FINAL PROPOSED RULE # _______.

Final Proposed Filing - Coversheet

Instructions:

In accordance with Title 3 Chapter 25 of the Vermont Statutes Annotated and the "Rule on Rulemaking" adopted by the Office of the Secretary of State, this filing will be considered complete upon filing and acceptance of these forms with the Office of the Secretary of State, and the Legislative Committee on Administrative Rules.

All forms shall be submitted at the Office of the Secretary of State, no later than 3:30 pm on the last scheduled day of the work week.

The data provided in text areas of these forms will be used to generate a notice of rulemaking in the portal of "Proposed Rule Postings" online, and the newspapers of record if the rule is marked for publication. Publication of notices will be charged back to the promulgating agency.

PLEASE REMOVE ANY COVERSHEET OR FORM NOT REQUIRED WITH THE CURRENT FILING BEFORE DELIVERY!

Certification Statement: As the adopting Authority of this rule (see 3 V.S.A. § 801 (b) (11) for a definition), I approve the contents of this filing entitled:

Vermont Commercial Building Energy Standards (CBES) Amendments

/s/ June E. Tierney , on 5/2/23
(signature) (date)

Printed Name and Title:
June E. Tierney, Commissioner, Vermont Department of Public Service

RECEIVED BY: ________

- ☐ Coversheet
- ☐ Adopting Page
- ☐ Economic Impact Analysis
- ☐ Environmental Impact Analysis
- ☐ Strategy for Maximizing Public Input
- ☐ Scientific Information Statement (if applicable)
- ☐ Incorporated by Reference Statement (if applicable)
- ☐ Clean text of the rule (Amended text without annotation)
- ☐ Annotated text (Clearly marking changes from previous rule)
- ☐ ICAR Minutes
- ☐ Copy of Comments
- ☐ Responsiveness Summary

1. TITLE OF RULE FILING:
   Vermont Commercial Building Energy Standards (CBES) Amendments
2. PROPOSED NUMBER ASSIGNED BY THE SECRETARY OF STATE
   22P029
3. ADOPTING AGENCY:
   Department of Public Service
4. PRIMARY CONTACT PERSON:
   (A PERSON WHO IS ABLE TO ANSWER QUESTIONS ABOUT THE CONTENT OF THE RULE).

   Name: Barry Murphy

   Agency: Department of Public Service

   Mailing Address: 112 State Street, Montpelier, VT 05620

   Telephone: 802-828-318 Fax:

   E-Mail: barry.murphy@vermont.gov

   Web URL *(WHERE THE RULE WILL BE POSTED)*:
   http://publicservice.vermont.gov/content/building-energy-standards-update
5. SECONDARY CONTACT PERSON:
   (A SPECIFIC PERSON FROM WHOM COPIES OF FILINGS MAY BE REQUESTED OR WHO MAY ANSWER QUESTIONS ABOUT FORMS SUBMITTED FOR FILING IF DIFFERENT FROM THE PRIMARY CONTACT PERSON).

   Name: Ben Civiletti

   Agency: Department of Public Service

   Mailing Address: 112 State Street, Montpelier, VT 05620

   Telephone: 802-622-4388 Fax:

   E-Mail: benjamin.civiletti@vermont.gov
6. RECORDS EXEMPTION INCLUDED WITHIN RULE:
   (DOES THE RULE CONTAIN ANY PROVISION DESIGNATING INFORMATION AS CONFIDENTIAL; LIMITING ITS PUBLIC RELEASE; OR OTHERWISE, EXEMPTING IT FROM INSPECTION AND COPYING?) No

   IF YES, CITE THE STATUTORY AUTHORITY FOR THE EXEMPTION:

   PLEASE SUMMARIZE THE REASON FOR THE EXEMPTION:
7. LEGAL AUTHORITY / ENABLING LEGISLATION:

(THE SPECIFIC STATUTORY OR LEGAL CITATION FROM SESSION LAW INDICATING WHO THE ADOPTING ENTITY IS AND THUS WHO THE SIGNATORY SHOULD BE. THIS SHOULD BE A SPECIFIC CITATION NOT A CHAPTER CITATION).

30 V.S.A. § 53 COMMERCIAL BUILDING ENERGY STANDARDS

8. EXPLANATION OF HOW THE RULE IS WITHIN THE AUTHORITY OF THE AGENCY:

   In accordance with 30 V.S.A. § 53(c), the Commissioner of the Department of Public Service is required to amend and update the Commercial Building Energy Standards (CBES)through administrative rules.

9. THE FILING HAS CHANGED SINCE THE FILING OF THE PROPOSED RULE.

10. THE AGENCY HAS INCLUDED WITH THIS FILING A LETTER EXPLAINING IN DETAIL WHAT CHANGES WERE MADE, CITING CHAPTER AND SECTION WHERE APPLICABLE.

11. SUBSTANTIAL ARGUMENTS AND CONSIDERATIONS WERE NOT RAISED FOR OR AGAINST THE ORIGINAL PROPOSAL.

12. THE AGENCY HAS NOT INCLUDED COPIES OF ALL WRITTEN SUBMISSIONS AND SYNOPSES OF ORAL COMMENTS RECEIVED.

13. THE AGENCY HAS NOT INCLUDED A LETTER EXPLAINING IN DETAIL THE REASONS FOR THE AGENCY'S DECISION TO REJECT OR ADOPT THEM.

14. CONCISE SUMMARY (**150 WORDS OR LESS**):

    This proposed rule amends the existing Vermont Commercial Building Energy Standards (CBES), last updated in 2020. The amendments reduce energy use in commercial buildings and improve efficiency of building operations by regulating the design of building envelopes for adequate thermal resistance and low air leakage and the design and selection of mechanical, ventilation, electrical, service water- heating and illumination systems and equipment which will enable effective use of energy in commercial building construction. This will reduce costs of operation while improving efficiency, reducing greenhouse gas emissions, and enhancing the internal environment of a building.

15. EXPLANATION OF WHY THE RULE IS NECESSARY:

The rule is necessary to achieve the effective utilization of energy in commercial buildings. Per 30 V.S.A. § 53(c), the Commissioner of the Department of Public Service is required to amend the commercial building energy standards after the issuance of updated standards for commercial construction under the International Energy Conservation Code (IECC).

16. EXPLANATION OF HOW THE RULE IS NOT ARBITRARY:

The CBES are based on the 2018 and 2021 International Energy Conservation Code (IECC), and are reviewed and commented on by an Advisory Committee made up of Vermont builders, architects, Energy Efficiency Utilities, multi-family housing developers, and low-income housing advocates.

17. LIST OF PEOPLE, ENTERPRISES AND GOVERNMENT ENTITIES AFFECTED BY THIS RULE:

The Department of Public Safety (DPS), State Historic Preservation Office (SHPO)/Agency of Commerce and Community Development (ACCD), Agency of Human Services (AHS) Office of Economic Opportunity (OEO), Act 250 Commissions, commercial builders, owners and operators, tenants, commercial building designers, architects, mechanical designers, lighting designers and municipalities.

18. BRIEF SUMMARY OF ECONOMIC IMPACT (150 WORDS OR LESS):

This rule represents the latest in a series of updates to the Vermont Commercial Building Energy Standards (CBES)that have been in effect for all commercial building construction since 2007; the last update took effect in 2020. Adoption of the rule will have cost impacts on the parties involved in new commercial construction, purchase, ownership, and existing commercial renovation. Though there will be an incremental increase in up-front costs, the investments will be cost-effective: the energy efficiency improvements will reduce energy costs and environmental impacts for the lifetime of the building, while enhancing indoor air quality. The incremental cost of the proposed rule, when compared to the 2020 CBES, ranges from approximately $0.35 - $1.30 per square foot and has a simple payback of 1.5 - 9.75 years and a return on investment (ROI) of 10.3 – 68.1%.

19. A HEARING WAS HELD.

20. HEARING INFORMATION
(THE FIRST HEARING SHALL BE NO SOONER THAN 30 DAYS FOLLOWING THE POSTING OF NOTICES ONLINE).

IF THIS FORM IS INSUFFICIENT TO LIST THE INFORMATION FOR EACH HEARING, PLEASE ATTACH A SEPARATE SHEET TO COMPLETE THE HEARING INFORMATION.

Date: 12/2/2022
Time: 10:00 AM
Street Address: VIRTUAL HEARING, MICROSOFT TEAMS
Zip Code:
URL for Virtual: https://teams.microsoft.com/l/meetup-join/19%3ameeting_ZTZkYWVhZjktOGFhNy00YjA0LTg2MmYtYTZmNTRhMWFmYzBl%40thread.v2/0?context=%7b%22Tid%22%3a%22f824a265-cbc1-4afc-accc-7191c2525f6d%22%2c%22Oid%22%3a%22d26bc85b-e562-4bc5-81ea-2a3b3911df03%22%7d.

Date:
Time: AM
Street Address:
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Street Address:
Zip Code:
URL for Virtual:

Date:
Time: AM
Street Address:
Zip Code:
URL for Virtual:

21. DEADLINE FOR COMMENT (NO EARLIER THAN 7 DAYS FOLLOWING LAST HEARING):

12/9/2022

KEYWORDS (PLEASE PROVIDE AT LEAST 3 KEYWORDS OR PHRASES TO AID IN THE SEARCHABILITY OF THE RULE NOTICE ONLINE).

commercial building energy standards

commercial energy code

CBES

Adopting Page

Instructions:

This form must accompany each filing made during the rulemaking process:

Note: To satisfy the requirement for an annotated text, an agency must submit the entire rule in annotated form with proposed and final proposed filings. Filing an annotated paragraph or page of a larger rule is not sufficient. Annotation must clearly show the changes to the rule.

When possible, the agency shall file the annotated text, using the appropriate page or pages from the Code of Vermont Rules as a basis for the annotated version. New rules need not be accompanied by an annotated text.

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1. TITLE OF RULE FILING:
   Vermont Commercial Building Energy Standards (CBES) Amendments
2. ADOPTING AGENCY:
   Department of Public Service
3. TYPE OF FILING (*PLEASE CHOOSE THE TYPE OF FILING FROM THE DROPDOWN MENU BASED ON THE DEFINITIONS PROVIDED BELOW*):
   - **AMENDMENT -** Any change to an already existing rule, even if it is a complete rewrite of the rule, it is considered an amendment if the rule is replaced with other text.
   - **NEW RULE -** A rule that did not previously exist even under a different name.
   - **REPEAL** - The removal of a rule in its entirety, without replacing it with other text.

   This filing is **AN AMENDMENT OF AN EXISTING RULE** .

4. LAST ADOPTED (*PLEASE PROVIDE THE SOS LOG#, TITLE AND EFFECTIVE DATE OF THE LAST ADOPTION FOR THE EXISTING RULE*):
   SOS LOG #:19-073
   Title: Commercial Building Energy Standards (CBES)
   Effective Date: 09/01/2020

Economic Impact Analysis

Instructions:

In completing the economic impact analysis, an agency analyzes and evaluates the anticipated costs and benefits to be expected from adoption of the rule; estimates the costs and benefits for each category of people enterprises and government entities affected by the rule; compares alternatives to adopting the rule; and explains their analysis concluding that rulemaking is the most appropriate method of achieving the regulatory purpose. If no impacts are anticipated, please specify "No impact anticipated" in the field.

Rules affecting or regulating schools or school districts must include cost implications to local school districts and taxpayers in the impact statement, a clear statement of associated costs, and consideration of alternatives to the rule to reduce or ameliorate costs to local school districts while still achieving the objectives of the rule (see 3 V.S.A. § 832b for details).

Rules affecting small businesses (excluding impacts incidental to the purchase and payment of goods and services by the State or an agency thereof), must include ways that a business can reduce the cost or burden of compliance or an explanation of why the agency determines that such evaluation isn't appropriate, and an evaluation of creative, innovative or flexible methods of compliance that would not significantly impair the effectiveness of the rule or increase the risk to the health, safety, or welfare of the public or those affected by the rule.

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1. TITLE OF RULE FILING:

   Vermont Commercial Building Energy Standards (CBES) Amendments

2. ADOPTING AGENCY:

   Department of Public Service

3. CATEGORY OF AFFECTED PARTIES:

   LIST CATEGORIES OF PEOPLE, ENTERPRISES, AND GOVERNMENTAL ENTITIES POTENTIALLY AFFECTED BY THE ADOPTION OF THIS RULE AND THE ESTIMATED COSTS AND BENEFITS ANTICIPATED:

   The substantive changes to be implemented by this rule in comparison with the existing rule are listed below along with their impacts on each category of affected parties.

Commercial Property Owners/Builders/Developers

Reduced energy use will result in monetary savings that accrue to the entity that pays the energy bills. That could be the owner, operator, tenants, or developer of the building. See Attachment A, Table 1: 2023 CBES Estimated Costs and Benefits.

The following are substantive changes that will affect commercial property owners, builders, designers, and developers:

1. Building Envelope

a. Wall and roof insulation efficiency are improved by 12.5% and 25% respectively, improving the comfort within a building and decreasing heating and cooling loads.

b. Air sealing was increased and envelope performance testing is required in most buildings. Air sealing reduces uncontrolled infiltration into the building, which causes uncomfortable drafts, mold growth, and building deterioration.

c. Window fenestration efficiency is improved by 14%, improving the comfort within a building and decreasing heating and cooling loads.

d. Requirement for under-slab insulation across the entire slab was removed and replaced with a requirement for 48” slab and footing insulation. Full under-slab insulation in buildings with a large footprint was not found to have sufficient energy savings to be cost-effective.

2. Mechanical Systems

a. Efficiencies meet federal standards and were not increased substantially.

3. Lighting

a. Lighting power density has decreased slightly, staying in line with the move toward LED light fixtures and controls. LED lighting is more efficient, has a longer lifetime, does not contain mercury, and is easier to use in dimming mode than fluorescent lighting. LED lights also do not produce as much heat, reducing the cooling load of a building.

4. Electrical Power

a. Most buildings require Electric Vehicle (EV) Level 2 charging stations and EV-ready parking spaces (electrical conduit) for a small number of parking places for most building types with more than 50 parking spaces.

Modifications to the proposed 2023 CBES rules since the Proposed Rule filing with the Secretary of State on 10/27/2022 were necessary due to recent modifications to the proposed 2023 RBES ("Residential Building Energy Standard"). As explained in the Final Proposed Rule filing for the 2023 RBES, these changes were necessary after the 2020 code reference home used in the cost-effectiveness model for comparison to the 2023 RBES was changed to better reflect a 2020 RBES-compliant home, and cost estimates were updated based on feedback from stakeholders. The proposed 2023 CBES are largely aligned with the proposed 2023 RBES regarding multifamily residential buildings: the RBES governs multifamily buildings with 3 floors or fewer, and the CBES governs multifamiy buildings with 4 floors or more. In order to maintain alignment with important elements for multifamily residential buildings between CBES and RBES, the following changes were implemented for CBES:

1) window U-factor requirements (changing from 0.27 back to the former 2020 RBES value of 0.30); and 2) wall U-factor requirements (changing from the proposed 0.033 back to 2020 CBES value of 0.042.

These changes resulted in a lowering of costs for Multifamily construction overall, as shown in Attachment A, Table 1.

4. IMPACT ON SCHOOLS:

INDICATE ANY IMPACT THAT THE RULE WILL HAVE ON PUBLIC EDUCATION, PUBLIC SCHOOLS, LOCAL SCHOOL DISTRICTS AND/OR TAXPAYERS CLEARLY STATING ANY ASSOCIATED COSTS:

A new 74,000 square foot Primary School building was modeled and analyzed with the new code standards. The incremental cost of building to the new standards is approximately $1.18 per square foot and has a simple payback of 6.24 years and a return on investment (ROI) of 16%. As the average life of the building is over 30 years and the mechanical and lighting is over 15 years, this is a very cost-effective investment that will extend the life of the building and be comfortable and healthy for its occupants.

