 or an equivalent *approved* method. A report that includes the tested surface area, floor area, air by volume, stories above grade, and *air leakage* rates shall be submitted to the *code official* and the building *owner*.

Exceptions:

1. For *buildings* less than 10,000 square feet (929 m^2), the entire *building thermal envelope* shall be permitted to be tested in accordance with ASTM E779, ASTM E3158, ASTM E1827 or an equivalent *approved* method.
2. For *buildings* greater than 50,000 square feet (4645 m^2), portions of the *building* shall be permitted to be tested and the measured *air leakage* shall be area weighted by the surface areas of the *building thermal envelope* in each portion. The weighted-average tested *air leakage* shall not be greater than the whole building *air leakage* limit. The following portions of the *building* shall be tested:
   - 2.1. The entire *building thermal envelope* area of stories that have any *conditioned spaces* directly under a roof.
   - 2.2. The entire *building thermal envelope* area of stories that have a *building entrance*, have a floor over unconditioned space, have a loading dock or that are below grade.
   - 2.3. Representative above-grade portions of the building totaling not less than 25 percent of the wall area enclosing the remaining *conditioned space*.

Section C402 – Building Thermal Envelope

- C402.7 Thermal Bridges In Above Grade Walls
  - Balconies and floor decks
  - Cladding Supports
  - Structural beams and columns
  - Vertical Fenestration
  - Parapets

Section C403 – Mechanical Systems

C403.1 General. Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with one of the following:

1. Section C403.1.1 and Sections C403.2 through C403.17 **= Prescriptive Criteria**
2. *Data Centers* shall comply with Section C403.1.1, Section C403.1.2 and Sections C403.6 through C403.17.
3. Section C409. **= HVAC Total System Performance Ratio (TSPR)**

- C403.3.2 HVAC Equipment Performance Requirements
  - Formatting changes mostly except for
    - Table C403.3.2(5) Warm Air Furbaces
    - Table C403.3.2(6) Gas and Oil Fired Boilers – increased minimum efficiencies for HW Boilers
    - Table C403.3.2(8) VRF – Reduced minimum efficiencies

TABLE C403.3.2(8)—ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF air conditioners, air cooled	< 65,000 Btu/h three-phase for applications in the US and single- and three-phase for applications outside the US	All	VRF multisplit system	13.0 SEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.5 EER 15.5 IEER	11.2 EER
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER 14.9 IEER	11.0 EER AHRI 1230
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	9.5 EER 13.9 IEER	10.0 EER

For SI: 1 British thermal unit per hour = 0.2931 W.
a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

Section C403 – Mechanical Systems

TABLE C403.3.2(5)—WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/ AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS[a]

DESCRIPTION	FUEL	ELECTRIC POWER PHASE	APPLICATION LOCATION	HEATING CAPACITY (INPUT), Btu/h[b]	COMBO-UNIT COOLING CAPACITY, Btu/h	SUBTYPE	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Warm-air furnace	Gas	1	Inside US	< 225,000	< 65,000	See Informative Appendix F, Table F-4[f]		
Warm-air furnace	Gas	1	Inside US	< 225,000	≥ 65,000	Nonweatherized	80% AFUE	Appendix N[g]
						Weatherized	81% AFUE or 80% E_t[c]	Appendix N[g]
								ANSI Z21.47
Warm-air furnace	Gas	1	Outside US	< 225,000	All	Nonweatherized	80% AFUE	Appendix N[g]
						Weatherized	81% AFUE or 80% E_t[c]	Appendix N[g]
								ANSI Z21.47
Warm-air furnace	Gas	3	All	< 225,000	All	Nonweatherized	80% AFUE	Appendix N[g]
						Weatherized	81% AFUE or 80% E_t[c]	Appendix N[g]
								ANSI Z21.47
Warm-air furnace	Gas	All	All	≥ 225,000 and ≤ 400,000	All	All	81% E_t[c]	ANSI Z21.47
Warm-air furnace	Gas	All	Inside US	> 400,000	All	All	80%E_t[c] before 1/1/2023 81% E_t[c] after 1/1/2023	ANSI Z21.47
Warm-air furnace	Gas	All	Outside US	> 400,000	All	All	80%Etc before 1/1/2023 81% Etc after 1/1/2023	ANSI Z21.47 or ANSI Z83.8
Warm-air furnace	Oil	1	Inside US	< 225,000	< 65,000	See Informative Appendix F, Table F-4[f]		
Warm-air furnace	Oil	1	Inside US	< 225,000	≥ 65,000	Nonweatherized	83% AFUE	Appendix N[g]
						Weatherized	78% AFUE or 80% E_t[d]	Appendix N[g]
								Section 42 UL 727
Warm-air furnace	Oil	1	Outside US	< 225,000	All	Nonweatherized	83% AFUE	Appendix N[g]
						Weatherized	78% AFUE or 80% E_t[d]	Appendix N[g]
								Section 42 UL 727
Warm-air furnace	Oil	3	All	<225,000	All	Nonweatherized	83% AFUE	Appendix N[g]
						Weatherized	78% AFUE or 80%E_t[d]	Appendix N[g]
								Section 42 UL 727
Warm-air furnace	Oil	All	All	≥ 225,000	All	All	82% E_t[d]	Section 42 UL 727
Warm-air furnace	Electric	1	Inside US	< 225,000	< 65,000	See Informative Appendix F, Table F-4[f]		
Warm-air furnace	Electric	1	Inside US	< 225,000	≥ 65,000	All	96% AFUE	Appendix N[g]
Warm-air furnace	Electric	1	Outside US	< 225,000	All	All	96% AFUE	Appendix N[g]
Warm-air furnace	Electric	3	All	< 225,000	All	All	96% AFUE	Appendix N[g]
Warm-air duct furnaces	Gas	All	All	All	All	All	80% E_c[d]	ANSI Z83.8

Section C403 – Mechanical Systems

C403.1 General. Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with one of the following:

1. Section C403.1.1 and Sections C403.2 through C403.17 **= Prescriptive Criteria**
2. *Data Centers* shall comply with Section C403.1.1, Section C403.1.2 and Sections C403.6 through C403.17.
3. Section C409. **= HVAC Total System Performance Ratio (TSPR)**

- C403.3.2 HVAC Equipment Performance Requirements
  - Formatting changes mostly except for
    - Table C403.3.2(5) Warm Air Furnaces
    - Table C403.3.2(6) Gas and Oil-Fired Boilers – increased minimum efficiencies for HW Boilers
    - Table C403.3.2(8) VRF – Reduced minimum efficiencies

TABLE C403.3.2(8)—ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF air conditioners, air cooled	< 65,000 Btu/h three-phase for applications in the US and single- and three-phase for applications outside the US	All	VRF multisplit system	13.0 SEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.5 EER 15.5 IEER	11.2 EER
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER 14.9 IEER	11.0 EER AHRI 1230
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	9.5 EER 13.9 IEER	10.0 EER

For SI: 1 British thermal unit per hour = 0.2931 W.
a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

Section C403 – Mechanical Systems

TABLE C403.3.2(9)—ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE*
VRF air cooled (cooling mode)	< 65,000 Btu/h three-phase for applications in the US and single- and three- phase for applications outside the US	All	VRF multisplit system	SEER2 = 13.4	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER 14.6 IEER	AHRI 1230
			VRF multisplit system with heat recovery	10.1 EER 14.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		VRF multisplit system	9.9 EER 14.4 IEER	
			VRF multisplit system with heat recovery	9.7 EER 13.9 IEER	
	≥ 240,000 Btu/h		VRF multisplit system	9.1 EER 12.7 IEER	
			VRF multisplit system with heat recovery	8.9 EER 12.5 IEER	
VRF water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit systems 86°F entering water	12.0 EER 16.0 IEER	AHRI 1230
			VRF multisplit systems with heat recovery 86°F entering water	11.8 EER 15.8 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h		VRF multisplit system 86°F entering water	12.0 EER 16.0 IEER	
			VRF multisplit system with heat recovery 86°F entering water	11.8 EER 15.8 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		VRF multisplit system 86°F entering water	10.0 EER 14.0 IEER	
			VRF multisplit system with heat recovery 86°F entering water	9.8 EER 13.8 IEER	
	≥ 240,000 Btu/h		VRF multisplit system 86°F entering water	10.0 EER 12.0 IEER	
			VRF multisplit system with heat recovery 86°F entering water	9.8 EER 11.8 IEER	

11.0 EER

10.8 EER

10.6 EER

10.4 EER

9.5 EER

9.3 EER

Section C403 – Mechanical Systems

- C403.3.2 HVAC Equipment Performance Requirements
  - Table C403.3.2(9) VRF Groundwater Rating now at 59 F Entering Water with large increases in Minimum Efficiencies
  - Tables C403.3.2(12) & C403.3.2(12) DX DOAS Units
    - Now Rated per ISMRE2 and ISMCOP2
  - Tables C403.3.2(15) Heat Pump & Heat Recovery Chillers
    - Increased Air Cooled Efficiencies for Heating at 17 F DB
    - Slight increase in Some Cooling Minimum Efficiencies
-

Section C403 – Mechanical Systems

- C403.3.4 Boilers
  - Added Boiler Combustion Air Requirements & Oxygen Control C403.3.4.1

C403.3.4 Boilers. Boiler systems shall comply with the following:

1. Combustion air positive shutoff shall be provided on all newly installed boiler systems that meet one or more of the following conditions:
   - 1.1. The total input capacity is not less than 2,500,000 Btu/h (733 kW) and one or more of the boilers are designed to operate with a nonpositive vent static pressure.
   - 1.2. Any stack serving the *boiler system* is connected to two or more boilers with a total combined input capacity of not less than 2,500,000 Btu/h (733 kW).
2. Newly installed boilers or boiler systems with a combustion air fan motor *nameplate horsepower* rating of 10 horsepower (7.46 kW) or more shall comply with one of the following:
   - 2.1. The fan motor shall be variable speed.
   - 2.2. The fan motor shall include controls that modulate fan airflow as a function of the load to a speed 50 percent or less of design air volume.

C403.3.4.1 Boiler oxygen concentration controls. Newly installed boilers with an input capacity of 5,000,000 Btu/h (1465 kW) and steady state full-load less than 90 percent shall maintain stack-gas oxygen concentrations not greater than the values specified in Table C403.3.4.1. Combustion air volume shall be controlled with respect to measured flue gas oxygen concentration. The use of a common gas and combustion air control linkage or jack shaft is not permitted.