5. ALTERNATIVES: *CONSIDERATION OF ALTERNATIVES TO THE RULE TO REDUCE OR AMELIORATE COSTS TO LOCAL SCHOOL DISTRICTS WHILE STILL ACHIEVING THE OBJECTIVE OF THE RULE.*

An alternative to this rule would be to adopt the 2021 International Energy Conservation Code (IECC) as is. This would result in fewer additional up-front costs as the efficiency measures are less stringent, but also significantly less energy savings (in terms of both efficiency and dollars) than the current 2020 CBES already adopted. This would also fail to address health and comfort issues addressed by the proposed modifications.

6. IMPACT ON SMALL BUSINESSES:
INDICATE ANY IMPACT THAT THE RULE WILL HAVE ON SMALL BUSINESSES (EXCLUDING IMPACTS INCIDENTAL TO THE PURCHASE AND PAYMENT OF GOODS AND SERVICES BY THE STATE OR AN AGENCY THEREOF):

Based on modeling of various commercial building prototypes, the incremental cost of the proposed rule, when compared to the 2020 CBES, ranges from approximately $0.35 - $1.30 per square foot and has a simple payback of 1.5 - 9.75 years and a return on investment (ROI) of 10.3 – 68.1%. As the average life of the building is over 30 years and the mechanical and lighting is over 15 years, this is a very cost-effective investment that will extend the life of the building and be comfortable and healthy for its occupants. These attributes increase the value of the property, reduce the monthly energy costs for the owner, operator, or tenants, and reduce maintenance costs. All these benefits are financially advantageous for a small business owner for the life of the building.

7. SMALL BUSINESS COMPLIANCE: *EXPLAIN WAYS A BUSINESS CAN REDUCE THE COST/BURDEN OF COMPLIANCE OR AN EXPLANATION OF WHY THE AGENCY DETERMINES THAT SUCH EVALUATION ISN'T APPROPRIATE.*

Complying with the energy standards will result in a business asset that will retain value and is durable. Such investments into infrastructure will result in a secure return on investment. The return on the investment will continue for the lifetime of the building and would have paid for itself many times over during that period.

8. COMPARISON:

COMPARE THE IMPACT OF THE RULE WITH THE ECONOMIC IMPACT OF OTHER ALTERNATIVES TO THE RULE, INCLUDING NO RULE ON THE SUBJECT OR A RULE HAVING SEPARATE REQUIREMENTS FOR SMALL BUSINESS:

An alternative to this rule would be to adopt the 2021 IECC as is. This would result in fewer additional up-front costs, yet would reduce energy savings. This would also fail to address health and comfort issues addressed by the proposed modifications and would fall significantly short of the path toward Vermont's Climate Action Plan goal to reduce greenhouse gas pollution to 26% below 2005 levels by 2025.

Adopting no rule at all would mean significant lost opportunities with each building being constructed, as those additional savings would not be captured through an improved energy code. Adopting no rule would also run afoul of the statutory requirement under 30 V.S.A. Section 53 that the Department "Commissioner shall ensure that appropriate revisions are made promptly after the issuance of updated standards for commercial construction under the IECC or ASHRAE/ANSI/IESNA standard 90.1, whichever provides the greatest level of energy savings."

9. SUFFICIENCY: *DESCRIBE HOW THE ANALYSIS WAS CONDUCTED, IDENTIFYING RELEVANT INTERNAL AND/OR EXTERNAL SOURCES OF INFORMATION USED.*

The savings analyses were conducted by building analysts and engineers contracted by the Department, who each have more than 20 years of experience in this field, with most of this experience in Vermont. This deep understanding of commercial building construction, energy modeling, and energy codes ensures the savings calculations and code modifications are credible and thorough. Additionally, the code modifications are based on the following:

1. Input from Vermont builders, developers, engineers, architects, and state representatives obtained in the form of the 2021 Code Collaborative work conducted by the PSD, the Advisory and Stakeholder meetings conducted between August 2021 and June 2022, and an open comment period from March – July 2022.
2. IECC 2021 and ASHRAE 2019 standards.
3. PNNL software models for multi-family, office, stand-alone retail, warehouse, and school buildings.
4. Energy modeling of the Pacific Northwest National Laboratory (PNNL) prototype buildings in Open Studio, a Department of Energy (DOE) software modeling program.
5. Input from New Buildings Institute (NBI) on codes in other states.
6. NBI’s Vermont Roadmap to Net-Zero by 2030, a roadmap for commercial buildings to comply with the Vermont Climate Action Plan’s greenhouse gas emission reduction goals.
7. Energy Information Administration (EIA) cost of carbon calculation.
8. Vermont Agency of Natural Resources information for the social cost of carbon in Vermont in 2023.// /////

The incremental costs of the proposed rule were developed using national studies, manufacturer costing data, and web searches. The analysis team requested assistance from contractors and designers throughout Vermont but were unsuccessful after multiple attempts.

ATTACHMENT A

Table 1: 2023 CBES Estimated costs and benefits

Type of Building	Average Annual Weighted Savings	Package Costs (over 2020 CBES)	Simple Payback (Years)	Return on Investment %	Annual Cashflow
Multifamily	$3,790	$33,246	8.8	11%	$892
Multifamily with Social Cost of Carbon	$5,041	$33,246	8.6	12%	N/A
Medium Office	$8,780	$72,803	8.3	12%	$2,432
Medium Office with Social Cost of Carbon	$10,619	$72,803	6.9	15%	N/A
Standalone Retail	$10,839	$17,290	1.6	63%	$9,332
Standalone Retail with Social Cost of Carbon	$13,361	$17,290	1.3	77%	N/A
Warehouse	$6,545	$19,536	3.0	33%	$4,841
Warehouse with Social Cost of Carbon	$7,973	$19,536	2.5	41%	N/A
Primary School	$13,984	$89,654	6.4	16%	$6,168
Primary School with Social Cost of Carbon	$16,642	$89,654	5.4	19%	N/A

The social cost of carbon is based upon the Vermont Agency of Natural Resources calculation for social cost of carbon in Vermont in 2023.

Environmental Impact Analysis

Instructions:

In completing the environmental impact analysis, an agency analyzes and evaluates the anticipated environmental impacts (positive or negative) to be expected from adoption of the rule; compares alternatives to adopting the rule; explains the sufficiency of the environmental impact analysis. If no impacts are anticipated, please specify "No impact anticipated" in the field.

Examples of Environmental Impacts include but are not limited to:

- Impacts on the emission of greenhouse gases
- Impacts on the discharge of pollutants to water
- Impacts on the arability of land
- Impacts on the climate
- Impacts on the flow of water
- Impacts on recreation
- Or other environmental impacts

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1. TITLE OF RULE FILING:

   Vermont Commercial Building Energy Standards (CBES) Amendments

2. ADOPTING AGENCY:

   Department of Public Service

3. GREENHOUSE GAS: *EXPLAIN HOW THE RULE IMPACTS THE EMISSION OF GREENHOUSE GASES (E.G. TRANSPORTATION OF PEOPLE OR GOODS; BUILDING INFRASTRUCTURE; LAND USE AND DEVELOPMENT, WASTE GENERATION, ETC.):*
   The energy savings from premises built to the updated CBES will result in direct reductions in greenhouse gas emissions through reduced on-site fuel consumption and indirect greenhouse gas reductions through reduced electricity demand for the lifetime of the building. This rule also allows for the consideration of embodied carbon emissions from insulation materials used in the construction process (points may be earned for calculating estimated embodied carbon emissions from

insulation materials and for demonstrating lower insulation Global Warming Potential (GWP) intensity.)

4. WATER: *EXPLAIN HOW THE RULE IMPACTS WATER (E.G. DISCHARGE / ELIMINATION OF POLLUTION INTO VERMONT WATERS, THE FLOW OF WATER IN THE STATE, WATER QUALITY ETC.):*
   No impact.
5. LAND: *EXPLAIN HOW THE RULE IMPACTS LAND (E.G. IMPACTS ON FORESTRY, AGRICULTURE ETC.):*
   No impact.
6. RECREATION: *EXPLAIN HOW THE RULE IMPACTS RECREATION IN THE STATE:*
   No impact.
7. CLIMATE: *EXPLAIN HOW THE RULE IMPACTS THE CLIMATE IN THE STATE:*
   The energy savings from premises built to the updated CBES will result in positive impacts through direct and indirect reductions in greenhouse gas emissions and minimize the other negative environmental impacts of energy use.
8. OTHER: *EXPLAIN HOW THE RULE IMPACT OTHER ASPECTS OF VERMONT'S ENVIRONMENT:*
   This rule promotes improved insulation and air sealing in new commercial construction and renovations to reduce building heating and cooling demands. This rule also promotes the use of efficient appliances and mechanical systems, which will further reduce electricity and fuel consumption. Additionally, the rule will improve building durability, occupant comfort and indoor air quality in new buildings.
9. SUFFICIENCY: *DESCRIBE HOW THE ANALYSIS WAS CONDUCTED, IDENTIFYING RELEVANT INTERNAL AND/OR EXTERNAL SOURCES OF INFORMATION USED.*
   This environmental impact analysis covers the full range of environmental and climate impacts of the CBES updates. Additonal information on the benefits of building energy codes can be found at the following websites:
   https://www.energycodes.gov/why-building-energy-codes
   https://www.imt.org/wp-content/uploads/2018/02/non-energy_benefits_of_energy_codes_report.pdf

Public Input Maximization Plan

Instructions:

Agencies are encouraged to hold hearings as part of their strategy to maximize the involvement of the public in the development of rules. Please complete the form below by describing the agency's strategy for maximizing public input (what it did do, or will do to maximize the involvement of the public).

This form must accompany each filing made during the rulemaking process:

1. TITLE OF RULE FILING:

   Vermont Commercial Building Energy Standards (CBES) Amendments

2. ADOPTING AGENCY:

   Department of Public Service

3. PLEASE DESCRIBE THE AGENCY'S STRATEGY TO MAXIMIZE PUBLIC INVOLVEMENT IN THE DEVELOPMENT OF THE PROPOSED RULE, LISTING THE STEPS THAT HAVE BEEN OR WILL BE TAKEN TO COMPLY WITH THAT STRATEGY:

   The Department of Public Service undertook a broad-based consensus building process to develop this rule. Between April and May 2022, the Department held two online public meetings to present the proposed code language and gather input from the public for modifying the draft 2023 CBES, which included builders, architects, multi-family housing developers, low-income housing advocates, electric and gas utilities, energy efficiency utilities and state agency staff (SHPO, Div. of Fire Safety).

   The Department also convened an CBES Advisory Committee as required by statute to delve deeper into the technical aspects of the code. The full Advisory Committee met in March and June of 2022 and a multifamily subcommittee met in late May. The Department modified the proposed CBES to incorporate changes recommended by the stakeholders and the Advisory Committee.

Public meeting participants, Advisory Committee members and other stakeholders were also encouraged to comment on the proposed CBES language posted on the PSD website. The PSD accepted comments for over a month (the comment period was extended per stakeholder request).

PSD developed the proposed rule based on these meetings, public comments and other feedback.

Information is available on the Department of Public Service website at:

https://publicservice.vermont.gov/content/building-energy-standards-update

After the proposed rule filing with the Secretary of State in late October 2022, we held a virtual public hearing and accepted comments for the duration of the public comment period.

4. BEYOND GENERAL ADVERTISEMENTS, PLEASE LIST THE PEOPLE AND ORGANIZATIONS THAT HAVE BEEN OR WILL BE INVOLVED IN THE DEVELOPMENT OF THE PROPOSED RULE:

Alison Stone - Vermont Natural Resources Board

Anna Brannon - Guidehouse

Bob Bolin - Burlington Electric Department

Bob Duncan - Duncan Wisniewski Architecture

Charles Carpenter - Efficiency Vermont

Charlie Willner - EverNorth

Chris Burns - Burlington Electric Department

Craig Peltier - Vermont Housing and Conservation Board

Dan Tuhus-Dubrow - Cx Associates

Dave Mentzer - Dore + Whittier Architects

Diana Burk - New Buildings Institute

Enrique Bueno - VT Passive House

Erica Ko - AIA Vermont Chapter

Eveline Killian - Cx Associates

Gabrielle Stebbins – Energy Futures Group

Greg Montgomery – Cathedral Square

Public Input

Jake Yanulavich – Burlington Electric Department

Jay Pilliod - Efficiency Vermont

Kathy Beyer - EverNorth

Keith Downes - Guidehouse

Laura Bailey - Vermont Green Building Network

Liz Bourguet - Energy Futures Group

Matt Cota - Vermont Fuel Dealers Association

Matt Musgrave - Associated General Contractors of Vermont

Michael Gifford - Vermont Gas Systems

Nick Thiltgen - DuBois & King, ASHRAE Representative

Richard Faesy - Energy Futures Group

Robert Sponable - Vermont Division of Fire Safety

Sean Denniston - New Buildings Institute

Steve O’Malley - Efficiency Vermont

Tim Perrin - Vermont Gas Systems

Will Fontaine - Snyder Construction

Will Reed - Vermont Foam Insulation

Scientific Information Statement

THIS FORM IS ONLY REQUIRED IF THE RULE RELIES ON SCIENTIFIC INFORMATION FOR ITS VALIDITY.

PLEASE REMOVE THIS FORM PRIOR TO DELIVERY IF IT DOES NOT APPLY TO THIS RULE FILING:

Instructions:

In completing the Scientific Information Statement, an agency shall provide a summary of the scientific information including reference to any scientific studies upon which the proposed rule is based, for the purpose of validity.

---

1. TITLE OF RULE FILING:

   Vermont Commercial Building Energy Standards (CBES) Amendments

2. ADOPTING AGENCY:

   Department of Public Service

3. BRIEF EXPLANATION OF SCIENTIFIC INFORMATION:

   30 V.S.A.§ 53, governing Commercial Building Energy Standards, requires an update of the Vermont standards to be made promptly after the issuance of updated standards for commercial construction under the IECC or ASHRAE/ANSI/IESNA standard 90.1. The proposed update of CBES is based on the 2018 edition of the International Energy Conservation Code (IECC) with 2021 IECC additional language and the American Society of Heating, Refrigeration and Air-conditioning Engineers, Inc. (ASHRAE) Standard 90.1-2019.

   The primary substantive differences between the 2018 IECC/ASHRAE 90.1-2019 and the proposed Vermont 2023 CBES standards are increases to the building thermal shell, air tightness and mechanical upgrades to energy equipment and systems. This higher proposed standard is based on a review of standards existing in other jurisdictions and current practices in Vermont and therefore includes requirements in the proposed Vermont CBES that are not included in the 2018 IECC, 2021 IECC or ASHRAE 90.1-2019, including envelope, mechanical, and lighting requirements.

4. CITATION OF SOURCE DOCUMENTATION OF SCIENTIFIC INFORMATION:

Energy modeling was provided using OpenStudio version v3.3.0 software, published by Alliance for Sustainable Energy, LLC. and developed by National Renewable Energy Laboratory (NREL), Argonne National Laboratory (ANL), Lawrence Berkeley National Laboratory (LBNL), Oak Ridge National Laboratory (ORNL) and Pacific Northwest National Laboratory (PNNL).

5. INSTRUCTIONS ON HOW TO OBTAIN COPIES OF THE SOURCE DOCUMENTS OF THE SCIENTIFIC INFORMATION FROM THE AGENCY OR OTHER PUBLISHING ENTITY:

OpenStudio software can be accessed at https://openstudio.net/

Incorporation by Reference

THIS FORM IS ONLY REQUIRED WHEN INCORPORATING MATERIALS BY REFERENCE. PLEASE REMOVE PRIOR TO DELIVERY IF IT DOES NOT APPLY TO THIS RULE FILING:

Instructions:

In completing the incorporation by reference statement, an agency describes any materials that are incorporated into the rule by reference and how to obtain copies.

This form is only required when a rule incorporates materials by referencing another source without reproducing the text within the rule itself (e.g., federal or national standards, or regulations).

Incorporated materials will be maintained and available for inspection by the Agency.

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1. TITLE OF RULE FILING:

   Vermont Commercial Building Energy Standards (CBES) Amendments

2. ADOPTING AGENCY:

   Department of Public Service

3. DESCRIPTION (*DESCRIBE THE MATERIALS INCORPORATED BY REFERENCE*):

   (1) The 2020 Vermont Commercial Building Energy Standards published by International Code Council (ICC).

   (2) Chapter 6 of the proposed rule lists the section number, full title, edition year, and address of the promulgator for all other standards that are referenced in the proposed rule. The attached "referenced standards" document reproduces that information with the addition of links to where copies can either be accessed or purchased.

4. FORMAL CITATION OF MATERIALS INCORPORATED BY REFERENCE:
   2020 Vermont Commercial Building Energy Standards. International Code Council(ICC), Inc.: July 2020.

First Printing. ISBN: 978-1-952468-32-9
For all other standards, see attached "referenced standards" document.

5. OBTAINING COPIES: *(EXPLAIN WHERE THE PUBLIC MAY OBTAIN THE MATERIAL(S) IN WRITTEN OR ELECTRONIC FORM, AND AT WHAT COST)*:

The 2020 VT Commercial Building Energy Standards can be obtained from the ICC website at: www.iccsafe.org. An electronic view only copy is available for free.

The Department of Public Service has hard copies available for free. Hard copies are available to order from the ICC for $27.50 (non-member) or $22 (member). Pdf downloads are available from ICC for $27.50 (non-member) or $18.95 (member).

All other standards: links have been provided in the attached "referenced standards" document where copies of the texts can either be accessed or purchased. The costs for obtaining these references range from $0 to $900.

The Department of Public Service also has this information available on its website at http://publicservice.vermont.gov/content/building-energy-standards-update.

6. MODIFICATIONS (*PLEASE EXPLAIN ANY MODIFICATION TO THE INCORPORATED MATERIALS E.G., WHETHER ONLY PART OF THE MATERIAL IS ADOPTED AND IF SO, WHICH PART(S)ARE MODIFIED)*:

The proposed rule modifies the 2020 VT Commercial Building Energy Standards by making Vermont amendments throughout the document. Vermont amendments are attached.

Run Spell Check

CHAPTER 6 [CE]
REFERENCED STANDARDS

AAMA

American Architectural
Manufacturers Association
1827 Walden Office Square
Suite 550
Schaumburg, IL 60173-
4268

AAMA/WDMA/CSA 101/I.S.2/A 440—17: North American Fenestration Standard/Specifications for Windows, Doors and Unit Skylights

Table C402.5.2

https://www.wdma.com/window-entry-door-and-skylight-standards

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AHAM

Association of Home
Appliance Manufacturers
1111 19th Street NW, Suite
402
Washington, DC 20036

ANSI/AHAM RAC-1—2015: Room Air Conditioners

Table C403.3.2(3)

https://webstore.ansi.org/Standards/AHAM/ANSIAHAMRAC2015

AHAM HRF-1—2016: Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers

Table C403.10.1

https://webstore.ansi.org/Standards/AHAM/AHAMHRF2016?source=blog&_ga=2.40943588.731630646.1668790694-603282858.1668790693

AHRI

Air-Conditioning, Heating, &
Refrigeration Institute
2111 Wilson Blvd, Suite
500
Arlington, VA 22201

ISO/AHRI/ASHRAE 13256-1 (2017): Water-to-Air and Brine-to-Air Heat Pumps—Testing and Rating for Performance

Table C403.3.2(2)

https://www.techstreet.com/standards/ashrae-13256-1-1998-ra-2012?product_id=1843289

ISO/AHRI/ASHRAE 13256-2 (1998 RA2014): Water-to-Water and Brine-to-Water Heat Pumps —Testing and Rating for Performance

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https://www.techstreet.com/standards/iso-13256-2-2021?product_id=2222355

210/240—2017 and 2023: Performance Rating of Unitary Air-conditioning and Air-source Heat Pump Equipment

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https://www.ahrinet.org/search-standards/ahri-210240-2023-2020-performance-rating-unitary-air-conditioning-air-source-heat

310/380—2017 (CSA-C744-17): Standard for Packaged Terminal Air Conditioners and Heat Pumps

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https://www.ahrinet.org/search-standards/ahri-340360-i-p2022-performance-rating-commercial-and-industrial-unitary-air

365(I-P)—2009: Commercial and Industrial Unitary Air-conditioning Condensing Units

Table C403.3.2(1), Table C403.3.2(6)
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400 (I-P)—2015: Performance Rating of Liquid to Liquid Heat Exchangers

Table C403.3.2(10)
https://www.ahrinet.org/search-standards/ahri-400-i-p2015-performance-rating-liquid-liquid-heat-exchangers

440—2008: Performance Rating of Room Fan Coils—with Addendum 1

C403.11.3
https://www.ahrinet.org/search-standards/ahri-440-2008-performance-rating-room-fan-coils-addendum-1

460—2005: Performance Rating of Remote Mechanical-draft Air-cooled Refrigerant Condensers

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https://www.ahrinet.org/search-standards/ahri-460-2005-performance-rating-remote-mechanical-draft-air-cooled-refrigerant

550/590 (I-P)—2018: Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle

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https://www.ahrinet.org/search-standards/ahri-550590-i-p2020-performance-rating-water-chilling-and-heat-pump-water-heating-packages-using

560—2018: Absorption Water Chilling and Water Heating Packages

Table C403.3.2(7)
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910—2014: Performance Rating of Indoor Pool Dehumidifiers

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920—2015: Performance Rating of DX-Dedicated Outdoor Air System Units

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1160 (I-P) —2014: Performance Rating of Heat Pump Pool Heaters (with Addendum 1)

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1200 (I-P)—2013: Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets

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1230—2014: Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air Conditioning and Heat Pump Equipment (with Addendum 1)

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1250 (I-P)—2014: Standard for Performance Rating in Walk-in Coolers and Freezers

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1360—2017: Performance Rating of Computer and Data Processing Room Air Conditioners

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AMCA

Air Movement and Control Association International
30 West University Drive
Arlington Heights, IL 60004-1806

208—18: Calculation of the Fan Energy Index
C403.8.3
https://webstore.ansi.org/Standards/AMCA/ANSIAMCA20818

220—19: Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating
C402.5.6
https://webstore.ansi.org/Standards/AMCA/ANSIAMCA22021

500D—18: Laboratory Methods for Testing Dampers for Rating
C403.7.7
https://webstore.ansi.org/Standards/AMCA/ANSIAMCA50018

230—15: Laboratory Methods of Testing Air Circulating Fans for Rating and Certification
C403.9
https://webstore.ansi.org/Standards/AMCA/ANSIAMCA23015

ANSI

American National Standards Institute
25 West 43rd Street, 4th Floor
New York, NY 10036

**Z21.10.3/CSA 4.3—17: Gas Water Heaters, Volume III—Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour,
Circulating Tank and Instantaneous**
Table C404.2
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Z21.47/CSA 2.3—16: Gas-fired Central Furnaces
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Z83.8/CSA 2.6—16: Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-fired Duct Furnaces
Table C403.3.2(4)
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APSP

The Association of Pool & Spa Professionals
2111 Eisenhower Avenue,

Suite 580
Alexandria, VA 22314

14—2019: American National Standard for Portable Electric Spa Energy Efficiency
C404.10
https://webstore.ansi.org/Standards/APSP/ANSIAPSPICC142019

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085

S640—2017: Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)
C405.4
https://webstore.ansi.org/Standards/ASABE/ANSIASABES640JUL2017R2022

ASHRAE

ASHRAE
1791 Tullie Circle NE
Atlanta, GA 30329

ANSI/ASHRAE/ACCA Standard 183—2007 (RA2017): Peak Cooling and Heating Load Calculations in Buildings, Except Low-rise Residential Buildings
C403.1.1
https://webstore.ansi.org/Standards/ASHRAE/ANSIASHRAEACCA1832007R2020

ANSI/ASHRAE Standard 62.1—2022: Ventilation for Acceptable Indoor Air Quality
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55—2017: Thermal Environmental Conditions for Human Occupancy
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https://webstore.ansi.org/Standards/ASHRAE/ANSIASHRAE552020

90.1—2019: Energy Standard for Buildings Except Low-rise Residential Buildings
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https://webstore.ansi.org/Standards/ASHRAE/ANSIASHRAEIES902019

90.4—2016: Energy Standard for Data Centers
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140—2014: Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs
C407.6.1
https://webstore.ansi.org/Standards/ASHRAE/ansiashraestandard1402014

146—2011: Testing and Rating Pool Heaters
Table C404.2
https://webstore.ansi.org/Standards/ASHRAE/ANSIASHRAE1462020

ASME

American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990

ASME A17.1—2019/CSA B44—19: Safety Code for Elevators and Escalators
C405.8.2
https://webstore.ansi.org/Standards/CSA/CSAASMEA172013B44

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959

C90—2016A: Specification for Load-bearing Concrete Masonry Units
Table C401.3
https://global.ihs.com/doc_detail.cfm?&input_doc_number=&input_doc_title=&document_name=ASTM%20C90&item_s_key=00015193&item_key_date=830016&origin=DSSC

C1363—11: Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

C303.1.4.1, Table C402.1.4, 402.2.7
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C1371—15: Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

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https://webstore.ansi.org/Standards/ASTM/ASTMC1371152022

C1549—2016: Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

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D1003—13: Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics

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D8052/D8052M—2017: Standard Test Method for Quantification of Air Leakage in Low-Sloped Membrane Roof Assemblies

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https://webstore.ansi.org/Standards/ASTM/ASTMD8052D8052M17

E283—2004(2012): Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen

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E408—13: Test Methods for Total Normal Emittance of Surfaces Using Inspection-meter Techniques

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E779—10(2018): Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

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E903—2012: Standard Test Method Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)

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E1677—11: Specification for Air Barrier (AB) Material or Systems for Low-rise Framed Building Walls

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E1827—2011(2017): Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door

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E1918—06(2016): Standard Test Method for Measuring Solar Reflectance of Horizontal or Low-sloped Surfaces in the Field

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E1980—11: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces

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E2178—13: Standard Test Method for Air Permanence of Building Materials

C402.5.1.2.1
https://webstore.ansi.org/Standards/ASTM/ASTME217813

E2357—2018: Standard Test Method for Determining Air Leakage of Air Barriers Assemblies

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E3158—2018: Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building

Section C402.5.3
https://webstore.ansi.org/Standards/ASTM/ASTME315818

F1281—2017: Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Pressure Pipe

Table C404.5.2.1
https://webstore.ansi.org/Standards/ASTM/ASTMF128217

F1361—2017: Standard Test Method for Performance of Open Deep Fat Fryers

Table C406.12(1)
https://webstore.ansi.org/Standards/ASTM/ASTMF136117

F1484—2018: Standard Test Method for Performance of Steam Cookers

Table C406.12(2)
https://webstore.ansi.org/Standards/ASTM/ASTMF148418

F1495—2014a: Standard Specification for Combination Oven Electric or Gas Fired

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https://webstore.ansi.org/Standards/ASTM/ASTMF149514a

F1496—2013: Standard Test Method for Performance of Convection Ovens

Table C406.12(4)
https://webstore.ansi.org/Standards/ASTM/ASTMF149613

F1696—2018: Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines

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https://webstore.ansi.org/Standards/ASTM/ASTMF169615

F1920—2015: Standard Test Method for Performance of Rack Conveyor Commercial Dishwashing Machines

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F2093—2018: Standard Test Method for Performance of Rack Ovens
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F2144—2017: Standard Test Method for Performance of Large Open Vat Fryers
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F2861—2017: Standard Test Method for Enhanced Performance of Combination Oven in Various Modes
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https://webstore.ansi.org/Standards/ASTM/ASTMF286117

CRRC

Cool Roof Rating Council
2435 North Lombard Street
Portland, OR 97217

ANSI/CRRC-S100—2020: Standard Test Methods for Determining Radiative Properties of Materials
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https://coolroofs.org/documents/ANSI-CRRC-S100-2021_Final.pdf

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CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights
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https://webstore.ansi.org/Standards/CSA/CSAA4402018

CSA B55.1—2015: Test Method for Measuring Efficiency and Pressure Loss of Drain Water Heat Recovery Units
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https://webstore.ansi.org/Standards/CSA/CSAB552015

CSA B55.2—2015: Drain Water Heat Recovery Units
C404.8
https://webstore.ansi.org/Standards/CSA/CSAB552015-1533305

CTI

Cooling Technology Institute
P. O. Box 681807
Houston, TX 77268

ATC 105—2019: Acceptance Test Code for Water Cooling Tower
Table C403.3.2(8)
https://global.ihs.com/doc_detail.cfm?&input_doc_number=&input_doc_title=&document_name=CTI%20ATC%2D105&item_s_key=00024769&item_key_date=770331&origin=DSSC

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ATC 105S—11: Acceptance Test Code for Closed Circuit Cooling Towers

Table C403.3.2(8)

https://global.ihs.com/doc_detail.cfm?&item_s_key=00646292&item_key_date=880531&input_doc_number=105S&input_doc_title=

ATC 106—11: Acceptance Test for Mechanical Draft Evaporative Vapor Condensers

Table C403.3.2(8)

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STD 201—11: Standard for Certification of Water Cooling Towers Thermal Performances

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CTI STD 201 RS(17): Performance Rating of Evaporative Heat Rejection Equipment

Table C403.3.2(8)

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DASMA

Door & Access Systems
Manufacturers Association,
International
1300 Sumner Avenue
Cleveland, OH 44115-2851

105—2017: Test Method for Thermal Transmittance and Air Infiltration of Garage Doors and Rolling Doors

https://www.dasma.com/wp-content/uploads/2022/03/ANSI-DASMA-105-2017-DASMA.pdf

DOE

U.S. Department of Energy
c/o Superintendent of
Documents
1000 Independence Avenue
SW
Washington, DC 20585

10 CFR, Part 430—2015: Energy Conservation Program for Consumer Products: Test Procedures and Certification and Enforcement
Requirement for Plumbing Products; and Certification and Enforcement Requirements for Residential Appliances; Final Rule

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https://ecfr.io/Title-10/pt10.3.430

10 CFR, Part 430, Subpart B, Appendix N—(2015): Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers

C202
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10 CFR, Part 431—2015: Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and Efficiency Standards; Final Rules

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https://ecfr.io/Title-10/pt10.3.431

10 CFR 431 Subpart B App B: Uniform Test Method for Measuring Nominal Full Load Efficiency of Electric Motors

C403.8.4, Table C405.7(1), Table C405.7(2), Table C405.7(3), C405.7(4)
https://ecfr.io/Title-10/pt10.3.431

NAECA 87—(88): National Appliance Energy Conservation Act 1987 [Public Law 100-12 (with Amendments of 1988-P.L. 100-357)]

Table C403.3.2(1), Table C403.3.2(2), Table C403.3.2(4)
https://appliance-standards.org/federal-legislation/national-appliance-energy-conservation-act-1987

HVI

Home Ventilating Institute
1740 Dell Range Blvd Ste H, PMB 45
Cheyenne, WY 82009

916-18 : Airflow Test Procedure

C403.8.5
https://docplayer.net/56830312-Hvi-airflow-test-procedure.html

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ICC

International Code Council, Inc.
500 New Jersey Avenue NW
6th Floor
Washington, DC 20001

ANSI/RESNET/ICC—19: Standard for Testing Airtightness of Building, Dwelling Unit and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems

C402.5.2, C402.5.3

IBC—21: International Building Code®

C201.3, C303.2, C402.5.3, C501.4
https://webstore.ansi.org/Standards/ICC/ICCIBC2021

ICC 500—2020: Standard for the Design and Construction of Storm Shelters

C402.4.2

https://shop.iccsafe.org/icc-500-2020-icc-nssa-standard-for-the-design-and-construction-of-storm-shelters.html

IFC—21: International Fire Code®
C201.3, C501.4
https://webstore.ansi.org/Standards/ICC/ICCIFC2021

IFGC—21: International Fuel Gas Code®
C201.3, C501.4
https://webstore.ansi.org/Standards/ICC/ICCIFGC2021

IPC—21: International Plumbing Code®
C201.3, C501.4
https://webstore.ansi.org/Standards/ICC/ICCIPC2021