Exception: These concentration limits do not apply where 50 percent or more of the *boiler system* capacity serves Group R-2 occupancies.

TABLE C403.3.4.1—BOILER OXYGEN CONCENTRATIONS

BOILER APPLICATION	MAXIMUM STACK-GAS OXYGEN CONCENTRATION[a]
Commercial boilers or where ≤ 10% of the boiler system capacity is used for process applications at design conditions	5%
Process boilers	3%

a. Concentration levels measured by volume on a dry basis over firing rates of 20 to 100 percent.
Exception: These concentration limits do not apply where 50 percent or more of the boiler system capacity serves Group R-2 occupancies.

Section C403 – Mechanical Systems

- C403.4.1 Thermostatic Controls
  - C403.4.1.2 Deadband
    - Heating & Cooling Setpoints individually adjustable
    - Minimum Deadband of 5 F for initial settings
    - Minimum Deadband of 1 F with adjusted Heating & Cooling Setpoints
  - C403.4.1.3 Setpoint Adjustment and Display
    - Independent Heating & Cooling Setpoint Adjustment and Display

Section C403 – Mechanical Systems

C403.4.7 Heating and cooling system controls for operable openings to the outdoors. All doors from a *conditioned space* to the outdoors and all other operable openings from a *conditioned space* to the outdoors that are larger than 40 square feet (3.7 m^2) when fully open shall have *automatic* controls interlocked with the heating and cooling system. The controls shall be configured to do the following within 5 minutes of opening:

1. Disable mechanical heating to the zone or reset the space heating temperature setpoint to 55°F (12.5°C) or less.
2. Disable mechanical cooling to the zone or reset the space cooling temperature setpoint to 90°F (32°C) or more. Mechanical cooling can remain enabled if the outdoor air temperature is below the space temperature.

Exceptions:

1. *Building entrances* with *automatic* closing devices.
2. Emergency exits with an *automatic* alarm that sounds when open.
3. Operable openings and doors serving *enclosed spaces* without a *thermostat* or heating or cooling temperature sensor.
4. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the heating or cooling loads of a restaurant or similar type of occupancy.
5. Warehouses that utilize operable openings for the function of the occupancy, where *approved* by the *code official*.
6. The first *entrance doors* where located in the *exterior wall* and are part of a vestibule system.
7. Operable openings into spaces served by radiant heating and cooling systems.
8. *Alterations* where walls would have to be opened solely for the purpose of meeting this requirement and where *approved*.
9. Doors served by air curtains meeting the requirements of Section C402.6.6.

Section C403 – Mechanical Systems

C403.4.8 Humidification and dehumidification controls. Humidification and dehumidification controls shall be in accordance with this section.

C403.4.8.1 Dehumidification. *Humidistatic controls* shall not use mechanical cooling to reduce the humidity below the lower of a dew point of 55°F (13°C) or relative humidity of 60 percent in the coldest *zone* served by the system. Lower humidity shall be permitted where mechanical cooling is being used for temperature control.

Exceptions:

1. Where approved, systems serving zones where specific humidity levels are required, such as museums and hospitals, and where *humidistatic controls* are capable of and configured to maintain a dead band of at least 10 percent relative humidity where no active humidification or dehumidification takes place.
2. Systems serving *zones* where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as *approved* by the authority having jurisdiction.

C403.4.8.2 Humidification. *Humidistatic controls* shall not use fossil fuels or electricity to produce relative humidity above 30 percent in the warmest *zone* served by the system.

Exceptions:

1. Where *approved*, systems serving *zones* where specific humidity levels are required, such as museums and hospitals, and where *humidistatic controls* are capable of and configured to maintain a deadband of at least 10 percent relative humidity where no active humidification or dehumidification takes place.
2. Systems serving *zones* where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as *approved* by the authority having jurisdiction.

C403.4.8.3 Control interlock. Where a *zone* is served by a system or systems with both humidification and dehumidification capability, means such as limit switches, mechanical stops, or for DDC systems, software programming, shall be provided capable of and configured to prevent simultaneous operation of humidification and dehumidification equipment.

Exception: Systems serving *zones* where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as *approved* by the authority having jurisdiction.

Section C403 – Mechanical Systems

- C403.5 Economizers – Revised Exception 7

  "Direct-expansion fan coils or unitary equipment with a capacity less than 54,000 Btu/h (15.8 kW) and multiple stages of compressor capacity installed with a dedicated outdoor air system.

- C403.5.3.4 Relief of Excess Outdoor Air

C403.5.3.4 Relief of excess outdoor air. Systems shall provide one of the following means to relieve excess outdoor air during *air economizer* operation to prevent overpressurizing the *building*.

1. Return or relief fan(s) meeting the requirements of Section C403.11.1.
2. A barometric or motorized damper relief path with a total pressure drop at a design relief airflow rate less than 0.10 inches water column (25 Pa) from the occupied space to the outdoors. Design relief airflow rate shall be the design supply airflow rate minus any continuous exhaust flows, such as toilet exhaust fans, whose makeup is provided by the economizer system.

The relief air outlet shall be located to avoid recirculation into the *building*.

Section C403 – Mechanical Systems

- C403.7.1 Demand Control Ventilation – required in
  - Single zone systems with air side economizer
  - Spaces larger than 250 SF in Climate Zone 5A with design occupant load of ≥ 15 people per 1000 SF that have an airside economizer with modulating outdoor air damper and design outdoor airflow of > 3,000 CFM
    - Exceptions
      - Have energy recovery and spaces less than 1,000 SF
      - Multiple Zone Systems with design OA of < 750 CFM
- C403.7.2 Parking Garage Ventilation Controls

C403.7.2 Parking garage ventilation controls. Ventilation systems employed in enclosed parking garages shall comply with Section 404.1 of the *International Mechanical Code* and the following:

1. Separate ventilation systems and control systems shall be provided for each *parking garage section*.
2. Control systems for each *parking garage section* shall be capable of and configured to reduce fan airflow to not less than 0.05 cfm per square foot [0.00025 $m^3/(s \times m^2)$] of the floor area served and not more than 20 percent of the design capacity.
3. The ventilation system for each *parking garage section* shall have controls and devices that result in fan motor demand of not more than 30 percent of design wattage at 50 percent of the design airflow.

Exception: Garage ventilation systems serving a single *parking garage section* having a total ventilation system motor *nameplate horsepower* (ventilation system motor nameplate kilowatt) not exceeding 5 hp (3.7 kW) at *fan system design conditions* and where the *parking garage section* has no mechanical cooling or mechanical heating.

Nothing in this section shall be construed to require more than one *parking garage section* in any parking structure.

Section C403 – Mechanical Systems

- C403.7.4 Energy Recovery Systems
  - Non-Transient Dwelling Units – minimum “Sensible Heat Recovery Efficiency” (SRE) at 65% at 32 F OA
- C403.7.5 Kitchen Exhaust Systems

C403.7.5 Kitchen exhaust systems. Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10 percent of the hood exhaust airflow rate. Conditioned supply air delivered to any space shall not exceed the greater of the following:

1. The ventilation rate required to meet the space heating or cooling load.
2. The hood exhaust flow minus the available transfer air from adjacent space where available transfer air is considered to be that portion of outdoor *ventilation* air not required to satisfy other exhaust needs, such as restrooms, and not required to maintain pressurization of adjacent spaces.

Kitchen exhaust hood systems serving Type I exhaust hoods shall be provided with *demand control kitchen ventilation* (DCKV) controls where a kitchen or kitchen/dining facility has a total Type I kitchen hood exhaust airflow rate greater than 5,000 cubic feet per minute (2360 L/s). DCKV systems shall be configured to provide a minimum of 50 percent reduction in exhaust and replacement air system airflow rates. Systems shall include controls necessary to modulate exhaust and replacement air system airflows in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle operation. Each hood shall be a factory-built commercial exhaust hood *listed* by a nationally recognized testing laboratory and shall have a maximum exhaust rate as specified in Table C403.7.5.

Where a single hood, or hood section, is installed over appliances with different duty ratings, the maximum allowable flow rate for the hood or hood section shall be based on the requirements for the highest appliance duty rating under the hood or hood section.

Exceptions:

1. UL 710 listed exhaust hoods that have a design maximum exhaust flow rate not greater than 250 cubic feet per minute (118 L/s) per linear foot (305 mm) of hood that serve kitchen or kitchen/dining facilities with a total kitchen hood exhaust airflow rate less than 5,000 cfm (2360 L/s).
2. Where allowed by the *International Mechanical Code*, an *energy recovery ventilation system* is installed on the kitchen exhaust with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent of the total exhaust hood airflow.

Section C403 – Mechanical Systems

- C403.7.8 Occupied Controls
  - For Classrooms, Conference Rooms, Breakrooms, Enclosed & Open Plan Offices & Corridors
  - Within 5 minutes of being unoccupied,
    - Automatically reset heating and cooling setpoints down and up 1 F accordingly
    - Shut off airflow to the zone as long as the space temperature is within setpoints
    - Automatically reset effective minimum outdoor air setpoint to account for unoccupied zones
- C403.7.9 Dwelling Unit Ventilation System
  - For individual dwelling units, cannot use Heating/Cooling system fan to provide outdoor air
    - Except if fan efficacy is not less than 1.2 CFM OA airflow per watt when there is no demand for heating or cooling

Section C403 – Mechanical Systems

- C403.8.5 Low-Capacity Ventilation Fans

Mechanical ventilation system fans with motors less than 1/12 hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points. Airflow shall be tested in accordance with the test procedure referenced in Table C403.8.5 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. (49.8 Pa). Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c. (24.9 Pa).

Exceptions:

1. Where ventilation fans are a component of a listed heating or cooling appliance.
2. Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.
3. Fans in radon mitigation systems.
4. Fans not covered within the scope of the test methods referenced in Table C403.8.5.
5. Ceiling fans regulated under 10 CFR 430, Appendix U.