IPMC—21: International Property Maintenance Code®
C501.4
https://shop.iccsafe.org/2021-international-property-maintenance-coder.html

IPSDC—21: International Private Sewage Disposal Code®
C501.4
https://shop.iccsafe.org/2021-international-property-maintenance-coder.html

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IEEE

Institute of Electrical and Electronic Engineers
3 Park Avenue, 17th Floor
New York, NY 10016

IEEE 515.1—2012: IEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications
C404.6.2
https://webstore.ansi.org/Standards/IEEE/IEEE5152022

IES

Illuminating Engineering Society
120 Wall Street, 17th Floor
New York, NY 10005-4001

ANSI/ASHRAE/IESNA 90.1—2019: Energy Standard for Buildings, Except Low-rise Residential Buildings
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https://shop.iccsafe.org/ansi-ashrae-ies-standard-90-1-2019-energy-standard-for-buildings-except-low-rise-residential-buildings-i-p-edition.html

ISO

International Organization for Standardization
Chemin de Blandonnet 8, CP 401, 1214 Vernier
Geneva, Switzerland

ISO/AHRI/ASHRAE 13256-1(2017): Water-to-Air and Brine-to-Air Heat Pumps -Testing and Rating for Performance

Table C403.3.2(2)

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ISO/AHRI/ASHRAE 13256-2(2017): Water-to-Water and Brine-to-Water Heat Pumps -Testing and Rating for Performance

C403.3.2(2)

https://shop.iccsafe.org/ansi-ari-ashrae-iso-13256-2-1998-ra-2012-water-source-heat-pumps-testing-and-rating-for-performance-part-2-water-to-water-and-brine-to-water-heat-pumps.html

NEMA

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, VA 22209

MG1—2016: Motors and Generators

C202

https://www.nema.org/docs/default-source/standards-document-library/ansi_nema-mg-1-2016-contents-and-foreword.pdf?sfvrsn=f27547b8_1

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

70—20: National Electrical Code

C501.4

https://catalog.nfpa.org/NFPA-70-National-Electrical-Code-NEC-Softbound-P1194.aspx?icid=D729

NFRC

National Fenestration Rating Council, Inc.
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770

100—2020: Procedure for Determining Fenestration Products *U-factors*

C303.1.3, C402.2.1.1

https://nfrccommunity.org/store/viewproduct.aspx?id=1380591

200—2020: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence

C303.1.3, C402.4.1.1

https://nfrccommunity.org/store/viewproduct.aspx?id=1402116

203—2017: Procedure for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence

C303.1.3

https://nfrccommunity.org/store/viewproduct.aspx?id=1402221

400—2020: Procedure for Determining Fenestration Product Air Leakage

Table C402.5.2

https://nfrccommunity.org/store/viewproduct.aspx?id=1402431

SMACNA

Sheet Metal and Air
Conditioning Contractors'
National Association, Inc.
4021 Lafayette Center Drive
Chantilly, VA 20151-1219

SMACNA—2012: HVAC Air Duct Leakage Test Manual Second Edition

C403.2.11.2.3

https://store.smacna.org/hvac-air-duct-leakage-test-manual

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

710—12: Exhaust Hoods for Commercial Cooking Equipment—with Revisions through November 2013

C403.7.5

https://standardscatalog.ul.com/standards/en/standard_710

727—18: Oil-fired Central Furnaces

Table C403.3.2(4)

https://standardscatalog.ul.com/standards/en/standard_727_10

731—18: Oil-fired Unit Heaters

Table C403.3.2(4)

https://standardscatalog.ul.com/standards/en/standard_731_6

1784—15: Air Leakage Tests of Door Assemblies—with Revisions through February 2015

C402.5.3

https://standardscatalog.ul.com/standards/en/standard_1784_4

2202—2009: *Electric Vehicle (EV) Charging System- with revisions through February 2018*
C405.13
https://standardscatalog.ul.com/ProductDetail.aspx?productId=UL2202_2_S_20091002

2594—2016: Standard for Electric Vehicle Supply Equipment
C405.13

US-FTC

United States-Federal Trade Commission
600 Pennsylvania Avenue NW
Washington, DC 20580

CFR Title 16 (2015): *R*-value Rule
C303.1.4
https://www.law.cornell.edu/cfr/text/16/part-460

WDMA

Window and Door Manufacturers Association
2025 M Street NW, Suite 800
Washington, DC 20036-3309

AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights
Table C402.5.2
https://webstore.ansi.org/Standards/CSA/AAMAWDMACSA101A4402017?gclid=EAIaIQobChMIksGX9Ka5-wIVGo_ICh2zYwkpEAAYASAAEgJ3TvD_BwE

2023 Vermont Commercial Building Energy Standard AMENDMENTS

DEPARTMENT OF PUBLIC SERVICE

112 State Street
Montpelier, VT 05620

802-828-2811

https://publicservice.vermont.gov/

These rules are adopted under 30 V.S.A. § 53. This document shall be known and cited as the *2023 Vermont Commercial Building Energy Standard Amendments*. The *2020 Vermont Commercial Building Energy Standards* (First Printing: July 2020) published by International Code Council (ICC), Inc., as amended herein, are incorporated by reference and are available on the ICC website at: www.iccsafe.org

PREFACE

delete and replace Preface as follows:

Introduction

The 2023 *Vermont Commercial Building Energy Standards* (CBES) is based on the 2020 *Vermont Commercial Building Energy Standards* (CBES), which are based upon the *International Energy Conservation Code*® (IECC®) 2018 edition. The 2023 CBES also includes elements of the 2021 IECC energy efficiency requirements as well as select language updates and additional, more stringent Vermont energy efficiency requirements. The 2023 CBES also incorporates elements of ANSI/ASHRAE/IES Standard 90.1- 2019 *Energy Standard for Buildings Except Low-Rise Residential Buildings.*

This comprehensive energy conservation code establishes minimum regulations for energy efficient buildings using prescriptive and performance-related provisions. It is founded on broad-based principles that make possible the use of new materials and new energy efficient designs.

The *International Energy Conservation Code* provisions provide many benefits, among which is the model code development process that offers an international forum for energy professionals to discuss performance and prescriptive code requirements. This model code also encourages international consistency in the application of provisions.

Development

This 2023 CBES is founded on principles intended to establish provisions consistent with the scope of an energy conservation code that adequately conserves energy; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

Background

The Vermont Commercial Building Energy Standards (CBES) was adopted by statute (30 V.S.A. § 53) in 2006. This code applies to all commercial buildings and residential buildings four stories or greater above grade in Vermont and took effect January 1, 2007.

Update Process

The Commercial Building Energy Standards statute requires that revisions to the CBES are made promptly after the issuance of updated standards under the International Energy Conservation

Code (IECC). The Department of Public Service (PSD) is required to convene stakeholders that include mortgage lenders, builders, building designers, utility representatives, and other persons with experience and expertise prior to the adoption of a revised CBES to provide recommendations

The 2023 CBES is based on the language in the *International Energy Conservation Code* (IECC) 2018 and 2021 editions and incorporates elements of ANSI/ASHRAE/IES Standard 90.1-2019 *Energy Standard for Buildings Except Low-Rise Residential Buildings*. The 2023 CBES includes a new "Additional Efficiency, Renewable, and Load Management Requirements" section based on a points approach to code compliance. The addition of "points" provides builders and designers greater flexibility in complying with the CBES. The Vermont PSD held a series of code collaborative meetings in 2021 and a series of stakeholder and advisory committee meetings in 2022 to gather feedback on proposed changes to the CBES. The revisions presented in this document were modified based on input received from these meetings.

EFFECTIVE USE OF THE 2023 VERMONT COMMERCIAL BUILDING ENERGY STANDARDS

The 2023 *Vermont Commercial Building Energy Standards* (CBES) is a code that regulates minimum energy conservation requirements for new buildings as well as additions, alterations, renovations, and repairs to existing buildings. The 2023 CBES addresses energy conservation requirements for all aspects of energy uses in commercial construction, including heating and ventilating, lighting, water heating, and power usage for appliances and building systems.

The 2023 CBES is a design document. For example, before constructing a building, the designer must determine the minimum insulation *R*-values and fenestration *U*-factors for the building exterior envelope. The CBES sets forth minimum requirements for exterior envelope insulation, window and door *U*-factors and SHGC ratings, duct insulation, lighting and power efficiency, mechanical ventilation, and water distribution insulation.

Arrangement and Format of the 2023 CBES

The 2023 CBES, like other codes published by ICC, is arranged and organized to follow sequential steps that generally occur during a plan review or inspection. The 2023 CBES is divided into six different parts:

Chapters	Subjects
1–2	Scope, Administration and Definitions
3	General Requirements
4	Commercial Energy Efficiency
5	Existing Buildings
6	Referenced standards

Italicized Terms

Selected terms set forth in Chapter 2: Definitions, are italicized where they appear in code text. Such terms are not italicized where the definition set forth in Chapter 2 does not impart the intended meaning in the use of the term. The terms selected have definitions that the user should read carefully to facilitate better understanding of the code.

The following is a chapter-by-chapter synopsis of the scope and intent of the provisions of the 2023 *Vermont Commercial Building Energy Standards*:

Chapter 1 Scope and Administration. This chapter contains provisions for the application, enforcement and administration of subsequent requirements of the code. In addition to establishing the scope of the code, Chapter 1 identifies which buildings and structures come under its purview. Chapter 1 is largely concerned with maintaining “due process of law” in enforcing the energy conservation criteria contained in the body of this code. Only through careful observation of the administrative provisions can the code official or other authority having jurisdiction, where one exists, reasonably expect to demonstrate that “equal protection under the law” has been provided.

Chapter 2 Definitions. Chapter 2 is the repository of the definitions of terms used in the body of the code. Codes are technical documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results. The code often uses terms that have a unique meaning in the code and the code meaning can differ substantially from the ordinarily understood meaning of the term as used outside of the code.

The terms defined in Chapter 2 are deemed to be of prime importance in establishing the meaning and intent of the code text. The user of the code should be familiar with and consult this chapter because the definitions are essential to the correct interpretation of the code and the user may not be aware that a term is defined.

Where understanding of a term’s definition is especially key to or necessary for understanding of a particular code provision, the term is shown in *italics* wherever it appears in the code. This is true only for those terms that have a meaning that is unique to the code. In other words, the generally understood meaning of a term or phrase might not be sufficient or consistent with the meaning prescribed by the code; therefore, it is essential that the code-defined meaning be known.

Guidance regarding tense, gender and plurality of defined terms as well as guidance regarding terms not defined in this code is provided.

Chapter 3 General Requirements. Chapter 3 provides interior design conditions that are used as a basis for assumptions in heating and cooling load calculations and provides basic material requirements for insulation materials and fenestration materials and provides standards for commercial mechanical ventilation and combustion safety.

Chapter 4 Commercial Energy Efficiency. Chapter 4 contains the energy-efficiency-related requirements for the design and construction of most types of commercial buildings, and residential buildings greater than three stories in height above grade. This chapter defines requirements for the portions of the building and building systems that impact energy use in new commercial construction and new residential construction greater than three stories in height and promotes the effective use of energy. The provisions within the chapter promote energy efficiency in the building envelope, the heating and cooling system, and the service water heating system of the building.

Chapter 5 Existing Buildings. Chapter 5 of each set of provisions contains the technical energy efficiency requirements for existing buildings. Chapter 5 provisions address the maintenance of buildings in compliance with the code as well as how additions, alterations, repairs and changes of occupancy need to be addressed from the standpoint of energy efficiency. Specific provisions are provided for historic buildings.

Chapter 6 Referenced Standards. The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 6 contains a comprehensive list of all standards that are referenced in the code. The standards are part of the code to the extent of the reference to the standard. Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the code official, or other authority having jurisdiction, where one exists, contractor, designer and owner.

Chapter 6 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency's standards are then listed in either alphabetical or numeric order based on the standard identification. The list also contains the title of the standard; the edition (date) of the standard referenced; any addenda included as part of the ICC adoption; and the section or sections of this code that reference the standard.

Marginal Markings

Solid vertical lines in the margins within the body of the code indicate Vermont specific additions and changes from the requirements of the IECC 2021 edition. Deletion indicators in the form of an arrow (➡) are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a table has been deleted.

Abbreviations and Notations

The following is a list of common abbreviations and units of measurement used in this code. Some of the abbreviations are for terms defined in Chapter 2. Others are terms used in various tables and text of the code.

AFUE	Annual fuel utilization efficiency
bhp	Brake horsepower (fans)
Btu	British thermal unit
Btu/h-ft^2	Btu per hour per square foot
C-factor	See Chapter 2—Definitions
CDD	Cooling degree days
cfm	Cubic feet per minute
cfm/ft^2	Cubic feet per minute per square foot
ci	Continuous insulation
COP	Coefficient of performance
DCV	Demand control ventilation

°C	Degrees Celsius
°F	Degrees Fahrenheit
DWHR	Drain water heat recovery
DX	Direct expansion
E_c	Combustion efficiency
E_v	Ventilation efficiency
E_t	Thermal efficiency
EER	Energy efficiency ratio
EF	Energy factor
ERI	Energy rating index
F-factor	See Chapter 2—Definitions
FDD	Fault detection and diagnostics
FEG	Fan efficiency grade
FL	Full load
ft^2	Square foot
gpm	Gallons per minute
HDD	Heating degree days
HERS	Home Energy Rating System
hp	Horsepower
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilating and air conditioning
IEER	Integrated energy efficiency ratio
IPLV	Integrated Part Load Value
Kg/m^2	Kilograms per square meter
kW	Kilowatt
LPD	Light power density (lighting power allowance)
L/s	Liters per second
Ls	Liner system
m^2	Square meters
MERV	Minimum efficiency reporting value
NAECA	National Appliance Energy Conservation Act
NPLV	Nonstandard Part Load Value
Pa	Pascal
PF	Projection factor
pcf	Pounds per cubic foot
PSD	Department of Public Service (Vermont)
psf	Pounds per square foot
PTAC	Packaged terminal air conditioner
PTHP	Packaged terminal heat pump
R-value	See Chapter 2—Definitions
SCOP	Sensible coefficient of performance
SEER	Seasonal energy efficiency ratio
SHGC	Solar Heat Gain Coefficient
SPVAC	Single packaged vertical air conditioner
SPVHP	Single packaged vertical heat pump
SRI	Solar reflectance index
SWHF	Service water heat recovery factor
U-factor	See Chapter 2—Definitions

VAV	Variable air volume
VRF	Variable refrigerant flow
VT	Visible transmittance
W	Watts
w.c.	Water column
w.g.	Water gauge

CHAPTER 1
ADMINISTRATION

PART 1—SCOPE AND APPLICATION

SECTION C101
SCOPE AND GENERAL REQUIREMENTS

delete and replace **C101.1 Title.**
This code shall be known as the 20202023 Commercial Building Energy Standards (CBES) of Vermont and shall be cited as such. It is referred to herein as “this code.”

delete and replace **C101.2 Scope.**
This code applies to *commercial buildings* and the buildings’ sites and provides the minimum energy-efficient, renewable energy, and energy storage requirements for the design and construction, and a plan for operation and maintenance of the following:

1. New buildings and their systems.

2. New portions of buildings and their systems.

3. New systems and equipment in existing buildings.

4. New stand-alone equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes.

Exceptions:

1. **Farm Structures.** This code shall not apply to farm structures as defined in 24 Vermont Statutes Annotated (V.S.A.) § 4413.
2. **Process applications.** This code shall not apply to manufacturing or industrial processes equipment that are not identified in this standard or are integral to equipment that is not identified in the standard.

delete and replace **C101.5 Compliance.**
Residential buildings shall meet the provisions of the 2023 *Vermont Residential Building Energy Standards* (RBES), and *Commercial buildings* shall meet the provisions of the 2023 *Vermont Commercial Building Energy Standards* (CBES).