TABLE C403.8.5—LOW-CAPACITY VENTILATION FAN EFFICACY[a]

SYSTEM TYPE	AIRFLOW RATE (CFM)	MINIMUM EFFICACY (CFM/WATT)	TEST PROCEDURE
Balanced ventilation system without heat or energy recovery	Any	1.2[a]	ASHRAE Standard 51 (ANSI/AMCA Standard 210)
HRV, ERV	Any	1.2	CAN/CSA 439
Range hood	Any	2.8	ASHRAE 51 (ANSI/AMCA Standard 210)
In-line supply or exhaust fan	Any	3.8	
Other exhaust fan	≤ 90	2.8	
	≥ 90 and < 200	3.5	
	≥ 200	4.0	

For SI: 1 cfm/ft = 0.47 L/s.
a. For balanced systems, HRVs and ERVs, determine the efficacy as the outdoor airflow divided by the total fan power.

Section C403 – Mechanical Systems

- C403.8.6.2 Intermittent Exhaust Control for Bathrooms and Toilet Rooms
  - Where an exhaust system serving a bathroom or toilet room is designed for intermittent operation, the exhaust system shall be provided with manual on capability and one or more of the following controls:
    1. A timer control that has a minimum setpoint not greater than 30 minutes.
    2. An occupant sensor control that automatically turns off exhaust fans within 30 minutes after all occupants have left the space.
    3. A humidity control capable of manual or automatic adjustment from a minimum setpoint not greater than 50 percent to a maximum setpoint not greater than 80 percent relative humidity.
    4. A contaminant control that responds to a particle or gaseous concentration.

  Exception: Bathroom and toilet room exhaust systems serving as an integral component of an outdoor air ventilation system in Group R-2, R-3 and R-4 occupancies shall not be required to provide controls other than manual on capability. An off setpoint shall not be used to comply with a minimum setpoint requirement.

Section C403 – Mechanical Systems

- C403.9 Large-Diameter Ceiling Fans

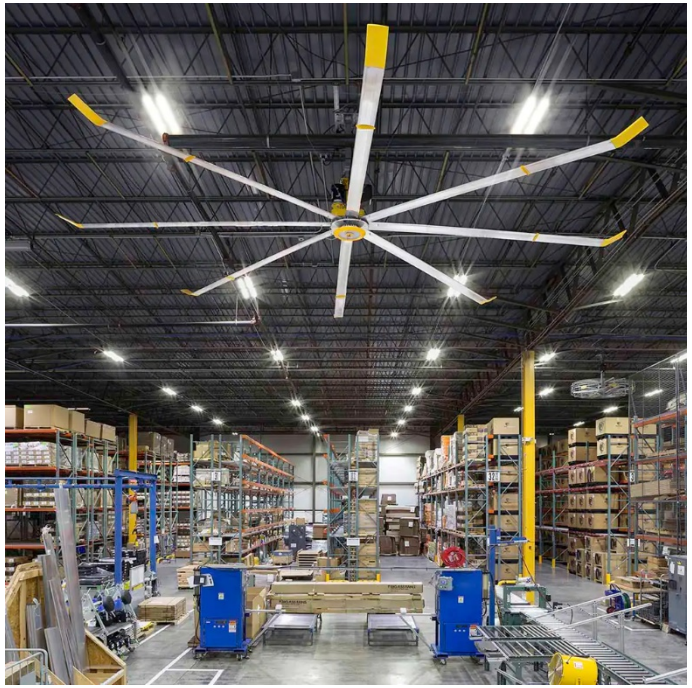


TABLE C403.9—CEILING FAN EFFICIENCY REQUIREMENTS[a]

EQUIPMENT TYPE	MINIMUM EFFICIENCY[b,c]	TEST PROCEDURE
Large-diameter ceiling fan for applications outside the US[c]	CFEI ≥ 1.00 at high (maximum) speed CFEI ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed	10 CFR 430, Appendix U or AMCA 230 and AMCA 208 (for FEI calculations)
Large-diameter ceiling fan	CFEI ≥ 1.00 at high (maximum) speed; and CFEI ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed	10 CFR 430, Appendix U

a. The minimum efficiency requirements at both high speed and 40% of maximum speed shall be met or exceeded to comply with this code.
b. Ceiling fans are regulated as consumer products by 10 CFR 430.
c. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

C403.9.1 Ceiling Fan Energy Index (CFEI). The Ceiling Fan Energy Index shall be calculated as the ratio of the electric input power of a reference *large-diameter ceiling fan* to the electric input power of the actual *large-diameter ceiling fan* as calculated in accordance with AMCA 208 with the following modifications to the calculations for the reference fan: using an airflow constant (Q) of 26,500 cfm (12.5 m^3/s), a pressure constant (P) of 0.0027 inch of water (0.6719 Pa), and fan efficiency constant (η) of 42 percent.

Section C403 – Mechanical Systems

- C403.10 Buildings with High Capacity Space Heating Boiler Systems (new)

C403.10 Buildings with high-capacity space-heating gas boiler systems. Gas hot water boiler systems for space heating with system input capacities of not less than 1,000,000 Btu/h (293 kW) and not greater than 10,000,000 Btu/h (2931 kW) in new *buildings* shall comply with Sections C403.10.1 and C403.10.2.

Exceptions:

1. Where 25 percent of the annual space heating requirement is provided by *on-site renewable energy*, site-recovered energy or heat recovery chillers.
2. Space heating boilers installed in individual *dwelling units*.
3. Where 50 percent or more of the design heating load is served using perimeter convective heating, radiant ceiling panels or both.
4. Individual gas boilers with input capacity less than 300,000 Btu/h (88 kW) shall not be included in the calculations of the total system input or total system efficiency.

C403.10.1 Boiler efficiency. Gas hot water boilers shall have a thermal efficiency (E_t) of not less than 90 percent where rated in accordance with the test procedures in Table C403.3.2(6). Systems with multiple boilers are allowed to meet this requirement where the space heating input provided by equipment with E_t above or below 90 percent provides an input capacity-weighted average E_t of not less than 90 percent. For boilers rated only for combustion efficiency, the calculation for the input capacity-weighted average E_t shall use the combustion efficiency value.

C403.10.2 Hot water distribution system design. The hot water distribution system shall be designed to meet the following:

1. Coils and other heat exchangers shall be selected so that at design conditions the hot water return temperature entering the boilers is 120°F (49°C) or less.
2. Under all operating conditions, the water temperature entering the boiler is not greater than 120°F (49°C) or the flow rate of supply hot water that recirculates directly into the return system, such as by three-way valves or minimum flow bypass controls, shall be not greater than 20 percent of the design flow of the boilers.

Section C403 – Mechanical Systems

- C403.12 Refrigeration Equipment
  - Revised test procedures for Walk-In Cooler and Freezer Door
  - New Table for Walk-in Cooler and Freezer Refrigeration System Efficiency Requirements
- C403.13.3 Piping Insulation
  - Added minimum R value to Minimum Insulation thickness table (Table C403.13.3(1))
- C403.13.3.1 Protection of piping insulation

  “Piping insulation exposed to the weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material. The protection shall be removable and reuseable for not less than 6 inches (152 mm) from the connection to the equipment piping for maintenance. Adhesive tape shall not be permitted as a means of insulation protection.”

Section C403 – Mechanical Systems

- C403.14.3 Roof and gutter deicing controls (new)
  - Automatically shut off system when ambient temperature is above 40 F
    - Include moisture sensor to shut off system in the absence of moisture
    - Daylight sensor to shut off the system between sunset and sunrise
- C4023.15 Dehumidification in spaces for plant growth and maintenance (new)
  - Need integrated HVAC System or on-site Heat Recovery Chillers with on site heat recovery to fullfill not less than 75% of annual dehumidification reheat energy
  - Or Dessicant systems for systems with design Dewpoint not more than 50 F
- C4023.16 Pressure Booster Systems (new)
  - Pressure sensors to vary pump speed and start/stop pumps
  - No pressure reducing devices allowed (except for safety devices)
  - No pump operation when no flow

Section C403 – Mechanical Systems

- C403.17 Clean Water Pumps (new)

C403.17 Clean water pumps. *Clean water pumps* meeting all the following criteria shall achieve a PEI rating not greater than 1.0:

1. Shaft input power is greater than or equal to 1.0 hp (0.75 kW) and less than or equal to 200 hp (149.1 kW) at its best efficiency point (BEP).
2. Designated as either an end-suction close-coupled, end-suction frame-mounted, in-line, radially split vertical or submersible turbine pump.
3. A flow rate of 25 gallons per minute (1.58 L/s) or greater at its BEP at full impeller diameter.
4. Maximum head of 459 feet (139.9 m) at its BEP at full impeller diameter and the number of stages required for testing.
5. Design temperature range from 14°F (-10°C) to 248°F (120°C).
6. Designed to operate with one of the following. Note that for either Item 6.1 or 6.2, the driver and impeller must rotate at the same speed.
    - 6.1. A 2- or 4-pole induction motor.
    - 6.2. A noninduction motor with a speed of rotation operating range that includes speeds of rotation between 2,880 and 4,320 rpm and/or 1,440 and 2,160 rpm.
7. For submersible turbine pumps, a 6-inch (152 mm) or smaller bowl diameter.
8. For end-suction close-coupled pumps and end-suction frame-mounted/own bearings pumps, specific speeds less than or equal to 5,000 rpm when calculated using US customary units.

Exceptions: The following pumps are exempt from these requirements:

1. Fire pumps.
2. Self-priming pumps.
3. Prime-assisted pumps.
4. Magnet-driven pumps.
5. Pumps designed to be used in a nuclear facility subject to 10 CFR 50.
6. Pumps meeting the design and construction requirements set forth in US Military Specification MIL-P-17639F (1996), "Pumps, Centrifugal, Miscellaneous Service Naval Shipboard Use" (as amended); MIL-P-17840C (1986), "Pump, Centrifugal, Close Coupled, Navy Standard for Use on Naval Ships" (as amended); MIL-P-17881D (1972), "Pump, Centrifugal, Boiler Feed, (Multi Stage)" (as amended); MIL-P-18472G (1989), "Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, and Distilling Plant" (as amended); MIL-P-18682D (1984), "Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard" (as amended).

Section C404 – Service Water Heating

- Table C404.2 Minimum Performance of Water Heating Equipment
  - Completely revised
  - Uses Uniform Energy Factor (UEF) and Thermal Efficiency (E_t).
    - See table footnotes for more information
- C404.2.1 High-input service water heating systems

C404.2.1 High-input service water-heating systems. Gas-fired *water heaters* installed in new *buildings* where the total input capacity provided by high-capacity gas-fired *water heaters* is 1,000,000 Btu/h (293 kW) or greater shall comply with either or both of the following requirements:

1. Where a singular piece of a high-capacity gas-fired *water heater* is installed, the water heater shall have a thermal efficiency, E_t, of not less than 92 percent.
2. Where multiple pieces of high-capacity gas-fired *water heaters* are connected to the same service water-heating system, the combined input-capacity-weighted average thermal efficiency, E_t, shall be not less than 90 percent, and a minimum of 30 percent of the input to the high-capacity gas-fired *water heaters* in the service water-heating system shall have an E_t of not less than 92 percent.