SECTION C102
ALTERNATIVE MATERIALS, DESIGN AND METHODS OF CONSTRUCTION AND EQUIPMENT

delete and replace **C102.1 General.**
The provisions of this code are not intended to prevent the installation of any material or to prohibit

any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. The Public Service Department shall have the authority to approve an alternative material, design or method of construction upon the written application of the owner or the owner's authorized agent. The code *official* shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability and safety. The *code official or authority having jurisdiction* shall respond to the applicant, in writing, stating the reasons why the alternative was approved or was not *approved*.

delete and replace **C102.1.1 Above code programs.**
The *code official or authority having jurisdiction* shall be permitted to deem a national, state or local energy efficiency program an exceeding the energy efficiency required by this code. Buildings *approved* in writing by such an energy efficiency program shall be considered to be in compliance with this code. The requirements identified as "mandatory" in Chapter 4 shall be met.

PART 2—ADMINISTRATION AND ENFORCEMENT

SECTION C103
CONSTRUCTION DOCUMENTS

delete and replace **C103.1 General.**
Where required construction documents and other supporting data shall be submitted in one or more sets, or in a digital format where allowed by the reviewing official, with each application for a permit. The construction documents shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed. Where special conditions exist, the *code official or authority having jurisdiction* is authorized to require necessary construction documents to be prepared by a registered design professional.

> **Exception:** The *code official or authority having jurisdiction* is authorized to waive the requirements for construction documents or other supporting data if the *code official or authority having jurisdiction* determines they are not necessary to confirm compliance with this code.

delete and replace **C103.2 Information on construction documents.**
Where required construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where approved by the *code official or authority having jurisdiction*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.

2. Insulation materials and their *R*-values.

3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).

4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.

5. Design ambient temperatures.

6. Interior temperatures for heating and cooling modes.

7. Relative humidity setpoints.

8. Ventilation rates.

9. Mechanical system design criteria.

10. Mechanical and service water heating systems and equipment types, sizes and efficiencies.

11. Economizer description.

12. Equipment and system controls.

13. Fan motor horsepower (hp) and controls.

14. Duct sealing, duct and pipe insulation and location.

15. Lighting fixture schedule with wattage and control narrative.

16. Location of *daylight* zones on floor plans.

17. Air barrier and air sealing details, including the location of the air barrier, a diagram showing the building's pressure boundary in plan(s) and section(s), and a calculation of the area of the pressure boundary as specified in Section C402.4.1.3.

Mechanical equipment schedules shall be included in the submitted construction documents and shall include, but are not limited to, the following information:

1. Equipment efficiencies.

2. Fan and pump nameplate motor and brake horsepower.

3. Fan efficiency grade (FEG), where applicable.

4. Hydronic system (if applicable) supply and return water design temperatures for boilers and all terminal devices (e.g., baseboards, unit ventilators, etc.).

5. Steam system (if applicable) design pressure for boilers and all terminal devices.

Add **C103.2.2 Electrification system.** The construction documents shall provide details for additional electric infrastructure, including branch circuits, conduit, or pre-wiring, panel capacity, and electrical service capacity in compliance with the provisions of this code.

delete and replace **C103.5 Retention of construction documents.**

One set of *approved* construction documents shall be retained by the *code official where one exists or authority having jurisdiction where one exists* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.

delete and replace **C103.6.2 Compliance documentation.**
Energy code compliance documentation and supporting calculations shall be delivered in one document to the building owner as part of the project record documents or manuals, or as a standalone document. This document shall include the specific energy code edition utilized for compliance determination for each system, documentation demonstrating compliance with Section C303.1.3 for each fenestration product installed, and the interior lighting power compliance path, building area or space-by-space, used to calculate the lighting power allowance.

For projects complying with Item 1 of Section C401.2, the documentation shall include:

1. The envelope insulation compliance path.

2. All compliance calculations including those required by Sections C402.1.3, C403.8.1, C405.3 and C405.5.

CHAPTER 2
DEFINITIONS

SECTION C202
GENERAL DEFINITIONS

add **ALL-ELECTRIC BUILDING.** A building that contains no combustion equipment, or plumbing for combustion equipment, installed within the building or building site.

add **ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE).** Boiler and furnace efficiency measurement as the percentage of heating fuel that is effectively turned into usable energy (heat).

add **APPLIANCE.** A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

delete and replace **AUTHORITY HAVING JURISDICTION***.* The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. For purposes of this code, neither the Vermont Public Service Department nor the Division of Fire Safety should be considered the authority having jurisdiction. Where there is conflict between rules adopted by the Division of Fire Safety and this code those adopted by the Division of Fire Safety have preemption over this code.

add **AUTOMOBILE_PARKING_SPACE.** A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

add **BIOGAS.** A mixture of hydrocarbons that is a gas at 60°F (15.5°C) and 1 atmosphere of pressure that is produced through the anaerobic digestion of organic matter.

add **CARBON DIOXIDE EQUIVALENT (CO2e).** A measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO2e approximates the warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO2).

delete and replace **CLIMATE ZONE.** A geographical region based on climatic criteria as specified in this code. Vermont is *Climate Zone* 6.

delete and replace ***CODE OFFICIAL.*** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. For purposes of this code, neither the Vermont Public Service Department nor the Division of Fire Safety should be considered the authority having jurisdiction. Where there is conflict between rules adopted by the Division of Fire Safety and this code those adopted by the Division of Fire Safety have preemption over this code.

add **Combined Energy Efficiency Ratio (CEER).** Window or room air conditioner efficiency measurement which combines the efficiency of the unit both in standby mode and in cooling mode.

add **COMBUSTION EQUIPMENT.** Any *equipment* or *appliance* used for space heating, *service water heating*, cooking, clothes drying and/or lighting that uses *fuel gas* or *fuel oil*.

delete and replace **COMMERCIAL BUILDING ENERGY STANDARDS (CBES).** The Vermont nonresidential Energy Code, based on the 2021 *International Energy Conservation Code* (IECC), but modified substantially.

add **COMMERCIAL COOKING APPLIANCES.** Appliances used in a commercial food service establishment for heating or cooking food, and which produce grease vapors, steam, fumes, smoke, or odors that are required to be removed through a local exhaust ventilation system. Such appliances include deep fat fryers, upright broilers, griddles, broilers, steam-jacketed kettles, hot-top ranges, under-fired broilers (charbroilers), ovens, barbecues, rotisseries, and similar appliances. For the purpose of this definition, a food service establishment shall include any building or a portion thereof used for the preparation and serving of food.

delete and replace **COMPUTER ROOM.** A room whose primary function is to house equipment for the processing and storage of electronic data which has a design total information technology equipment (ITE) equipment power density less than or equal to 20 watts per square foot (20 watts per 0.092 m^2) of conditioned area or a design total ITE equipment load less than or equal to 10 kW.

add **DATA CENTER.** A room or series of rooms that share data center systems, whose primary function is to house equipment for the processing and storage of electronic data and that has a design total ITE equipment power density exceeding 20 watts per square foot (20 watts per 0.092 m^2) of conditioned area and a total design ITE equipment load greater than 10 kW.

add **DATA CENTER SYSTEMS.** HVAC systems and equipment, or portions thereof, used to provide cooling or ventilation in a data center.

delete and replace **DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system where one or more pumps prime the service hot water piping with heated water upon a demand for hot water.

add **DIRECT DIGITAL CONTROL (DDC).** A type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control physical devices.

add **ELECTRIC VEHICLE (EV).** An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

add **ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE).** A designated *automobile parking space* that is provided with all the requisite infrastructure in place within five feet to allow installation of electrical wiring and connection to power for EVSE

add **ELECTRIC VEHICLE FAST CHARGER (EV FAST CHARGER).** Also referred to as a Level 3 charger. An *EV fast charger* is an *EVSE* equipped with a direct-current (DC) plug for electric vehicle charging with either a CHAdeMO or SAE combined charging system (CCS) format connector. Other DC fast charging plug standards may be accepted as they are developed.

add **ELECTRIC VEHICLE READY SPACE (EV READY SPACE).** An *automobile parking space* that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed *EVSE*.

add **ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).** Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle*.

add **ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space).** An *automobile parking space* that is provided with a dedicated *EVSE* connection.

add **ENERGY EFFICIENCY RATIO (EER).** Air handling unit measure of efficiency defined as the system output in Btu/h per watt of electrical energy input.

add **ENTHALPY RECOVERY RATIO.** Change in the enthalpy of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air enthalpy, expressed as a percentage.

add **ENVIRONMENTAL PRODUCT DECLARATION (EPD), TYPE III PRODUCT-SPECIFIC.** An EPD is a document that describes the results of a life cycle assessment (LCA) for a material or product. While there are industry-specific EPDs, which average results across multiple product manufacturers, product-specific EPDs are the most thorough type of EPD. Type III, product-specific EPDs cover a single product from a manufacturer and are reviewed by a third-party entity. They conform to ISO 14025 and either EN 15804 or ISO 21930. Like all product specific EPDs, the scope must cover the product's life-cycle from cradle to gate.

add **EQUIPMENT.** Piping, ducts, vents, control devices and other components of systems other than appliances that are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

add **FAN, EMBEDDED.** A fan that is part of a manufactured assembly where the assembly includes functions other than air movement.

add **FAN ARRAY.** Multiple fans in parallel between two plenum sections in an air distribution system.

delete **FAN EFFICIENCY GRADE (FEG).** A numerical rating identifying the fan's aerodynamic ability to convert shaft power, or impeller power in the case of a direct-driven fan, to air power.

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

add **FAN NAMEPLATE ELECTRICAL INPUT POWER.** The nominal electrical input power rating stamped on a fan assembly nameplate.

add **FAN SYSTEM ELECTRICAL INPUT POWER.** The sum of the fan electrical power of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors.

add **FAULT DETECTION AND DIAGNOSTICS (FDD) SYSTEM.** A software platform that utilizes building analytic algorithms to convert data provided by sensors and devices to automatically identify faults in building systems and provide a prioritized list of actionable resolutions to those faults based on cost or energy avoidance, comfort and maintenance impact.

delete and replace **FENESTRATION.** Products classified as either skylights or vertical fenestration.

> **Skylights.** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal, including unit skylights, tubular daylighting devices and glazing materials in solariums, sunrooms, roofs, greenhouses and sloped walls.
>
> **Vertical fenestration.** Windows that are fixed or operable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees (1.05 rad) from horizontal.

add **FUEL GAS.** A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.

add **FUEL OIL.** Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

add **GARAGE DOOR.** A large door that allows a vehicle to access the building or allows a shipping truck to load or unload.

delete and replace **GENERAL LIGHTING.** Interior lighting that provides a substantially uniform level of illumination throughout a space.

add **GLOBAL WARMING POTENTIAL (GWP).** GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO2. The following GWP values are used based on a 100-year time horizon: 1 for CO_2, < 10 for pentane (e.g., C_5H_{12}), and 1430 for R-134a (CH_2FCF_3).

add **GLOBAL WARMING POTENTIAL (GWP) INTENSITY.** For the purposes of this document, GWP intensity refers to the GWP impact from materials (kg CO2e) divided by the project's total conditioned floor area in square feet (ft2).

delete and replace **GREENHOUSE.** A structure or a thermally isolated area of a building that maintains a specialized sunlit environment exclusively used for, and essential to, the cultivation, protection or maintenance of plants. *Greenhouses* are those that are erected for a period of 180 days or more.

delete and replace **GROSS AREA OF EXTERIOR WALLS.** The normal projection of all exterior walls, including the edge area of above grade floors, the edge area of roof insulation, and the area of all windows and doors installed therein (see "Exterior wall").

add **HEATING SEASONAL PERFORMANCE FACTOR (HSPF).** Heat pump heating efficiency rating measured as the ratio of heat output over the heating season (in Btu) to electricity used (in watt-hours).

delete and replace **HIGH-EFFICACY LIGHT SOURCES.** Non-linear medium screw- and pin-base lamps with an efficacy of not less than 65 lumens per watt; or light fixtures of not less than 65 lumens per watt. In determining the number or percent of lamps, each replaceable lamp (or light string) connected to a permanently installed lighting fixture shall count as one lamp.

delete **HUMIDISTAT.** A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

add **INFORMATION TECHNOLOGY EQUIPMENT (ITE).** Items including computers, data storage devices, servers and network and communication equipment.

add **INTEGRATED ENERGY EFFICIENCY RATIO (IEER).** Integrated efficiency value of a mechanical system operating at 100%, 75%, 50%, and 25% of full load capacity designed to reflect the efficiency at different load levels.

add **INTERNAL CURTAIN SYSTEM.** A system consisting of movable panels of fabric or plastic film used to cover and uncover the space enclosed in a greenhouse on a daily basis.

add **LARGE-DIAMETER CEILING FAN.** A ceiling fan that is greater than 7 feet (2134 mm) in diameter. These fans are sometimes referred to as High-Volume, Low-Speed (HVLS) fans.

delete and replace **METAL BUILDING.** A complete integrated set of mutually dependent components and assemblies that form a building, which consists of a steel-framed superstructure and metal exterior cladding.

add **MIXED-FUEL BUILDING.** A *building* that contains *combustion equipment* or includes piping for such *equipment.*

delete and replace **NETWORKED GUESTROOM CONTROL SYSTEM.** A control system, with access from the front desk or other central location associated with a *Group R*-1 building, that is capable of identifying the rented and unrented status of each guestroom according to a timed schedule, and is capable of controlling HVAC in each hotel and motel guestroom separately.

delete and replace **OCCUPANCY CLASSIFICATIONS.** Building occupancies shall be defined by the 2021 *International Building Code*, which is summarized here. Discrepancies in the summary or further clarifications shall defer to the *International Building Code*.

Assembly Group A is the occupancy group used for buildings that are for the gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption or awaiting transportation.

The first occupancy group is A-1. The group is for the production and viewing of the performing arts, motion pictures, or television and radio studios admitting an audience.

The next occupancy group is A-2. The group includes assembly uses intended for food and/or drink consumption, such as: banquet halls, casino gambling areas, night-clubs, restaurants, cafeterias, taverns, and bars.

Group A-3 includes assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A such as: community halls, courtrooms, gymnasiums, and waiting areas in transportation terminals.

Group A-4 includes assembly uses intended for viewing of indoor sporting events and activities with spectator seating.

Group A-5 includes assembly uses intended for participation in or viewing outdoor activities.

Business Group B is the occupancy group used for office, professional or service-type transactions, including storage or records and accounts.

Educational Group E is the occupancy group used by six or more persons at any one time for educational purposes through the 12th grade.

Factory Industrial Group F is the occupancy group used for disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operation that are not classified as Group H or Group S.

High-hazard Group H is the occupancy group used for manufacturing, processing, generation or storage of materials that constitute a physical or health hazard.

Institutional Group I is the occupancy group used for more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised environment and receive custodial care.

Mercantile Group M is the occupancy group used for the display and sale of merchandise, and involves stocks of goods, wares or merchandise.

Residential Group R is the occupancy group used for buildings that include sleeping rooms and are not institutional. There are four different occupancy groups within R.

The first occupancy group is R-1. This group is for transient uses like hotels, motels and boarding houses.

Group R-2 is occupancies containing sleeping units or more than two dwelling units where the occupants are primarily permanent. This includes apartments, dormitories, fraternities and sororities. It also includes vacation timeshares (with more than two units) and convents and monasteries. Boarding houses or congregate living facilities with 16 or fewer occupants go into Group R-3.

Group R-3 is for permanent occupancies that are not R-1, R-2, or R-4.

Group R-4 is for occupancies for more than five but not more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised residential environment and receive custodial care.

Storage Group S is the occupancy group used for storage that is not classified as a hazardous occupancy.

delete and replace **ON-SITE RENEWABLE ENERGY.** Energy from renewable energy resources harvested at the building project site.

delete and replace **RENEWABLE ENERGY RESOURCES.** Energy produced using a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate including, but not limited to, solar hot water, solar hot air, solar photovoltaics, wind, and hydro.

1. Methane gas and other flammable gases produced by the decay of sewage treatment plant wastes or landfill wastes and anaerobic digestion of agricultural products, byproducts, or wastes shall be considered renewable energy resources, but no form of solid waste, other than agricultural or silvicultural waste, shall be considered renewable.

2. The only portion of electricity produced by a system of generating resources that shall be considered renewable is that portion generated by a technology that qualifies as renewable.

3. The following fuels shall not be considered renewable energy supplies: coal, oil, propane, and natural gas.

4. Biomass is considered renewable.

delete and replace **RESIDENTIAL BUILDING ENERGY STANDARDS (RBES).** The *Vermont Residential Energy Code* based on the 2015 *International Energy Conservation Code with 2018, 2020, and 2023 additions*.

add **SEASONAL ENERGY EFFICIENCY RATIO (SEER).** Air conditioner efficiency rating, measured as the ratio of cooling output over a typical cooling season (in Btuh), divided by the provided electrical energy (in watt-hours).

delete and replace **SEMI-CONDITIONED SPACE.** An enclosed space within a building that is not a conditioned space, but is directly or indirectly mechanically heated or cooled.

add **SOLAR-READY ZONE.** A section of sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.

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

add **THERMAL DISTRIBUTION EFFICIENCY (TDE).** The resistance to changes in air heat as air is conveyed through a distance of air duct. TDE is a heat loss calculation evaluating the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.

add **TYPE III PRODUCT-SPECIFIC ENVIRONMENTAL PRODUCT DECLARATION (EPD).** See ENVIRONMENTAL PRODUCT DECLARATION, TYPE III PRODUCT-SPECIFIC.

add **VEGETATIVE ROOF.** An assembly of interacting components designed to waterproof a building’s top surface that includes, by design, vegetation and related landscape elements.

add **VISIBLE TRANSMITTANCE, ANNUAL [VT_{annual}].** The ratio of visible light entering the space through the fenestration product assembly to the incident visible light during the course of a year, which includes the effects of glazing material, frame, and light well or tubular conduit, and is expressed as a number between 0 and 1.

delete and replace **WALL, ABOVE-GRADE.** A wall associated with the *building thermal envelope* that is more than 15 percent above grade and is on the exterior of the building or any wall that is associated with the *building thermal envelope* that is not on the exterior of the building. This includes, but is not limited to, between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

CHAPTER 3 [CE]
GENERAL REQUIREMENTS

SECTION C303
MATERIALS, SYSTEMS AND EQUIPMENT

delete and replace **C303.1.2 Insulation mark installation.**
Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection. For insulation materials that are installed without an observable manufacturer's R-value mark, such as blown or draped products, an insulation certificate complying with Section C303.1.1 shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed R-value of the insulation material.

delete and replace **TABLE C303.1.3(2)**

TABLE C303.1.3(2)
DEFAULT OPAQUE DOOR *U*-FACTORS

DOOR TYPE	OPAQUE *U*-FACTOR
Uninsulated Metal[1]	1.20
Insulated Metal (Rolling)	0.90
Insulated Metal (Other)	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

1. Uninsulated opaque doors are prohibited when part of the thermal envelope.

CHAPTER 4 [CE]
COMMERCIAL ENERGY EFFICIENCY

SECTION C401
GENERAL

delete and replace **C401.2 Application.**
Commercial buildings shall comply with Section C401.2.1 or C401.2.2.

delete and replace **C401.2.1 CBES Prescriptive Compliance.** The Prescriptive Compliance option requires compliance with Sections C402 through C407. Dwelling units and sleeping units in

Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance, provided that they comply with Section R406 of *RBES*.

delete and replace **C401.2.2 ASHRAE 90.1.** Commercial buildings shall comply with the requirements of ANSI/ASHRAE/IESNA 90.1-2019. New buildings using ANSI/ASHRAE/IESNA 90.1-2019 compliance paths (a) or (b) (see ANSI/ASHRAE/IESNA 90.1-2019 section 4.2.1.1 *New Buildings*) shall comply with Section C406 in the 2023 CBES. Commercial building projects utilizing the alternative compliance path of ANSI/ASHRAE/IESNA 90.1-2019 must follow all applicable provisions listed in Section C401.2.2.1.

add **C401.2.2.1 Applicable provisions to Standard 90.1-2019.**

1. All instances of the term building official in ASHRAE/IESNA 90.1-2019 shall be replaced with the terms *code official or authority having jurisdiction*.

2. ASHRAE/IESNA 90.1-2019 *Section 4.2.1.1 New Buildings*. Delete the equation for Performance Cost Index Target (PCI_t) and replace with:

   PCI_t = [BPF × (BBUEC + BBREC)]/BBP.

   Delete Table 4.2.1.1 *Building* Performance Factor (BPF) and replace with:

TABLE 4.2.1
BUILDING PERFORMANCE FACTOR (BPF)

BUILDING AREA TYPE[a]	VERMONT BPF
Multifamily	0.55
Healthcare/hospital	0.46
Hotel/motel	0.43
Office	0.43
Restaurant	0.50
Retail	0.37
School	0.34
Warehouse	0.53
All Others	0.45

a. In cases where both a general *building* area type and a specific *building* area type are listed, the specific *building* area type shall apply.

3. ASHRAE/IESNA 90.1-2019 *Section 5.1.4.1 United States Locations*. Delete the exception clause and replace with the following:

   a. Adjustments may be made only in the following cases:

      a. Winter heating design temperatures for projects either:

i. Located at an elevation of 1,500 feet or higher.

ii. Located in Caledonia, Essex or Orleans counties.

iii. Adjustments shall be made as listed in the National Climate Data Center for the specific weather station: http://www.ncdc.noaa.gov/cdo-web/.

b. As approved by the *code official or authority having jurisdiction*.

4. ASHRAE/IESNA 90.1-2019 *Section 5 Building Envelope*. All envelope requirements shall comply with the following tables in the 2023 *Vermont Commercial Building Energy Standards*(CBES):

   i. *Table C402.1(2) and Table C402.1(3), Building Envelope Requirements—Opaque Assemblies and Elements*. Any spaces that qualify as Semiheated in ASHRAE/IESNA 90.1-2019 need only comply with the *Semiconditioned* requirement in Table C402.1(2) and Table C402.1(3).

   ii. *Table C402.1(4), Building Envelope Requirements—Metal Building Assembly Descriptions*.

   iii. *Table C402.3, Building Envelope Fenestration Maximum U-Factor and SHGC Requirements*.

5. ASHRAE/IESNA 90.1-2019 *Section 5.4.3 Air Leakage*. Delete section in its entirety and replace *with Section C402.4 Air leakage—thermal envelope of the 2023 Vermont CBES*.

6. ASHRAE/IESNA 90.1-2019 *Section 5.5.3.1 Roof Insulation*. Delete section in its entirety and replace with *Section C402.2.1 Roof assembly of the 2023 Vermont CBES*.

7. ASHRAE/IESNA 90.1-2019 *Section 5.5.3.3 Below-Grade Wall Insulation*. Delete section in its entirety and replace with *Section C402.2.3 Below-grade walls of the 2023 Vermont CBES*.

8. ASHRAE/IESNA 90.1-2019 *Section 5.5.3.5 Slab-on-Grade Floor Insulation*. Add to the end of this section the requirements of section *C402.2.6 Slabs-on-grade perimeter insulation of the 2023 Vermont CBES*.

9. ASHRAE/IESNA 90.1-2019 *Section 6.2 Compliance Path(s)*. Add new section as follows:

   a. *Section 6.2.3 Electric Resistance Space Heating*. Building heating with electrical resistance units, including baseboard radiation, heat pump reheat coils, duct coils, boilers, domestic hot water heaters, and coils in terminal units and air systems is prohibited.

      Exceptions to 6.2.3:

a. Areas, such as stairways, that are not permitted to be penetrated with piping or duct and no other method of heating is possible.

b. Replacement of existing electrical resistance unit.

c. Special conditions of occupancy or use that require electrical resistance heat to maintain health, safety or environmental conditions.

d. Limited areas where a practical application of resistance electrical heat is demonstrated (e.g., small interior space, such as a rest room, which is distant from the distribution system, hazardous material storerooms, stairwell or other means of emergency egress).

e. Domestic hot water heaters less than or equal to 7.5 kW in total unit input capacity.

f. Multifamily buildings with heating loads less than or equal to 6.0 Btu/hour/square foot at design temperature.∗

g. *Cold-Climate Heat Pump* where:∗

   a. the full heating demand can be met with the heat pump at an outside air temperature of 5°F (-15°C).

   b. the building *thermal envelope* shall be tested in accordance with ASTM E779 at a pressure differential of 0.3 inch water gauge (75 Pa) and deemed to comply with the provisions of Section C402.4.1 when the tested air leakage rate of the building thermal envelope is not greater than 0.15 cfm/ft^2 (including the areas of the slab and below grade walls).

∗Buildings served by the City of Burlington Electric (BED) must also receive approval from BED before installing electric resistance heating equipment.

10. ASHRAE/IESNA 90.1-2019 *Section 6.3.2(e) Criteria*. Delete “an electric resistance heater.”

11. ASHRAE/IESNA 90.1-2019 *Section 6.4.3.5 Heat Pump Auxiliary Heat Control*. Delete section in its entirety and replace with *Section C403.4.1.1 Heat pump supplementary heat of the 2023 Vermont CBES*.

12. ASHRAE/IESNA 90.1-2019 *Section 6.4.3.8 Ventilation Controls for High-Occupancy Areas*. Add *exception (6)*: Ventilation needs for process loads.

13. ASHRAE/IESNA 90.1-2019 *Section 6.4.3.9 Heated or Cooled Vestibules*. Delete section in its entirety and replace with *Section C403.4.1.4 Duct and plenum insulation and sealing of the 2023 Vermont CBES*.

14. ASHRAE/IESNA 90.1-2019 *Section 6.4.4.1.2 Duct and Plenum Insulation*. Delete section in its entirety and replace with *Section C403.11.1 Duct and plenum insulation and sealing of the 2023 Vermont* CBES.

15. Add new Section 6.4.7 to ASHRAE/IESNA 90.1-2019, titled *Economizer Fault Detection and Diagnostics (FDD)*. Insert *Section C403.5.5 Economizer fault detection and diagnostics (FDD) of the 2023 Vermont CBES*.

16. ASHRAE/IESNA 90.1-2019 Section 6.5.1 *Economizers*. Delete section in its entirety and replace with *Section C403.5 Economizers of the 2023 Vermont CBES*.

17. ASHRAE/IESNA 90.1-2019 Tables 6.5.6.1-1 and 6.5.6.1-2 *Exhaust Air Energy Recovery Requirements for Ventilation Systems*. Both tables shall be greater than or equal to 3,000 hours per year rather than 8,000 hours.

18. ASHRAE/IESNA 90.1-2019 Tables 6.5.6.1-1 and Table 6.5.6.1-2 *Exhaust Air Energy Recovery Requirements*, delete requirement for systems with ≥ 10% and < 20% outdoor air (second column of tables).

19. ASHRAE/IESNA 90.1-2019 *Section 6.5.6.2 Heat Recovery for Service Water Heating*. Add exception (3): If compliance with Section 6.5.6.2 will be detrimental to chiller operating efficiency due to conflicts with optimized chiller head pressure control.

20. ASHRAE/IESNA 90.1-2019 *Section 6.7.2.4 System Commissioning*. Delete section in its entirety and replace with *Section C407 System Commissioning of the 2023 Vermont CBES*.

21. ASHRAE/IESNA 90.1-2019 *Section 7.1 General*. Add new section as follows:

    a. *Section 7.1.1.4 Electrical Water Heating Limitation*. Individual electric service water heating units shall be limited to a maximum of 7.5 kW total power input.

       Exception: Instantaneous electric water heaters used to serve emergency showers and emergency eye wash stations.

22. ASHRAE/IESNA 90.1-2019 *Table 7.8 Performance Requirements for Water Heating Equipment*.

    a. Change first row (Electric tabletop water heaters) size category to < 7.5 kW.

    b. Change second row (Electric water heaters) size category to < 7.5 kW.

    c. Delete entire third row for electric water heaters > 12 kW.

23. ASHRAE/IESNA 90.1-2019 *Section 9 Lighting*. All lighting power density (LPD) requirements shall comply with the following tables in the 2023 *Vermont Commercial Building Energy Standards* (CBES):

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

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

iii. *Table C405.4.2(2), Individual Lighting Power Allowances for Building Exteriors*. Note that Vermont does not have any exterior lighting zone 4 areas.

Exception: *Exterior lighting zone 0 shall follow LPD requirements given by* ASHRAE/IESNA 90.1-2019 Table 9.4.4-2.

24. ASHRAE/IESNA 90.1-2019 *Section 9.4.1.3 Special Applications*. At the end of the section add the following wording:

    d. Luminaires providing means of egress illumination where the means of egress shall be illuminated at all times the room or space is occupied shall be controlled by occupancy sensors, or a signal from another building control system, that automatically reduces the lighting power by at least 50% when unoccupied for a period longer than 15 minutes.

    Exceptions:

    1. Means of egress illumination that does not exceed 0.02 watts per square foot of building area is exempt from this requirement.

    2. Emergency lighting designated to meet Section 1008.3 of the *International Building Code*.

25. ASHRAE/IESNA 90.1-2019 *Section 9.4.1.4 Exterior Lighting Control*. Add the following requirement:

    e. Exterior lighting shall be *full cut off* fixtures, limiting the light output to less than 10% at and below 10 degrees below the horizontal. Fixtures shall be independently certified by manufacturer as full cut off or meet the definition of a *fully shielded* light fixture.

26. ASHRAE/IESNA 90.1-2019 *Section 9.4.4 Dwelling Units*. Delete section in its entirety and replace with: Not less than 90% of the *permanently installed* lighting fixtures shall use lamps with an *efficacy* of at least 65 lm/W or have a total *luminaire efficacy* of at least 55 lm/W.

27. ASHRAE/IESNA 90.1-2019 *Section 9.6.2 Additional Interior Lighting Power.* Amend the exception in part (a) to read that the power shall not exceed 0.6 W/ft^2 of such *spaces* instead of 0.75 W/ft^2. In part (b), delete the equation for Additional Interior Lighting Power Allowance and replace with:

    Additional interior lighting power allowance = 250 W + (Retail Area 1 × 0.20 W/ft^2) + (Retail Area 2 × 0.20 W/ft^2) + (Retail Area 3 × 0.50 W/ft^2) + (Retail Area 4 × 0.90 W/ft^2)

28. ASHRAE/IESNA 90.1-2019 *Section 10.4 Mandatory Provisions*. Add the following sections:

    i. *10.4.6, Renewable energy systems*, which will meet the requirements of *Section C405.10 Renewable energy systems* in the 2023 Vermont CBES.

    ii. *10.4.7 Electric Vehicle Charging Stations*, which will meet the requirements of *Section C405.11 Electric Vehicle Charging Stations* in the 2023 Vermont CBES.

delete and replace **C401.3 CBES Certificate and Affidavits.**
30 V.S.A. §53 requires certification that both the design and the construction of a commercial building is in compliance with the CBES. Copies of the CBES Certificate and Affidavits are available on the Department of Public Service website at https://publicservice.vermont.gov/energy_efficiency/cbes.

Certification shall be issued by an approved party completing and signing a certificate and affixing it permanently on a wall in the space where the space conditioning equipment is located, in the interior space where the electrical service panel is located, or in a visible location in the immediate vicinity of one of these areas. If located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. Copies of the signed certification documents shall be included in the construction files for the project, shall be sent to the local town clerk for recording in the land records, and shall be sent to the Vermont Public Service Department. The certificate shall include the following:

1. Compliance method
2. Thermal envelope details including:
    a. R-values of insulation installed in or on ceilings, roofs, walls, foundations and slabs, 101229848 basement walls, crawl space walls and floors and ducts outside conditioned spaces.
    b. U-factors and solar heat gain coefficients (SHGC) of fenestrations.
3. Results from any building envelope air leakage testing performed on the building.
4. An indication of the solar-ready zone and other requirements of Section C402.5.