Exceptions:

1. The input rating of *water heaters* installed in individual *dwelling units* shall not be required to be included in the total input rating of service water-heating equipment for a *building*.
2. The input rating of water heaters with an input rating of not greater than 105,000 Btu/h (30.8 kW) shall not be required to be included in the total input rating of service water-heating equipment for a *building*.
3. Where not less than 25 percent of the annual *service water-heating* requirement is provided by *on-site renewable energy* or site-recovered energy, the minimum E_t requirements of this section shall not apply. On-site renewable energy used to meet Section C405.15.1 or C406.3.1 shall not be used to meet this exception.

Section C404 – Service Water Heating

- C404.4 Service water heating pipe insulation
  - New exceptions
    - Factory-installed piping within water heaters and hot water storage tanks
    - Piping that conveys hot water that has not been heated through the use of fossil fuels or electricity
    - Piping in existing buildings where alterations are made to existing service water heating systems where there is insufficient space or access to meet the requirements
    - Where piping passes through a framing member if it requires increasing the size of the framing member

C404.4.1 Installation requirements. The following piping shall be insulated per the requirements of this section:

1. Recirculating system piping, including the supply and return piping.
2. The first 8 feet (2.4 m) of outlet piping from:
   - 2.1. Storage *water heaters.*
   - 2.2. Hot water storage tanks.
   - 2.3. Any *water heater* and hot water supply boiler containing not less than 10 gallons (37.9 L) of water heated by a direct heat source, an indirect heat source, or both a direct heat source and an indirect heat source.
3. The first 8 feet (2.4 m) of branch piping connecting to recirculated, heat traced or impedance-heated piping.
4. The makeup water inlet piping between *heat traps* and the storage *water heaters* and the storage tanks they are serving, in a nonrecirculating *service water heating* storage system.
5. Hot water piping between multiple *water heaters*, between multiple hot water storage tanks, and between *water heaters* and hot water storage tanks.
6. Piping that is externally heated (such as heat trace or impedance heating).
7. For direct-buried *service water heating* system piping, reduction of these thicknesses by $1^{1}/_{2}$ inches (38.1 mm) shall be permitted (before thickness adjustment required in Section C404.4) but not to thicknesses less than 1 inch (25.4 mm).

Section C404 – Service Water Heating

- C404.6.1 Circulation Systems

Heated-water circulation systems shall be provided with a circulation pump. Gravity and thermo-syphon circulation systems shall be prohibited. *The system return pipe shall be a dedicated return pipe. Controls shall be configured to automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is not a demand for hot water. Where a circulation pump serves multiple risers or piping zones, controls shall include self-actuating thermostatic balancing valves or another means of flow control to automatically balance the flow rate through each riser or piping zone.*

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.1 General

This section has been reworded but the intent remains the same. Section C405 contains requirements for electric power, lighting systems and power generation.

Most of this section addresses electric lighting systems.

This section also addresses the following:

- Electrical distribution systems.
- Motors.
- Vertical and horizontal transportation systems.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2 Lighting Controls

This section has also been completely reworded. However, the most significant change is in the exceptions. Lighting controls are not required for the following:

1. Spaces where an automatic shutoff could endanger occupant safety or security. [Added]
2. Interior exit stairways, interior exit ramps and exit passageways. [No change]
3. Emergency lighting that is automatically off during normal operations. [No change]
4. Emergency lighting required by the International Building Code in exit access components that are not provided with fire alarm systems. [Added]
5. Up to 0.02 watts per square foot of lighting in exit access components that are provided with fire alarm systems. [Added]

What was deleted…

Areas designated as security or emergency areas that are required to be continuously lighted.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2 Lighting Controls

C405.2.1 Occupant sensor controls

Added the requirement to install occupant sensor controls in the following specific spaces:

1. Computer room, data center.
2. Medical supply room in a health care facility.
3. Laundry/washing area.
4. Telemedicine room in a health care facility.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2 Lighting Controls

C405.2.1 Occupant sensor controls

Added the requirement to install occupant sensor controls in the following specific spaces:

1. Computer room, data center.
2. Medical supply room in a health care facility.
3. Laundry/washing area.
4. Telemedicine room in a health care facility.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2 Lighting Controls

C405.2.2.1 Time-switch control function

Added a seventh requirement

7. For spaces where schedules are not available, time switch controls are programmed to a schedule that turns off lights not less than 12 hours per day

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2.3 Dimming controls

This section completely replaces the old C405.2.3 Lighting-reduction controls. It's been revised and specifically calls for diming controls for general lighting in the following area

1. Classroom/lecture hall/training room.
2. Conference/multipurpose/meeting room.
3. In a dining area for bar/lounge or leisure, family dining.
4. Laboratory.
5. Lobby.
6. Lounge/break room.
7. Offices.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2.3 Dimming controls

This section completely replaces the old C405.2.3 Lighting-reduction controls. It's been revised and specifically calls for diming controls for general lighting in the following area

8. Gymnasium/fitness center.
9. Library reading room.
10. In a health care facility for imaging rooms, exam rooms, nursery and nurses' station.
11. Spaces not provided with occupant sensor controls complying with Section C405.2.1.1.

The only exception is now luminaires controlled by special application controls complying with Section C405.2.5.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2.3.1 Dimming control function.

This section completely replaces the old C405.2.3.1 Light-reduction control function.

Spaces required to have dimming control shall be provided with manual controls that allow lights to be dimmed from full output to 10 percent [previously 50%] of full power or lower with continuous dimming, as well as turning off lights. Manual control shall be provided within each room to dim lights.

Exceptions: Manual dimming control is not required in spaces where high-end trim lighting controls are provided that comply with the following:

1. The calibration adjustment equipment is located for ready access only by authorized personnel.
2. Lighting controls with ready access for users cannot increase the lighting power above the maximum level established by the high-end trim controls.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2.4 Daylight responsive controls

Section has been made more stringent.

1. Spaces with a total of more than 75 watts [previously 150 W] of general lighting within primary sidelit daylight zones complying with Section C405.2.4.2.
2. Spaces with a total of more than 150 watts [previously 300 W] of general lighting within sidelit daylight zones complying with Section C405.2.4.2.
3. Spaces with a total of more than 75 watts [previously 150 W] of general lighting within toplit daylight zones complying with Section C405.2.4.3.

The exception for total connected lighting power has been removed. A new exception exempts enclosed office spaces less than 250 square feet.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2.5 Specific application controls.

Reorganized with the requirements for Sleeping Units having been moved.

Specifically calls for lighting integrated into range hoods to be controlled separately from the fan.

C405.2.8 Reserved. Previously C405.2.8 Parking garage lighting control. Parking garage lighting control is now **C405.2.9 Interior parking area lighting control.** The requirements are essentially unchanged.

C405.2.8.1 Demand responsive lighting controls function.

This section specifies the capabilities of demand responsive lighting control functions where installed. This is to clarify to designers and code officials what control systems would comply. This section relates to additional energy efficiency credit G01 Lighting load management found in Section C406.3.2.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2.10 Sleeping unit and dwelling unit lighting and switched receptacle controls

All of the requirements for sleeping units and dwelling units have been put in their own section. The section provides specific requirements for the following

C405.2.10.1 Sleeping units and dwelling units in hotels, motels and vacation timeshare properties.

1. Not less than two 125V, 15- and 20-amp switched receptacles in each room, except for bathrooms, kitchens, foyers, hallways and closets.
2. Lighting controls that automatically turn off all lighting and switched receptacles within 20 minutes after all occupants have left the unit.

Exception: Automatic shutoff is not required where captive key override controls all lighting and switched receptacles in units with five or fewer permanently installed lights and switched receptacles.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.2.10 Sleeping unit and dwelling unit lighting and switched receptacle controls

All of the requirements for sleeping units and dwelling units have been put in their own section. The section provides specific requirements for the following

C405.2.10.2 Sleeping units in congregate living facilities.

1. Lighting in bathrooms shall be controlled by an occupant sensor control that automatically turns off lights within 20 minutes after all occupants have left the space.
2. Each unit shall have a manual control by the entrance that turns off all lighting and switched receptacles in the unit, except for lighting in bathrooms and kitchens. The manual control shall be marked to indicate its function.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.3 Interior lighting power requirements

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD and TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD were updated with generally more stringent requirements

TABLE C405.3.2(1)

INTERIOR LIGHTING POWER ALLOWANCES:

BUILDING AREA METHOD

BUILDING AREA TYPE	2024 IECC	2021 IECC
	LPD (watts/ft²)	
Automotive facility	0.73	0.75
Convention center	0.64	0.64
Courthouse	0.75	0.79
Dining: bar lounge/leisure	0.74	0.80
Dining: cafeteria/fast food	0.70	0.76
Dining: family	0.65	0.71
Dormitory	0.52	0.53
Exercise center	0.72	0.72
Fire station	0.56	0.56
Gymnasium	0.75	0.76
Health care clinic	0.77	0.81
Hospital	0.92	0.96
Hotel/Motel	0.53	0.56
Library	0.83	0.83
Manufacturing facility	0.82	0.82
Motion picture theater	0.43	0.44
Multiple-family	0.46	0.45
Museum	0.56	0.55
Office	0.62	0.64

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.3.2.1 Building Area Method and C405.3.2.2 Space-by-Space Method

Sleeping units and dwelling units are excluded from lighting power allowance calculations by application of Section C405.3.3 (Lighting power for sleeping units and dwelling units). The area of sleeping units and dwelling units is not included in the calculation.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.3.3 Lighting power for sleeping units and dwelling units. Sleeping units in Group I-2 occupancies that are patient rooms shall comply with Sections C405.3.1 and C405.3.2. For all other sleeping units and dwelling units, permanently installed lighting, including lighting integrated into range hoods and exhaust fans, shall be provided by lamps capable of operating with an efficacy of not less than 65 lumens per watt or luminaires capable of operating with an efficacy of not less than 45 lumens per watt.

Exceptions:

1. Lighting integral to other appliances.
2. Antimicrobial lighting used for the sole purpose of disinfecting.
3. Luminaires with an input rating of less than 3 watts.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.4 Horticultural lighting replaces C405.4 Lighting for plant growth and maintenance

Permanently installed luminaires shall have a photosynthetic photon efficacy of not less than 1.7 micromoles per joule for horticultural lighting in greenhouses and not less than 1.9 micromoles per joule for all other horticultural lighting.

Luminaires for horticultural lighting in greenhouses shall be controlled by a device that automatically turns off the luminaire when sufficient daylight is available.

Luminaires for horticultural lighting shall be controlled by a device that automatically turns off the luminaire at specific programmed times.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.5.2 Exterior lighting power allowance

TABLE C405.5.2(2)—LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS and TABLE C405.5.2(3)—INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS have both been updated and made more stringent

TABLE C405.5.2(2)—LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS				
	LIGHTING ZONES			
	Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance	160 W (350W)	280 W (400 W)	400 W (500 W)	560 W (900 W)
Uncovered Parking Areas				
Parking area, exterior	0.015 W/ft^2 (0.03 W/ft^2)	0.026 W/ft^2 (0.03 W/ft^2)	0.037 W/ft^2 (0.03 W/ft^2)	0.052 W/ft^2 (0.03 W/ft^2)
Building Grounds				
Walkways and ramps less	0.50 W/lf (0.50 W/lf)	0.50 W/lf (0.50 W/lf)	0.55 W/lf (0.60 W/lf)	0.60 W/lf (0.70 W/lf)
Dining areas	0.156 W/ft^2 (0.65 W/ft^2)	0.273 W/ft^2 (0.65 W/ft^2)	0.390 W/ft^2 (0.75 W/ft^2)	0.546 W/ft^2 (0.95 W/ft^2)

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.9 Data centers and computer rooms

This section was inserted and the old C405.9 Vertical and horizontal transportation systems was moved to C405.10. No other changes were made to Vertical and horizontal transportation systems

C405.9.1 Data centers

Requires compliance with ASHRAE 90.4

C405.9.2 Computer rooms

Introduces minimum Uninterruptible Power Supply (UPS) efficiency

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.12 Energy monitoring,

Energy monitoring requirements are expanded to include nonelectrical end uses and now apply to buildings larger than 10,000 square feet (previously 25,000 square feet).

On-site renewable energy sources shall be metered.

TABLE C405.13.2—ELECTRICAL 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, fireplaces, swimming pools, spas and snow-melt systems.
Electric hot water heating for uses other than space conditioning	Electricity used to generate hot water. **Exception:** Electric water heating with design capacity that is less than 10 percent of the building service rating.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.13.7 Nonelectrical energy submetering

Nonelectrical energy supplied to the building shall be provided with submeters or other measurement devices to collect energy consumption data, with exceptions.

1. HVAC and water heating equipment serving only an individual dwelling unit – exempt.
2. Fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency – exempt.
3. Individual tenant space having a floor area not greater than 2,500 square feet where a dedicated source meter is provided – exempt.
4. Equipment powered primarily by solid fuels serving loads other than building heating and service water heating loads – exempt.

C405 Electrical Power and Lighting Systems

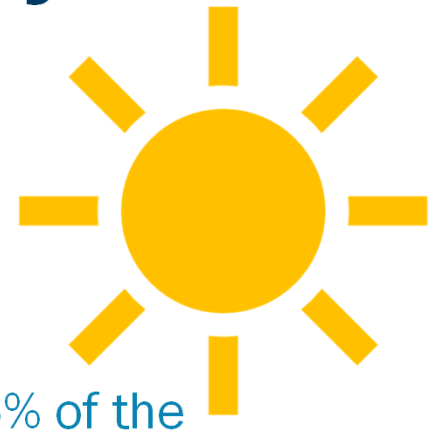
Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.13.7 Nonelectrical energy submetering

TABLE C405.13.8—NONELECTRICAL ENERGY USE CATEGORIES	
END USE CATEGORY	DESCRIPTION OF END USE
Total HVAC system	Heating and cooling systems, including but not limited to boilers, chillers and furnaces. District heating and cooling energy entering the building's distribution system shall be monitored at the point of entry to the building distribution system.
Process loads	Any single load that is not included in the HVAC or service water heating categories where the rated fuel gas or fuel oil input of the load and that is not less than 5 percent of the sum of the rated fuel gas or fuel oil input of all monitored equipment, including but not limited to manufacturing equipment, process equipment, commercial kitchens, and commercial laundry equipment.
Other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to fireplaces, swimming pools, spas, gas lighting, and snow-melt systems.
Service water heating	Fuel used to heat potable water. Exception: Water heating with design capacity that is less than 10 percent of the sum of the rated fuel gas or fuel oil input of all monitored equipment.

C405 Electrical Power and Lighting Systems



Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.15 Renewable energy systems – Added for the first time in 2024

Applies to buildings in Climate Zones 0-7. The goal is to supply, on average, 15% of the building's total energy use.

Ideally, located on-site. However, factors limit on-site installation including site location, roof area restrictions and building size. These factors are included as exceptions to the on-site requirement.

Buildings that meet on-site exceptions must procure off-site renewable energy instead.

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.15 Renewable energy systems – Added for the first time in 2024

The amount of off-site renewable energy to be procured is calculated based Equation 4-11

Equation 4-11 $TRE_{off} = (REN_{off} \times 0.75\ W/ft^2 \times FLRA - IRE_{on}) \times 15$

where:

TRE_{off} = Total off-site renewable electrical energy in kWh to be procured in accordance with Table C405.15.2.

REN_{off} = Annual off-site renewable electrical energy from Table C405.15.2, in units of kWh/W of array capacity.

FLRA = The sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors.

IRE_{on} = Annual on-site renewable electrical energy generation of a new on-site renewable energy system, to be installed as part of the building project, whose rated capacity is less than the rated capacity required in Section C405.15.1 (i.e. you didn't meet the minimum, but you still provided something).

C405 Electrical Power and Lighting Systems

Chapter 4: Commercial Energy Efficiency

C405 Electrical Power and Lighting Systems

C405.15 Renewable energy systems – Added for the first time in 2024

The annual off-site renewable energy requirement is a multiplier based on climate zone. The multiplier considers on-site renewable energy production potential and transmission losses associated with off-site generation.

TABLE C405.15.2—ANNUAL OFF-SITE RENEWABLE ENERGY REQUIREMENTS	
CLIMATE ZONE	**ANNUAL OFF-SITE RENEWABLE ELECTRICAL ENERGY (kWh/W)**
1A, 2B, 3B, 3C, 4B and 5B	1.75
0A, 0B, 1B, 2A, 3A and 6B	1.55
4A, 4C, 5A, 5C, 6A and 7	1.35

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

Section C406 has been rewritten and expanded. Notably it now includes Renewable and Load Management requirements.

The section is broken into two parts

- C406.1.1 Additional energy efficiency credit requirements
- C406.1.2 Additional renewable and load management credit requirements

Section C406 Additional Efficiency, Renewable and Load Management

- C406.1 Compliance
  - Buildings shall comply as follows:
    - Buildings with greater than 2,000 square feet of conditioned floor area shall comply with Section C406.1.1.
    - Buildings with greater than 5,000 square feet of conditioned floor area shall comply with Sections C406.1.1 and C406.1.2.
    - Build-out construction greater than 1,000 square feet of conditioned floor area that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.1.2.
  - Exceptions:
    - Core and shell buildings where not less than 20 percent of the net floor area is without final lighting or final HVAC that comply with all of the following:
      - Buildings with greater than 5,000 square feet of conditioned floor area shall comply with Section C406.1.2.
      - Portions of the building where the net floor area is without final lighting or final HVAC shall comply with Section C406.1.1.2.
      - Portions of the building where the net floor area has final lighting and final HVAC systems shall comply with Section C406.1.1.

Section C406 Additional Efficiency, Renewable and Load Management

- C406.1.1 Additional energy efficiency credit requirements.
  - Buildings shall comply with measures from Section C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1(1) based on building occupancy group and climate zone. Where a project contains multiple occupancies, the total required energy credits from each building occupancy shall be weighted by the gross conditioned floor area to determine the weighted-average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for the purposes of Section C406.
  - Exceptions:
    - Portions of buildings devoted to manufacturing or industrial use.
    - Where a building achieves more renewable and load management credits in Section C406.3 than are required in C406.1.2, surplus credits shall be permitted to reduce the required energy efficiency credits per equation

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

Applies to the following:

1. Buildings with greater than 2,000 square feet of conditioned floor area shall comply with Section C406.1.1 - Additional energy efficiency credit requirements.
2. Buildings with greater than 5,000 square feet of conditioned floor area shall comply with Sections C406.1.1 - Additional energy efficiency credit requirements and C406.1.2 - Additional renewable and load management credit requirements
3. Build-out construction greater than 1,000 square feet of conditioned floor area that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.1.2 - Additional renewable and load management credit requirements.

Exceptions for core and shell buildings.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.1.1 Additional energy efficiency credit requirements

Comply with measures from Section C406.2 to achieve the required number of efficiency credits from Table C406.1.1(1) based on building occupancy group and climate zone.

This section allows for excess renewable and load management credits to be applied to the requirements for energy efficiency credits, with limits.

TABLE C406.1.1(1)—ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

BUILDING OCCUPANCY GROUP	CLIMATE ZONE																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4 and I-1	65	66	67	77	80	86	80	81	90	86	90	90	86	90	90	70	89	80	78
I-2	43	42	38	37	36	38	32	32	30	36	36	35	43	43	44	46	47	50	53
R-1	63	62	66	65	70	71	77	80	84	81	83	88	85	86	90	83	87	87	85
B	62	62	64	66	66	65	64	64	68	70	72	74	71	73	77	71	74	74	71
A-2	70	70	72	72	75	75	70	73	82	69	74	78	67	72	78	60	67	57	51
M	80	79	83	79	81	84	67	74	87	80	66	65	79	62	50	75	67	75	58
E	56	57	55	58	58	57	59	62	59	61	66	62	64	67	67	65	67	63	58
S-1 and S-2	61	60	61	60	58	57	44	54	62	85	68	75	90	82	72	90	89	90	90
All other	31	31	31	32	32	33	30	32	36	35	35	35	37	36	36	36	37	36	34

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.1.2 Additional renewable and load management credit requirements

Comply with measures from Section C406.3 to achieve the required number of renewable and load management credits from Table C406.1.2 based on building occupancy group and climate zone.