Where there is more than one value for any component of the building envelope, the certificate shall indicate the area-weighted average value where available. If the area-weighted average is not available, the certificate shall list each value that applies to 10 percent or more of the total component area.

SECTION C402
BUILDING ENVELOPE REQUIREMENTS

delete and replace **C402.1 General.**
In addition to the envelope requirements of Section C402, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, envelope enhancements may be needed..

The requirements of C402 that may be affected and the corresponding C406 references are summarized in Table C402.1(1). For a full list of potential measures See Table C406.2.1 and Table C406.3.1.

Table C402.1(1): C406 MEASURES AFFECTING BUILDING ENVELOPE

ID	C406 Energy Credit Title	C402 Reference	C406 Section
E01	Envelope Performance	n/a	C406.2.1.1
E02	UA Reduction	C402.1.3	C406.2.1.2
E03	Envelope Leak Reduction	C403.3.2	C406.2.1.3
E04	Add Roof Insulation	C402.1.1	C406.2.1.4
E05	Add Wall Insulation	C402.1.1	C406.2.1.5
E06	Improve Fenestration	Table C402.3	C406.2.1.6
G03	Automated Shading	n/a	C406.3.4
G07	Building Thermal Mass	n/a	C406.3.8
C01	Insulation Embodied Carbon	n/a	C406.3.9

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2, shall comply with the following:

1. The opaque portions of the building thermal envelope shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.1; the *U*-, *C*- and *F*-factor-based method of Section C402.1.2; the component performance alternative of Section C402.1.3; or the building above-grade performance alternative of Section C402.1.4. Building assemblies between conditioned and semi-conditioned spaces shall comply with the semi-conditioned requirements.

2. Fenestration in building envelope assemblies shall comply with Section C402.3.

   Exception: Semi-conditioned spaces do not have fenestration requirements.

3. Air leakage of building envelope assemblies shall comply with Section C402.4. Buildings with both conditioned and semi-conditioned spaces shall independently comply with the requirements of Section C402.4.

4. Solar readiness of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.3, the building and building thermal envelope shall comply with Section C401.2, Item 2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.10.1.

delete **TABLE C402.1(1)** *and replace* **TABLE C402.1(2)**

TABLE C402.1(2)
***CONDITIONED SPACE* BUILDING ENVELOPE REQUIREMENTS—OPAQUE ASSEMBLIES AND ELEMENTS[a,b]**

COMPONENT	MAXIMUM OVERALL *U*-FACTOR		EXAMPLE ASSEMBLIES MEETING U-FACTOR REQUIREMENT	
	All Other *Occupancy Classifications*	**R-2 *Occupancy Classifications***	**All Other *Occupancy Classifications***	**R-2 *Occupancy Classifications***
Roofs				
Insulation entirely above deck	U-0.022	Same as All Other ←	R-45ci	Same as All Other ←
Metal buildings	U-0.023	Same as All Other ←	R-10 + R-10 + R-32ci	Same as All Other ←
Attic and Other[i]	U-0.017	U-0.020	R-60	R-49
Walls, Above grade				
Mass[f]	U-0.037	Same as All Other ←	R-25ci	Same as All Other ←
Metal Building	U-0.039	Same as All Other ←	R-13 + R-19.5ci or R-25ci	Same as All Other ←
Metal-framed	U-0.037	Same as All Other ←	R-13 + R-18.8ci or R-25ci	Same as All Other ←
Wood-framed and other	U-0.036	U-0.042	R-13 + R-16ci or R-19 + R-12ci or R-25ci	R-13 + R-12ci or R-19 + R-8ci or R-20ci
Walls, Below Grade[c]				
Below-grade wall	C-0.048	Same as All Other ←	R-20ci	Same as All Other ←
Floors				
Mass[d]	U-0.038	Same as All Other ←	R-23ci	Same as All Other ←
Joist/Framing—Metal	U-0.027	Same as All Other ←	R-38 + R-6ci	Same as All Other ←
Joist/Framing—Wood and Other	U-0.027	Same as All Other ←	R-38	Same as All Other ←
Slab-on-Grade Floors				
Unheated slabs	F-0.434	Same as All Other ←	R-20 for 48" below	Same as All Other ←

Heated slabs[e]	F-0.433	Same as All Other ←	R-20 for 48" below + R-15 full slab	Same as All Other ←
Opaque Doors				
Swinging[g]	U-0.37		N/A	
Non-Swinging	N/A		R-4.75	
Garage door <14% glazing[h]	N/A		R-10	

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.
ci = Continuous insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors, and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1-2019 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/IESNA 90.1-2019 Appendix A. Alternatively, Table C402.1(4) for metal building assembly descriptions, Table C402.1(5) for metal building roof assembly *U*-factors, Table C402.1(6) for attic roofs with wood joists *U*-factors, Table C402.1(7) for metal building wall assembly *U*-factors, Table C402.1(8) for metal-framed wall assembly U-factors, and Table C402.1(9) for wood-framed wall assembly U-factors may be used in lieu of ANSI/ASHRAE/IESNA 90.1-2019 Appendix A.
b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The R-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.
c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.
d. "Mass floors" shall be in accordance with **Section C402.2.3** and shall include floors weighing not less than:
1. 35 pounds per square foot of floor surface area; or
2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
e. Evidence of compliance with the *F*-factors indicated in the table for heated slabs shall be demonstrated by the application of the unheated slab *F*-factors and *R*-values derived from ASHRAE 90.1-2019 Appendix A.
f. "Mass walls" shall be in accordance with **Section C402.2.2**
g. Swinging door U-factors shall be determined in accordance with NFRC-100.
h. Garage doors having a single row of fenestration shall have an assembly U-factor less than or equal to 0.31, provided that fenestration area is not less than 14 percent and not more than 25 percent of the total door area.
i. For Group R buildings, R-49 (U-0.023) for insulation in the ceiling slope

add **TABLE C402.1(3)**

TABLE C402.1(3)
SEMI-CONDITIONED SPACE BUILDING ENVELOPE REQUIREMENTS—OPAQUE ASSEMBLIES AND ELEMENTS[a,b]

COMPONENT	MAXIMUM OVERALL *U*-FACTOR	EXAMPLE ASSEMBLIES MEETING U-FACTOR REQUIREMENT
	All *Occupancy Classifications*	**All *Occupancy Classifications***
Roofs		
Insulation entirely above deck	U-0.039	R-25ci

Metal buildings	U-0.037	R-19 + R-11 LS or R-25 + R-8 LS
Attic and Other[i]	U-0.027	R-38
Walls, Above grade		
Mass[f]	U-0.104	R-9.5ci
Metal Building	U-0.060	R-15.8ci
Metal-framed	U-0.064	R-13 + R-7.5ci
Wood-framed and other	U-0.051	R-13 + R-7.5ci
Walls, Below Grade[c]		
Below-grade wall	C-0.119	R-7.5ci
Floors		
Mass[d]	U-0.064	R-12.5ci
Joist/Framing—Metal	U-0.052	R-19
Joist/Framing—Wood and Other	U-0.033	R-30
Slab-on-Grade Floors		
Unheated slabs	F-0.540	R-10 for 24 in. below
Heated slabs[e]	F-0.860	R-15 for 24 in below
Opaque Doors		
Swinging[g]	U-0.37	N/A
Non-Swinging	N/A	R-4.75
Garage door <14% glazing[h]	N/A	R-10

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.
ci = Continuous insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors, and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1-2019 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/IESNA 90.1-2019 Appendix A. Alternatively, Table C402.1(4) for metal building assembly descriptions, Table C402.1(5) for metal building roof assembly *U*-factors, Table C402.1(6) for attic roofs with wood joists *U*-factors, Table C402.1(7) for metal building wall assembly *U*-factors, Table C402.1(8) for metal-framed wall assembly U-factors, and Table C402.1(9) for wood-framed wall assembly U-factors may be used in lieu of ANSI/ASHRAE/IESNA 90.1-2019 Appendix A.
b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The R-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.
c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.
d. "Mass floors" shall be in accordance with **Section C402.2.3** and shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
e. Evidence of compliance with the *F*-factors indicated in the table for heated slabs shall be demonstrated by the application of the unheated slab *F*-factors and *R*-values derived from ASHRAE 90.1-2019 Appendix A.
f. "Mass walls" shall be in accordance with **Section C402.2.2**
g. Swinging door U-factors shall be determined in accordance with NFRC-100.

h. Garage doors having a single row of fenestration shall have an assembly U-factor less than or equal to 0.36, provided that fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

delete **TABLE C402.1(2)** *and replace* **TABLE C402.1(4)**

TABLE C402.1(4)
BUILDING ENVELOPE REQUIREMENTS—METAL BUILDING ASSEMBLY DESCRIPTIONS

BUILDING ENVELOPE REQUIREMENTS—METAL BUILDING ASSEMBLY DESCRIPTIONS	DESCRIPTION	REFERENCE
ROOFS		
Since Layer	The rated R-value of insulation is for insulation installed perpendicular to and draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly U-factor.	ANSI/ASHRAE/IESNA 90.1-2019
Double Layer	The first rated R-value of insulation is for insulation installed perpendicular to and draped over purlins. The second rated R-value of insulation is for unfaced insulation installed above the first layer and parallel to the purlins and then compressed when the metal roof panels are attached. A minimum R-3 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly U-factor.	ANSI/ASHRAE/IESNA 90.1-2019
Continuous Insulation	For assemblies with continuous insulation the continuous insulation is installed above or below the purlins, uncompressed and uninterrupted by framing members.	ANSI/ASHRAE/IESNA 90.1-2019
Liner system	A continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. For multilayer installations, the last rated *R*-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached. A minimum R-5 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly *U*-factor.	ANSI/ASHRAE/IESNA 90.1-2019
Filled Cavity (Fc)	The first *rated R-value of insulation* represents faced or unfaced insulation installed between the purlins. The second *rated R-value of insulation* represents unfaced insulation installed above the first layer, perpendicular to the purlins and compressed when the metal *roof* panels are attached. A supporting structure retains the bottom of the first layer at the prescribed depth required for the full thickness of insulation. A minimum R-5 thermal spacer block between the purlins and the metal *roof* panels is required unless compliance is shown by the overall assembly *U-factor*.	ANSI/ASHRAE/IESNA 90.1-2019
WALLS		

Single-Layer Compressed	The first rated *R*-value of insulation is for insulation compressed between metal building wall panels and the steel structure.	ANSI/ASHRAE/IESNA 90.1-2019
Continuous Insulation	For assemblies with continuous insulation, the continuous insulation is installed on the outside or inside of the girts, uncompressed and uninterrupted by the framing members.	ANSI/ASHRAE/IESNA 90.1-2019
Single-Layer in Cavity	The insulation is installed in the cavity between the girts, not compressed by the framing. A membrane or facing, installed separately or adhered to the insulation, is installed inside of the girts to form a continuous layer. A thermal spacer block or thermal break strip between the girts and metal wall panels is required when specified in Table A3.2.3.	ANSI/ASHRAE/IESNA 90.1-2019
Double-Layer	The first rated R-value of insulation is for insulation installed in the cavity between the girts, not compressed by the framing. The second rated R-value of insulation is for insulation compressed between metal wall panels and the steel structure. A membrane or facing, installed separately or adhered to the insulation, is installed inside of the girts to form a continuous layer. A thermal spacer block or thermal break strip between the girts and metal wall panels is required when specified in Table A3.2.3.	ANSI/ASHRAE/IESNA 90.1-2019

delete **TABLE C402.1(3)** *and replace* **TABLE C402.1(5)**

TABLE C402.1(5)
ASSEMBLY *U*-FACTORS FOR METAL BUILDING ROOFS

INSULATION SYSTEM	**RATED *R*-VALUE OF INSULATION**	**OVERALL *U*-FACTOR FOR ENTIRE BASE ROOF ASSEMBLY**	**OVERALL U-FACTOR FOR ASSEMBLY OF BASE ROOF PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)**					
			Rated *R*-Value of Continuous Insulation					
Standing Seam Roofs with Thermal Spacer Blocks[a]			**R-15.8**	**R-19**	**R-22.1**	**R-25**	**R-32**	**R-38**
Single layer[b]	None	1.280					00.031	0.026
	R-10	0.115		0.036	0.032	0.030	0.025	0.021
	R-11	0.107		0.035	0.032	0.029	0.024	0.021
	R-13	0.101		0.035	0.031	0.029	0.024	0.021
	R-16	0.096		0.034	0.031	0.028	0.024	0.021
	R-19	0.082	0.036	0.032	0.029	0.027	0.023	0.020
Double layer[b]	R-10 + R-10	0.088	0.037	0.033	0.030	0.028	0.023	0.020
	R-10 + R-11	0.086	0.036	0.033	0.030	0.027	0.023	0.020
	R-11 + R-11	0.085	0.036	0.033	0.030	0.027	0.023	0.020
	R-10 + R-13	0.084	0.036	0.032	0.029	0.027	0.023	0.020
	R-11 + R-13	0.082	0.036	0.032	0.029	0.027	0.023	0.020
	R-13 + R-13	0.075	0.034	0.031	0.028	0.026	0.022	0.019
	R-10 + R-19	0.074	0.034	0.031	0.028	0.026	0.022	0.019
	R-11 + R-19	0.072	0.034	0.030	0.028	0.026	0.022	0.019
	R-13 + R-19	0.068	0.033	0.030	0.027	0.025	0.021	0.019

	R-16 + R-19 R-19 + R-19	0.065 0.060	0.032 0.031	0.029 0.028	0.027 0.026	0.025 0.024	0.021 0.021	0.019 0.018
Liner system[c]	R-19 + R-11	0.037						
	R-25 + R-8	0.037						
	R-25 + R-11	0.031						
	R-30 + R11	0.029						
	R-25 + R-11 + R-11 LS	0.026						
Filled cavity[c]	R-10 + R-19 Fc	0.041	0.025	0.023	0.022	0.020	0.018	0.016
Thru-fastened Roofs without Thermal Spacer Blocks								
	R-10	0.184			0.036	0.033	0.027	0.023
	R-11	0.182			0.036	0.033	0.027	0.023
	R-13	0.174			0.036	0.033	0.026	0.023
	R-16	0.157			0.035	0.032	0.026	0.023
	R-19	0.151			0.035	0.032	0.026	0.022

Note: (Multiple *R*-values are listed in order from inside to outside)
Shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.

a. A standing seam roof clip that provides a minimum 1.5 inch distance between the top of the purlins and the underside of the metal building roof panels is required.
b. A minimum R-3 thermal spacer block is required.
c. A minimum R-5 thermal spacer block is required.

delete **TABLE C402.1(4)** *and replace* **TABLE C402.1(6)**

TABLE C402.1(6)
ASSEMBLY *U*-FACTORS FOR ATTIC ROOFS WITH WOOD JOISTS

RATED *R*-VALUE OF INSULATION ALONE	OVERALL *U*-FACTOR FOR ENTIRE ROOF ASSEMBLY[a]
Wood-framed Attic, Standard Framing	
R-38	U-0.027
R-49	U-0.021
R-60	U-0.017
R-71	U-0.015
R-82	U-0.013
R-93	U-0.011
R-104	U-0.010
R-115	U-0.009

R-126	U-0.008
Wood-framed Attic, Advanced Framing	
R-38	U-0.026
R-49	U-0.020
R-60	U-0.016
R-71	U-0.014
R-82	U-0.012
R-93	U-0.011
R-104	U-0.010
R-115	U-0.009
R-126	U-0.008
Wood Joists, Single-Rafter Roof[b]	
R-38 + R-15ci	U-0.020

a. Lightly shaded areas comply with conditioned R-2 spaces, but not other conditioned building occupancies. Darkly shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.
b. The first *R*-value is the cavity insulation, while the second value is the continuous insulation uninterrupted by framing.