This section allows the number of credits to be reduced by any carryover energy efficiency credits in Section C406.2

TABLE C406.1.2—RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

BUILDING OCCUPANCY GROUP	CLIMATE ZONE																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4 and I-1	34	37	31	46	48	56	49	56	38	31	42	32	26	33	34	23	27	25	25
I-2	23	24	25	25	25	28	26	30	22	25	32	24	25	28	29	26	28	22	20
R-1	30	28	35	30	34	36	34	37	41	32	37	27	28	33	32	25	29	22	18
B	38	39	45	42	45	49	47	56	57	44	55	42	38	47	46	38	45	38	31
A-2	8	8	9	9	8	9	9	11	13	8	11	9	8	10	9	8	9	8	3
M	32	32	42	37	39	47	44	58	57	42	54	46	38	48	5	42	45	38	34
E	27	34	38	37	39	47	44	58	57	42	54	46	38	48	50	42	45	38	34
S-1 and S-2	89	90	90	90	90	90	90	90	90	90	90	90	70	90	90	84	86	71	54
All other	35	39	46	42	46	52	49	56	56	40	52	42	37	44	44	36	39	32	28

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.2 Additional energy efficiency credits achieved.

Based on Building Use Group and Climate Zone, there are Energy Credit Measures that you can choose from to achieve the required number of credits.

Not all are available in every climate zone

Section C406 Additional Efficiency, Renewable and Load Management

TABLE C406.2(7)—BASE ENERGY CREDITS FOR GROUP E OCCUPANCIES[a]

ID	ENERGY CREDIT MEASURE	SECTION	CLIMATE ZONE																	
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	8	18	7	19	12	13	20	17	11	24	20	17	33	32	29	40	38	46	44
E03	Reduced air leakage	C406.2.1.3	4	3	3	3	2	5	2	1	1	1	1	1	1	1	1	2	1	1	1
E04	Add roof insulation	C406.2.1.4	8	8	4	9	5	7	16	7	1	14	7	10	18	13	13	23	25	22	28
E05	Add wall insulation	C406.2.1.5	5	7	4	8	3	6	8	6	2	6	3	6	5	5	6	7	6	7	8
E06	Improve fenestration	C406.2.1.6	8	10	6	9	11	11	15	9	1	16	8	15	22	18	19	33	29	19	18
H01	HVAC performance	C406.2.2.1	30	28	25	26	23	21	20	18	15	19	18	17	19	20	15	23	20	25	29
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	4	3	3	5	5	10	9	11	6	15	11	18	26
H03	Cooling efficiency	C406.2.2.3	9	8	6	7	5	4	2	2	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	45	42	37	41	36	34	41	39	30	43	46	58	57	65	40	79	63	88	117
W01	SHW preheat recovery	C406.2.3.1 a	7	7	9	8	10	11	13	13	15	14	15	15	15	14	17	13	15	14	12
W02	Heat pump water heater	C406.2.3.1 b	4	4	6	5	7	7	9	9	10	10	10	11	11	10	12	10	11	10	9
W03	Efficient gas water heater	C406.2.3.1 c	4	4	6	5	6	7	8	8	9	9	9	10	9	9	11	8	10	9	7
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	5	6	5	5	6	5	5	7	4	5	4	4
W05	Point of use water heaters	C406.2.3.3 a	3	4	4	4	4	5	5	5	6	5	5	5	5	5	6	4	5	4	3
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	2	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	6	7	6	6	7	6	6	8	5	7	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	2	2	2	2	3	3	3	3	4	3	3	4	3	3	4	3	3	3	3
P01	Energy monitoring	C406.2.4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
L01	Lighting performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	6	6	6	5	6	7	6	6	6	5	5	6	4	4	3	2
L03	Increase occp. sensor	C406.2.5.3	4	4	5	5	5	6	6	6	7	6	6	5	4	4	5	3	4	3	2
L04	Increase daylight area	C406.2.5.4	6	6	7	7	7	7	7	7	8	6	6	6	5	5	6	5	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.6	6	7	7	7	8	8	8	8	10	7	8	7	6	7	8	5	6	4	2
Q01	Efficient elevator	C406.2.6.1	3	4	4	4	4	5	5	5	5	5	5	5	5	5	5	4	5	4	3
Q02	Commercial kitchen equip.	C406.2.6.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.6.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.6.4	4	4	4	4	3	3	3	3	2	3	3	3	3	3	2	4	3	4	4

DOAS = Dedicated Outside Air System; HVAC = Heating, Ventilation and Air Conditioning; SHW = Service Hot Water; UA = *U*-Factor × Area.

a. "x" indicates measure is not available in that climate zone for that measure.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.2 Additional energy efficiency credits achieved.

6 “categories”

- C406.2.1 More efficient building thermal envelope
- C406.2.2 More efficient HVAC equipment performance.
- C406.2.3 Reduced energy use in service water heating.
- C406.2.4 P01 Energy monitoring.
- C406.2.5 Energy savings in lighting systems.
- C406.2.6 Efficient equipment credits.

Multiple credits in each category

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.2 Additional energy efficiency credits achieved.

C406.2.1 More efficient building thermal envelope

- C406.2.1.1 E01 Improved envelope performance ASHRAE 90.1 Appendix C.
- C406.2.1.2 E02 Component performance envelope reduction.
- C406.2.1.3 E03 Reduced air leakage.
- C406.2.1.4 E04 Added roof insulation.
- C406.2.1.5 E05 Added wall insulation.
- C406.2.1.6 E06 Improve fenestration.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.2 Additional energy efficiency credits achieved.

C406.2.2 More efficient HVAC equipment performance.

- C406.2.2.1 H01 HVAC Total System Performance Ratio (TSPR).
- C406.2.2.2 H02 More efficient HVAC equipment heating performance.
- C406.2.2.3 H03 More efficient HVAC cooling equipment and fan performance.
- C406.2.2.4 H04 Residential HVAC control.
- C406.2.2.5 H05 Dedicated outdoor air system.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.2 Additional energy efficiency credits achieved.

C406.2.3 Reduced energy use in service water heating.

C406.2.3.1 Service water heating system efficiency.

C406.2.3.1.1 W01 Recovered or renewable water heating.

C406.2.3.1.2 W02 Heat pump water heater.

C406.2.3.1.3 W03 Efficient fossil fuel water heater.

C406.2.3.2 W04 Service hot water piping insulation increase.

C406.2.3.3 Service water-heating distribution temperature maintenance.

W05 Point of use water heaters.

W06 Thermostatic balancing valves.

W07 Heat trace system.

C406.2.3.4 W08 Water-heating system submeters.

C406.2.3.5 W09 Service hot water flow reduction.

C406.2.3.6 W10 Shower drain heat recovery.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.2 Additional energy efficiency credits achieved.

- C406.2.4 P01 Energy monitoring.
- C406.2.5 Energy savings in lighting systems.
  - C406.2.5.1 L01 Lighting system performance (reserved).
  - C406.2.5.2 L02 High-end trim lighting controls.
  - C406.2.5.3 L03 Increase occupancy sensor.
  - C406.2.5.4 L04 Increased daylight area.
  - C406.2.5.5 L05 Residential light control.
  - C406.2.5.6 L06 Reduced lighting power.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.2 Additional energy efficiency credits achieved.

C406.2.6 Efficient equipment credits.

- C406.2.6.1 Q01 Efficient elevator equipment.
- C406.2.6.2 Q02 Efficient commercial kitchen equipment.
- C406.2.6.3 Q03 Efficient residential kitchen equipment.
- C406.2.6.4 Q04 Fault detection and diagnostics system.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.3 Renewable and load management credits achieved.

Similar to C406.2, available credits are based on building occupancy group and climate zone.

Not all are available in every climate zone

Section C406 Additional Efficiency, Renewable and Load Management

TABLE C406.3(7)—RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP E OCCUPANCIES

ID	ENERGY CREDIT ABBREVIATED TITLE	SECTION	CLIMATE ZONE																
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	Renewable energy	C406.3.1	10	11	13	12	13	16	15	21	22	15	19	15	14	17	16	13	16	12	10
G01	Lighting load management	C406.3.2	7	12	12	13	13	15	14	16	13	12	16	16	10	14	18	16	13	14	14
G02	HVAC load management	C406.3.3	18	22	32	23	25	31	26	26	20	23	31	24	20	31	12	18	27	16	9
G03	Automated shading	C406.3.4	7	13	16	12	18	17	17	18	13	12	17	17	10	15	13	14	10	16	17
G04	Electric energy storage	C406.3.5	16	16	18	17	19	21	21	23	26	22	24	24	23	24	24	20	22	19	19
G05	Cooling energy storage	C406.3.6	36	9	46	21	36	32	39	62	39	24	37	22	20	28	13	16	31	3	4
G06	SHW energy storage	C406.3.7	5	5	6	5	6	6	7	7	8	7	7	8	7	7	8	7	7	7	6
G07	Building thermal mass	C406.3.8	7	2	11	5	17	28	23	27	63	21	44	48	37	60	38	31	50	47	21

HVAC = Heating, Ventilation and Air Conditioning; SHW = Service Hot Water.
x = Credits excluded from this building use type and climate zone.

Section C406 Additional Efficiency, Renewable and Load Management

Chapter 4: Commercial Energy Efficiency

C406 Additional Efficiency, Renewable and Load Management Requirements

C406.3 Renewable and load management credits achieved.

- C406.3.1 R01 Renewable energy.
- C406.3.2 G01 Lighting load management.
- C406.3.3 G02 HVAC load management.
- C406.3.4 G03 Automated shading load management.
- C406.3.5 G04 Electric energy storage.
- C406.3.6 G05 Cooling energy storage.
- C406.3.7 G06 Service hot water energy storage.
- C406.3.8 G07 Building thermal mass.

Section C406 Additional Efficiency, Renewable and Load Management

- C406.1.1 Additional energy efficiency credit requirements.
  - Buildings shall comply with measures from Section C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1(1) based on building occupancy group and climate zone. Where a project contains multiple occupancies, the total required energy credits from each building occupancy shall be weighted by the gross conditioned floor area to determine the weighted-average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for the purposes of Section C406.
  - Exceptions:
    - Portions of buildings devoted to manufacturing or industrial use.
    - Where a building achieves more renewable and load management credits in Section C406.3 than are required in C406.1.2, surplus credits shall be permitted to reduce the required energy efficiency credits per equation

Section C406 Additional Efficiency, Renewable and Load Management

TABLE C406.1.1(1)—ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

BUILDING OCCUPANCY GROUP	CLIMATE ZONE																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4 and I-1	65	66	67	77	80	86	80	81	90	86	90	90	86	90	90	70	89	80	78
I-2	43	42	38	37	36	38	32	32	30	36	36	35	43	43	44	46	47	50	53
R-1	63	62	66	65	70	71	77	80	84	81	83	88	85	86	90	83	87	87	85
B	62	62	64	66	66	65	64	64	68	70	72	74	71	73	77	71	74	74	71
A-2	70	70	72	72	75	75	70	73	82	69	74	78	67	72	78	60	67	57	51
M	80	79	83	79	81	84	67	74	87	80	66	65	79	62	50	75	67	75	58
E	56	57	55	58	58	57	59	62	59	61	66	62	64	67	67	65	67	63	58
S-1 and S-2	61	60	61	60	58	57	44	54	62	85	68	75	90	82	72	90	89	90	90
All other	31	31	31	32	32	33	30	32	36	35	35	35	37	36	36	36	37	36	34

TABLE C406.1.1(2)—LIMIT TO ENERGY EFFICIENCY CREDIT CARRYOVER FROM RENEWABLE AND LOAD MANAGEMENT CREDITS

BUILDING OCCUPANCY GROUP	CLIMATE ZONE																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4 and I-1	5	5	5	5	5	5	5	24	19	5	22	18	5	5	19	5	5	5	5
I-2	16	14	11	8	6	5	5	10	6	8	14	10	17	26	29	21	21	22	39
R-1	7	5	8	5	19	5	32	40	41	24	41	42	17	37	41	5	24	15	22
B	7	5	5	8	6	6	14	26	31	23	39	34	19	35	45	5	19	17	27
A-2	18	16	14	15	13	9	11	23	32	5	23	23	5	5	26	5	5	5	5
M	5	5	5	5	5	5	5	5	20	5	5	5	5	5	5	5	5	5	5
E	13	13	18	16	17	14	21	35	40	25	43	29	23	32	27	11	17	25	5
S-1 and S-2	5	5	5	5	5	5	5	5	13	5	17	20	5	35	23	5	5	11	40
All other	5	5	5	5	5	5	5	7	17	5	10	7	5	6	11	5	5	5	5

Section C406 Additional Efficiency, Renewable and Load Management

TABLE C406.1.2—RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

BUILDING OCCUPANCY GROUP	CLIMATE ZONE																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4 and I-1	34	37	31	46	48	56	49	56	38	31	42	32	26	33	34	23	27	25	25
I-2	23	24	25	25	25	28	26	30	22	25	32	24	25	28	29	26	28	22	20
R-1	30	28	35	30	34	36	34	37	41	32	37	27	28	33	32	25	29	22	18
B	38	39	45	42	45	49	47	56	57	44	55	42	38	47	46	38	45	38	31
A-2	8	8	9	9	8	9	9	11	13	8	11	9	8	10	9	8	9	8	3
M	32	32	42	37	39	47	44	58	57	42	54	46	38	48	5	42	45	38	34
E	27	34	38	37	39	47	44	58	57	42	54	46	38	48	50	42	45	38	34
S-1 and S-2	89	90	90	90	90	90	90	90	90	90	90	90	70	90	90	84	86	71	54
All other	35	39	46	42	46	52	49	56	56	40	52	42	37	44	44	36	39	32	28

Section C406 Additional Efficiency, Renewable and Load Management

TABLE C406.2(4)—BASE ENERGY CREDITS FOR GROUP B OCCUPANCIES[a]

ID	ENERGY CREDIT MEASURE	SECTION	CLIMATE ZONE																	
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	7	8	3	6	5	3	7	[illegible]	1	13	4	8	21	15	11	13	24	37	43
E03	Reduced air leakage	C406.2.1.3	5	3	4	2	2	2	5	1	x	8	x	2	13	4	x	18	9	18	7
E04	Add roof insulation	C406.2.1.4	2	2	2	2	2	2	3	2	1	3	1	2	3	2	2	3	3	2	3
E05	Add wall insulation	C406.2.1.5	13	14	8	11	4	4	7	4	1	5	2	4	6	4	3	9	7	10	8
E06	Improve fenestration	C406.2.1.6	5	5	4	5	7	7	8	2	1	8	2	4	10	5	1	21	17	10	9
H01	HVAC performance	C406.2.2.1	22	22	19	20	17	17	15	15	11	15	15	11	16	15	11	19	17	18	20
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	1	1	1	3	2	2	5	4	3	9	7	8	12
H03	Cooling efficiency	C406.2.2.3	7	6	4	5	3	3	1	2	1	1	2	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	31	31	27	29	25	25	28	26	18	35	28	28	47	38	29	64	53	58	74
W01	SHW preheat recovery	C406.2.3.1 a	8	9	10	9	11	11	12	12	14	13	13	14	13	13	15	12	13	14	14
W02	Heat pump water heater	C406.2.3.1 b	3	3	3	3	4	4	5	4	5	5	5	6	5	5	6	5	5	6	6
W03	Efficient gas water heater	C406.2.3.1 c	5	5	6	6	7	7	8	7	8	8	8	9	8	8	9	8	8	9	8
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	4	5	4	4	5	4	4	5	4	4	4	4
W05	Point of use water heaters	C406.2.3.3 a	12	15	17	16	18	18	19	19	22	20	20	22	20	20	22	18	19	20	19
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	5	6	5	5	6	5	5	6	5	5	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
L01	Lighting performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	6	6	6	6	6	6	7	6	6	6	5	5	6	4	5	3	2
L03	Increase occp. sensor	C406.2.5.3	5	6	6	6	6	6	6	6	8	6	6	6	5	5	6	4	5	4	3
L04	Increase daylight area	C406.2.5.4	7	7	8	8	8	8	8	8	9	6	7	7	6	6	6	6	6	7	5
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.6	7	7	8	8	8	8	8	8	9	7	8	8	6	7	8	5	6	5	3
Q01	Efficient elevator	C406.2.6.1	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	4	5	4	4
Q02	Commercial kitchen equip.	C406.2.6.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.6.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.6.4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	3	3	3	3

DOAS = Dedicated Outside Air System; HVAC = Heating, Ventilation and Air Conditioning; SHW = Service Hot Water; UA = U-Factor × Area.

a. "x" indicates credit is not available in that climate zone for that measure.

Section C407 Simulated Building Performance Compliance Method

- 2024: C407.2 Mandatory requirements. Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.

2. **An annual energy cost that is less than or equal to ~~80 percent of the annual energy cost of the standard reference design.~~ the percentage of the annual energy cost (PAEC) of the standard reference design calculated in Equation 4-34.** Energy prices shall be taken from a source approved by the code official, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permit-ted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with on-site renewable energy shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the standard reference design and the proposed design.

Exceptions:

1. Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

2. Where energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area is substituted for the energy cost, the energy use shall be calculated using source energy factors from Table C407.2(2). For electricity, US locations shall use values from eGRID subregions. Locations outside the United States shall use the value for "All other electricity" or locally derived values.

Section C407 Simulated Building Performance Compliance Method

- Example: Percentage of Annual Energy Cost Example

For compliance with the Simulated Building Performance compliance option, determine the annual energy cost required for the proposed design of a 3,200 ft 2 office building in Climate Zone 5C. The annual energy cost of the proposed design must be less than or equal to the percentage of the annual energy cost (PAEC) of the standard reference design.

- Equation 4-34 PAEC 100 (0.80 0.025 ECr/1,000)
- A 3,200 ft 2 office building (B Occupancy) in Climate Zone 5C requires 77 energy credits (see Table C406.1.1(1)).
- PAEC 100 (0.80 0.025 - **77**/1,000)
- PAEC 74.8
- The annual energy cost of the proposed design of a 3,200 ft 2 office building in Climate Zone 5C must have an annual energy cost less than or equal to **74.8%** of the annual energy cost of the standard reference design.

TABLE C407.2(1)—REQUIREMENTS FOR SIMULATED BUILDING PERFORMANCE	
SECTION[a]	**TITLE**
Envelope	
C401.3	*Building thermal envelope* certificate
C402.2.1.1	Joints staggered
C402.2.1.2	Skylight curbs
C402.2.6	Insulation of radiant heating system panels
C402.6	Air leakage—*building 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
C403.4.1	Thermostatic controls
C403.4.2	Off-hour controls
C403.4.7	Heating and cooling system controls for operable openings to the outdoors
C403.5.5	Economizer fault detection and diagnostics

Removed heating and cooling system controls

TABLE C407.2(1)—REQUIREMENTS FOR SIMULATED BUILDING PERFORMANCE—continued	
SECTION[a]	**TITLE**
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
C403.12, except C403.12.3	Refrigeration equipment performance
C403.13	Construction of HVAC system elements
C403.14	Mechanical systems located outside of the *building thermal envelope*
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C406.1.2	Additional renewable and load management credit requirements
C408	Maintenance information and system commissioning
a. Reference to a code section includes all the relative subsections except as indicated in the table.	

Multiple updates to section numbers

TABLE C407.2(2)—SOURCE ENERGY CONVERSION FACTORS FOR ELECTRICITY	
SOURCE ENERGY	**CONVERSION FACTOR**
Fossil Fuels Delivered to Buildings	
Natural gas	1.092
LPG or propone	1.151
Fuel oil (residual)	1.191
Fuel oil (distillate)	1.158
Coal	1.048
Gasoline	1.187
Other fuels not specified in this table	1.048
Electricity	
NEWE-NPCC New England	2.66
Thermal Energy	
Chilled water	0.60
Steam	1.84
Hot water	1.73

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

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Service water heating[e]	Fuel type: same as proposed	As proposed
	Efficiency: as specified in Table C404.2	For Group R, as proposed multiplied by SWHF. For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed	As proposed
	Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	
Energy recovery	Where the proposed design specifies mechanical ventilation, as specified in Section C403.7.4 based on the standard reference design airflows.	As proposed
	Where the proposed design specifies natural ventilation, as proposed.	
Fan power	As specified in Section C403.8 for the proposed design. **Exceptions:** 1. Where the fan power of the proposed design is exempted from the requirements of Section C403.8, as proposed. 2. Fan systems addressed by Section C403.8.1: fan system BHP shall be as proposed or to the limits specified in Section C403.8.1, whichever is smaller. If the limit is reached, the power of each fan shall be reduced proportionally until the limit is met. 3. Fan systems serving areas where the mechanical ventilation is provided in accordance with an engineered ventilation system design of Section 403.2 of the *International Mechanical Code* shall not use the particulate filtration or air cleaner pressure drop adjustment available in Table C403.8.1(1) when calculating the fan system BHP limit for the portion of the airflow being treated to comply with the engineered ventilation system design.	As proposed

On-site renewable energy	Where a system providing on-site renewable energy has been modeled in the proposed design, the same system shall be modeled identically in the standard reference design except the rated capacity shall meet the requirements of Section C405.15.1 Where no system is designed or included in the proposed design, model an unshaded photovoltaic system with the following characteristics: Size: rated capacity per Section C405.15.1. Module type: crystalline silicone panel with glass cover, 19.1% nominal efficiency and temperature coefficient of -0.35%/°C. Performance shall be based on a reference temperature of 77°F (25°C), air mass of 1.5 atmosphere and irradiance of 317 Btu/h × ft^2 (1000 W/m^2). Array type: rack-mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C). Total system losses (DC output to AC output): 11.3%. Tilt: 0 degrees (mounted horizontally). Azimuth: 180 degrees.	As proposed

Section C407 Simulated Building Performance Compliance Method

- C407.5.1.2 Testing required by software vendors. Prior to approval, software tools shall be tested by the software vendor in accordance with ASHRAE Standard 140, except Sections 7 and 8. During testing, hidden inputs that are not normally available to the user shall be permitted to avoid introducing source code changes strictly used for testing. Software vendors shall publish, on a publicly available website, the following ASHRAE Standard 140 test results, input files and modeler reports for each tested version of a software tool:

1. Test results that demonstrate the software tool was tested in accordance with ASHRAE Standard 140 and that meet or exceed the values for “The Minimum Number of Range Cases within the Test Group to Pass” for all test groups in ASHRAE Standard 140, Table A3-14.

2. Test results of the performance analysis tool and input files used for generating the ASHRAE Standard 140 test cases along with the results of the other performance analysis tools included in ASHRAE Standard 140, Annexes B8 and B16.

3. The modeler report in ASHRAE Standard 140, Annex A2, Attachment A2.7, Report Blocks A and G shall be completed for results exceeding the maximum or falling below the minimum of the reference values shown in ASHRAE Standard 140, Tables A3-1 through A3-13, and Report Blocks A and E shall be completed for any omitted results.

Section C407 Simulated Building Performance Compliance Method

- C407.5.2 Algorithms not tested. Algorithms not tested in accordance with Section C407.5.1.2, including algorithms that are alternatives to those that were tested, and numerical settings not tested, such as time steps and tolerances, shall be permitted to be used where modeling the proposed design and standard reference design.

Section C408 Maintenance Information & Systems Commissioning

- C408.2 Mechanical Systems and Service Water Heating Systems Commissioning and Completion Requirements
  - Exception has changed
    - 2021 IECC was less than 480 MBH Cooling and 600 MBH Heating
    - Revised to Buildings with less than 10,000 square feet gross conditioned floor area and combined heating, cooling and service water heating capacity of less than 960,000 Btu/h (281 kW)

Section C409 - Calculation of The HVAC Total System Performance Ratio

- **Total System Performance Ratio (TSPR)** as a compliance metric for HVAC systems.
  - Instead of evaluating individual components (like chillers, boilers, fans) separately, TSPR measures the **overall efficiency of the entire HVAC system** in delivering heating, cooling, and ventilation over a typical year.
  - **Reason for Addition:**
    - Traditional prescriptive paths and component-level efficiency ratings (COP, EER, SEER) do not fully capture real-world system performance.
    - Whole-building performance modeling (like C407) is accurate but **complex, costly, and time-intensive**.
    - TSPR provides a **simpler, system-level performance approach** that encourages integrated design and better energy outcomes without requiring full building energy modeling.

Section C409 - Calculation of The HVAC Total System Performance Ratio

- Compliance – HVAC Systems must meet certain Section C403 requirements
- Performance Target
  - TSPR of Proposed System ≥ TSPR of Standard Reference System

TABLE C409.4—MECHANICAL PERFORMANCE FACTORS

BUILDING USE	OCCUPANCY GROUP	CLIMATE ZONE																	
		0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Office (all others)[a]	B	0.72	0.715	0.70	0.705	0.685	0.65	0.71	0.68	0.645	0.805	0.70	0.78	0.845	0.765	0.805	0.865	0.835	0.875	0.895
Office (large)[a]	B	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.81	0.77	0.67	0.76	0.63	0.71	0.72	0.63	0.73	0.71	0.71	0.71
Retail	M	0.60	0.57	0.50	0.55	0.46	0.46	0.43	0.51	0.40	0.45	0.57	0.68	0.46	0.68	0.67	0.50	0.45	0.44	0.38
Hotel/motel	R-1	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.45	0.59	0.52	0.38	0.47	0.51	0.35	0.38	0.31	0.26
Multi-family/ dormitory	R-2	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.72	0.55	0.53	0.50	0.44	0.54	0.47	0.38	0.55	0.50	0.51	0.47
School/ education and libraries	E (A-3)	0.82	0.81	0.80	0.79	0.75	0.72	0.71	0.72	0.67	0.73	0.72	0.68	0.82	0.73	0.61	0.89	0.80	0.83	0.77

a. Large-office conditioned floor area greater than 150,000 square feet or more than five stories.

  - Simulation Tools tested per ASHRAE Standard 140
  - Specific Documentation Requirements

Section C409 - Calculation of The HVAC Total System Performance Ratio

TABLE C409.6.1.10.1—PROPOSED BUILDING HVAC SYSTEMS SUPPORTED BY HVAC TSPR SIMULATION SOFTWARE	
SYSTEM NO.	**SYSTEM NAME**
1	Packaged terminal air conditioner (with electric or hydronic heat)
2	Packaged terminal air heat pump
3	Packaged single-zone gas furnace[a] and/or air-cooled air conditioner (includes split systems)[b]
4	Packaged single-zone heat pump (air to air only)(includes split systems[b] and electric or gas supplemental heat)
5	Variable refrigerant flow (air cooled only)
6	Four pipe fan coil
7	Water-source heat pump (water loop), water-source *variable refrigerant flow system* or water-source air conditioner
8	Ground source heat pump
9	Packaged variable air volume (DX cooling)[a]
10	Variable air volume (hydronic cooling)[a]
11	Variable air volume with fan-powered terminal units
12	Dedicated outdoor air system (in conjunction with systems 1–8)

a. Reheat or primary heat may be electric, hydronic or gas furnace.
b. Condensing units with DX air handlers are modeled as package furnaces with air conditioners or heat pumps.

Section C409 - Calculation of The HVAC Total System Performance Ratio

C409.2.1 Systems not permitted. The following HVAC systems are not permitted to use Section C403.1, Item 3:

1. HVAC systems using:
   - 1.1. District heating water, chilled water or steam.
   - 1.2. Small-duct high-velocity air-cooled, space-constrained air-cooled, or single-package vertical air conditioner; single-package vertical heat pump; or double-duct air conditioner or double-duct heat pump, as defined in subpart F to 10 CFR Part 431.
   - 1.3. Packaged terminal air conditioners and packaged terminal heat pumps that have a cooling capacity greater than 12,000 Btu/h (3.5 kW).
   - 1.4. A common heating source serving both HVAC and *service water heating* equipment.
2. HVAC systems that provide recovered heat for *service water heating.*
3. HVAC systems not specified in Table C409.6.1.10.1.
4. HVAC systems specified in Table C409.6.1.10.1 with characteristics or parameters in Table C409.6.1.10.2(1), not identified as applicable to that HVAC system type.
5. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water-to-water heat pumps, air-to-water heat pumps, or a combination of air- and water-cooled chillers on the same chilled water loop.
6. HVAC systems served by heating water systems that include air-to-water or water-to-water heat pumps.
7. Underfloor air distribution and displacement ventilation HVAC systems.
8. Space-conditioning systems that do not include mechanical cooling.
9. HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, *data centers* and *computer rooms*.
10. *Buildings* or areas of medical office buildings required to use ASHRAE Standard 170.
11. *Buildings* or areas that are required by regulation to have continuous air-handling unit operation.
12. HVAC systems serving laboratories with fume hoods.
13. Locker rooms with more than two showers.
14. Natatoriums and rooms with saunas.
15. Restaurants and commercial kitchens with a total cooking capacity greater than 100,000 Btu/h (29 kW).
16. Areas of *buildings* with commercial refrigeration equipment exceeding 100 kW of power input.
17. Cafeterias and dining rooms

Section C409 - Calculation of The HVAC Total System Performance Ratio

How does C409 differ from C407 (Simulated Building Performance)?

Aspect	Section C407 – Simulated Building Performance	Section C409 – HVAC TSPR
Scope	Whole building energy performance	HVAC system performance only
Metric	Annual **energy cost** (or site/source energy) compared to a reference building	Ratio of annual HVAC system energy use to delivered heating/cooling loads
Method	Requires **full energy modeling** of the proposed design and a baseline reference design	Requires **system-level modeling** using a simplified tool (e.g., TSPR calculator)
Trade-offs	Allows trade-offs between envelope, lighting, HVAC, etc.	Trade-offs **within HVAC system design only**
Complexity	High – involves defining thermal blocks, schedules, internal gains, etc.	Lower – focuses on HVAC system configuration and performance
Use Case	Best for projects seeking maximum flexibility across all building systems	Best for projects prioritizing HVAC efficiency without full building simulation

C407 = holistic, building-wide performance path (similar to ASHRAE 90.1 Energy Cost Budget Method).

C409 = targeted, HVAC-only performance metric that simplifies compliance while promoting integrated system efficiency

Chapter 5 – Existing Buildings

- C502.3.7 Additional Energy Efficiency Credit Requirements
  - Additions must achieve not less than 50% of required efficiency credits from Table C406.1.1(1)
  - Exceptions:
    - Groups U, S, F and H
    - Less than 1000 SF and less than 50% of existing floor area
    - Additions without new equipment listed in equipment tables
    - Additions do not increase conditioned space
    - Where the addition or the addition AND the building together comply with C407