renumber **TABLE C402.1(5)** *to* **TABLE C402.1(7)**

renumber **TABLE C402.1(6)** *to* **TABLE C402.1(8)**

delete **TABLE C402.1(7)** *and replace* **TABLE C402.1(9)**

TABLE C402.1(9)
ASSEMBLY *U*-FACTORS FOR WOOD-FRAMED WALLS

RATED *R*-VALUE OF CAVITY INSULATION (EFFECTIVE INSTALLED)	OVERALL *U*-FACTOR FOR ASSEMBLY	OVERALL *U*-FACTOR FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)								
		R-6	**R-9**	**R-12**	**R-15**	**R-20**	**R-25**	**R-30**	**R-35**	**R-40**
Wood Studs at 16 in. on Center and 3.5 in. Depth										
R-0 (0.0)	0.292					0.042	0.035	0.030	0.026	0.023
R-11 (11.0)	0.096		0.050	0.044	0.038	0.032	0.028	0.024	0.022	0.020
R-13 (13.0)	0.089		0.047	0.041	0.037	0.031	0.027	0.024	0.021	0.019
R-15 (15.0)	0.083		0.045	0.039	0.035	0.030	0.026	0.023	0.020	0.019
Wood Studs at 16 in. on Center and 5.5 in. Depth										
R-19 (18.0)	0.067	0.046	0.040	0.036	0.032	0.027	0.024	0.021	0.019	0.018
R-21 (21.0)	0.063	0.043	0.038	0.034	0.030	0.026	0.023	0.021	0.019	0.017
Wood Studs at 16 in. on Center and R-10 Headers										

R-19 (18.0)	0.063	0.045	0.039	0.035	0.031	0.027	0.024	0.021	0.019	0.017
R-21 (21.0)	0.059	0.042	0.037	0.033	0.030	0.026	0.023	0.020	0.018	0.017
Wood Studs at 24 in. on Center and 3.5 in. Depth										
R-0 (0.0)	0.298					0.042	0.035	0.030	0.026	0.023
R-11 (11.0)	0.094		0.050	0.043	0.038	0.032	0.027	0.024	0.022	0.019
R-13 (13.0)	0.086		0.047	0.041	0.036	0.031	0.026	0.023	0.021	0.019
R-15 (15.0)	0.080		0.044	0.039	0.035	0.029	0.026	0.023	0.020	0.018
Wood Studs at 24 in. on Center and 5.5 in. Depth										
R-19 (18.0)	0.065	0.045	0.039	0.035	0.032	0.027	0.024	0.021	0.019	0.018
R-21 (21.0)	0.060	0.042	0.037	0.033	0.030	0.026	0.023	0.020	0.018	0.017
Wood Studs at 24 in. on Center and R-10 Headers										
R-19 (18.0)	0.062	0.044	0.039	0.034	0.031	0.027	0.024	0.021	0.019	0.017
R-21 (21.0)	0.057	0.041	0.036	0.032	0.029	0.025	0.023	0.020	0.018	0.017

Note: Lightly shaded areas comply with building occupancies other than conditioned R-2 spaces. Darkly shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces .

delete and replace **C402.1.1 Insulation component *R*-value-based method.**
Building thermal envelope opaque assemblies shall comply with the requirements of Sections C402.2 and C402.3. For opaque portions of the *building thermal envelope* intended to comply on an insulation component *R-value* basis, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in the "Minimum R-values" columns of Table C402.1(2) and Table C402.1(3). Where cavity insulation is installed in multiple layers, the cavity insulation R-values shall be summed to determine compliance with the cavity insulation R-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation R-values shall be summed to determine compliance with the continuous insulation R-value requirements. Cavity insulation R-values shall not be used to determine compliance with the continuous insulation R-value requirements in Table C402.1(2) and Table C402.1(3). Commercial buildings or portions of commercial buildings enclosing *conditioned spaces* shall use the *R*-values from the "Conditioned Space" Table C402.1(2). Commercial buildings or portions of commercial buildings enclosing semi-conditioned spaces shall use the *R*-values from the "Semi-conditioned Space" Table C402.1(3). Walls between conditioned and semi-conditioned spaces shall use the *R*-values from the "Semi-conditioned Space" Table C402.1(3).

delete and replace **C402.1.2 Assembly *U*-factor, *C*-factor or *F*-factor-based method.**
Building thermal envelope opaque assemblies shall meet the requirements of Sections C402.2 and C402.3. Building thermal envelope opaque assemblies intended to comply on an assembly *U*-, *C*- or *F*-factor basis shall have a *U*-, *C*- or *F*-factor not greater than that specified in the "Maximum Overall *U*-factor" columns of Table C402.1(2) and Table C402.1(3). Commercial buildings or portions of commercial buildings enclosing *conditioned spaces* shall use the *U*-, *C*- or *F*-factor from the "*Conditioned Space*" Table C402.1(2). Commercial buildings or portions of commercial buildings enclosing semi-conditioned spaces shall use the *U*-, *C*- or *F*-factor from the "Semi-conditioned Space" Table C402.1(3). Walls between conditioned and semi-

conditioned spaces shall use the *R*-values from the "Semi-conditioned Space" Table C402.1(3).

add **C402.1.2.1 Roof/ceiling assembly.**
The maximum, roof/ceiling assembly U-factor shall not exceed that specified in Table C402.1(2) and Table C402.1(3) based on construction materials used in the roof/ceiling assembly.

add **C402.1.2.1.1 Tapered, above-deck insulation based on thickness.**
Where used as a component of a maximum roof/ceiling assembly U-factor calculation, the sloped roof insulation R-value contribution to that calculation shall use the average thickness in inches (mm) along with the material R-value-per-inch (per-mm) solely for U-factor compliance as prescribed in Section C402.1.1.

add **C402.1.2.1.2 Suspended ceilings.**
Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly U-factor of the roof/ceiling construction.

add **C402.1.2.1.3 Joints staggered.**
Continuous insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

delete and replace **C402.1.3 Component performance alternative.**
Building envelope values and fenestration areas determined in accordance with Equation 4-1 shall be an alternative to compliance with the *U-, F-* and *C*-factors in Tables C402.1(2) and Table C402.1(3) and C402.3 and the maximum allowable fenestration areas in Section C402.3.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.3.3.

A + B + C + D + E ≤ Zero **(Equation 4-1)**

where:

A	=	Sum of the (UA Dif) values for each distinct assembly type of the building thermal envelope, other than slabs on grade and below-grade walls.
UA Dif	=	UA Proposed - UA Table.
UA Proposed	=	Proposed *U*-value × Area.
UA Table	=	(*U*-factor from Table C402.1(2) and Table C402.1(3) or C402.3) × Area.
B	=	Sum of the (FL Dif) values for each distinct slab on-grade perimeter condition of the building thermal envelope.
FL Dif	=	FL Proposed - FL Table.
FL Proposed	=	Proposed *F*-value × Perimeter length.
FL Table	=	[*F*-factor specified in Table C402.1(2) and Table C402.1(3)] × Perimeter length.
C	=	Sum of the (CA Dif) values for each distinct below-grade wall assembly type of the building thermal envelope.
CA Dif	=	CA Proposed - CA Table.
CA Proposed	=	Proposed *C*-value × Area.

CA Table	=	[Maximum allowable *C*-factor specified in Table C402.1(2) and Table C402.1(3)] × Area.

Where the proposed vertical glazing area is less than or equal to the maximum vertical glazing area allowed by Section C402.3.1, the value of D (Excess Vertical Glazing Value) shall be zero. Otherwise:

D	=	(DA × UV) - (DA × U Wall), but not less than zero.
DA	=	(Proposed Vertical Glazing Area) - (Vertical Glazing Area allowed by Section C402.3.1).
UA Wall	=	Sum of the (UA Proposed) values for each opaque assembly of the exterior wall.
U Wall	=	Area-weighted average *U*-value of all above-grade wall assemblies.
UAV	=	Sum of the (UA Proposed) values for each vertical glazing assembly.
UV	=	UAV/total vertical glazing area.

Where the proposed skylight area is less than or equal to the skylight area allowed by Section C402.3.1, the value of E (Excess Skylight Value) shall be zero. Otherwise:

E	=	(EA × US) - (EA × U Roof), but not less than zero.
EA	=	(Proposed Skylight Area) - (Allowable Skylight Area as specified in Section C402.3.1).
U Roof	=	Area-weighted average *U*-value of all roof assemblies.
UAS	=	Sum of the (UA Proposed) values for each skylight assembly.
US	=	UAS/total skylight area.

delete and replace **C402.1.4 Building above-grade performance alternative.** Above-grade building envelope values determined in accordance with Equation 4-2 shall be an alternative to compliance with the *U*-factors in Tables C402.1(2) and Table C402.1(3) and C402.3 and the maximum allowable fenestration areas in Section C402.3.1. Below-grade walls, floors, and slabs shall meet the applicable requirements of Section C402.1.1 or C402.1.2. *Fenestration* shall meet the applicable SHGC requirements of Section C402.3.3.

UA-Total/Area ≤ 0.032 **(Equation 4-2)**

where:

UA-Total	=	Sum of the (UA) values for each distinct above-grade assembly type of the building thermal envelope including above-grade walls, roofs, doors, vertical fenestration, and skylights.
UA	=	Proposed *U*-value × Area.
Area	=	Surface area in square feet of the above-grade thermal barrier (above-grade wall area plus roof area).

delete and replace **C402.2 Specific building thermal envelope insulation requirements.** Insulation in building thermal envelope opaque assemblies shall comply with Sections C402.2.1 through C402.2.8 and Table C402.1(2) and Table C402.1(3).

delete and replace **C402.2.1 Roof assembly.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1(2) and Table C402.1(3), based on construction materials used in the roof assembly.

add **C402.2.1.1 Tapered, above-deck insulation based on thickness.** Where used as a component of a roof/ceiling assembly R-value calculation, the sloped roof insulation R-value contribution to that calculation shall use the average thickness in inches (mm) along with the material R-value-per-inch (per-mm) solely for R-value compliance as prescribed in Section 402.1.3.

add **C402.2.1.2 Minimum insulation, lowest point.** The minimum insulation of abovedeck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than R-12.

add **C402.2.1.3 Suspended ceilings.** Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (R-value) of roof insulation in roof/ceiling construction.

add **C402.2.1.4 Joints staggered.** Continuous insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

add **C402.2.1.5 Mechanical curbs.** The minimum insulation of abovedeck roof insulation at the location of a mechanical curb, shall be not less than R-12.

add **C402.2.1.6 Skylight curbs.** Skylight curbs shall be insulated to the level of roofs with insulation entirely above the deck or R-10, whichever is less.

Exception: Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

delete and replace **C402.2.2 Above-grade walls.** The minimum thermal resistance (*R*-value) of materials installed in the wall cavity between framing members and continuously on the walls shall be as specified in Table C402.1(2) and Table C402.1(3), based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1(2) and Table C402.1(3) except as otherwise noted in the table. In determining compliance with Table C402.1(2) and Table C402.1(3), the use of the U-factor of concrete masonry units with integral insulation shall be permitted. “Mass walls” where used as a component in the thermal envelope of a building shall comply with one of the following:

1. Weigh not less than 35 pounds per square foot (171 kg/m^2) of wall surface area.

2. Weigh not less than 25 pounds per square foot (122 kg/m^2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m^3).

3. Have a heat capacity exceeding 7 Btu/ft^2 • °F (144 kJ/m^2 • K).

4. Have a heat capacity exceeding 5 Btu/ft^2 • °F (103 kJ/m^2 • K), where the material weight is not more than 120 pcf (1900 kg/m^3).

delete and replace **C402.2.3 Floors.**
The thermal properties (component *R*-values or assembly *U*-, *C*- or *F*-factors) of floor assemblies over outdoor air or unconditioned space shall be as specified in Table C402.1(2) and Table C402.1(3), based on construction materials used in the floor assembly. Floor framing *cavity insulation* or structural slab insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs.

"Mass floors" where used as a component of the thermal envelope of a building shall provide one of the following weights:

1. 35 pounds per square foot (171 kg/m^2) of floor surface area.

2. 25 pounds per square foot (122 kg/m^2) of floor surface area where the material weight is not more than 120 pounds per cubic foot. (1923 kg/m^3)

Exceptions:

1. The floor framing *cavity insulation* or structural slab insulation shall be permitted to be in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies where combined with insulation that meets or exceeds the minimum *U*-value in Table C402.1(2) and Table C402.1(3) for "Metal framed" or "Wood framed and other" values for "Walls, Above Grade" and extends from the bottom to the top of all perimeter floor framing or floor assembly members.

2. Insulation applied to the underside of concrete floor slabs shall be permitted an airspace of not more than 1 inch (25 mm) where it turns up and is in contact with the underside of the floor under walls associated with the *building thermal envelope.*

delete and replace **C402.2.4 Slabs-on-grade.**
The minimum thermal resistance (*R*-value) of the insulation for unheated or heated slab-on-grade floors designed in accordance with the *R*-value method of Section C402.1.1 shall be as specified in Table C402.1(2) and Table C402.1(3).

add **C402.2.4.1 Insulation installation.** Where installed, the perimeter insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The perimeter insulation shall extend downward from the top of the slab for the minimum distance shown in the table or to the top of the footing, whichever is less, or downward to not less than the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. Insulation extending away from the building shall be protected by pavement or by not less than of 10 inches (254 mm) of soil. Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

Exception: Where the slab-on-grade floor is greater than 24 inches (61 mm) below the finished exterior grade, perimeter insulation is not required.

delete and replace **C402.2.5 Below-grade walls.**
The *C*-factor for the below-grade exterior walls shall be in accordance with Table C402.1(2) and Table C402.1(3). The *R*-value of the insulating material installed continuously within or on the below-grade exterior walls of the building envelope shall be in accordance with Table C402.1(2) and Table C402.1(3). The *C*-factor or *R*-value required shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground level, or to the level of the lowest floor of the conditioned space enclosed by the below-grade wall, whichever is less.

delete and replace **C402.2.6 Insulation of radiant heating systems.**
Radiant heating system panels, and their associated components that are installed in interior or exterior assemblies shall be insulated to an *R*-value of not less than R-3.5 on all surfaces not facing the space being heated. *Radiant heating system* panels that are installed in the *building thermal envelope* shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the *R*-value of insulation installed in the opaque assembly in which they are installed or the assembly shall comply with Section C402.1.2.

Exception: Heated slabs on grade insulated in accordance with the “Heated slabs” row of Table C402.1(2) and Table C402.1(3).

delete and replace **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 an unventilated cavity constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.

Exception: The thermal resistance of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.

delete and replace **C402.3 Fenestration.**
Fenestration shall comply with Sections C402.3.1 through C402.3.5 and Table C402.3. Daylight responsive controls shall comply with this section and Section C405.2.3.1.

delete and replace **TABLE C402.3**

TABLE C402.3
BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

VERTICAL FENESTRATION		
***U*-factor**		
Fixed fenestration other than *storefront*	0.29	
Storefront fenestration	0.33	
Operable fenestration, R-2 *occupancy classifications*	0.30	
Operable fenestration, *occupancy classifications* other than R-2	0.36	
Entrance doors	0.63	
SHGC		
PF	Fixed	Operable
PF < 0.2	0.38	0.34
0.2 ≤ PF < 0.5	0.46	0.41
PF ≥ 0.5	0.61	0.54
SKYLIGHTS		
U-factor	0.41	
SHGC	0.38	

NR = No requirement, PF = Projection factor.

delete and replace **C402.3.1.1 Increased vertical fenestration area with daylight responsive controls (see Section C405.2.3).**
Not more than 40 percent of the gross above-grade wall area shall be vertical fenestration, provided that all of the following requirements are met:

1. In buildings not greater than two stories above grade, not less than 50 percent of the net floor area is within a *daylight zone*.

2. In buildings three or more stories above grade, not less than 25 percent of the net floor area is within a *daylight zone*.

3. *Daylight responsive controls* are installed in *daylight zones*.

4. Visible transmittance (VT) of vertical fenestration is not less than 1.1 times solar heat gain coefficient (SHGC).

Exception: Fenestration that is outside the scope of NFRC 200 is not required to comply with Item 4.

delete and replace **C402.3.1.2 Increased skylight area with daylight responsive controls.** The skylight area shall be not more than 6 percent of the roof area provided that *daylight responsive controls* are installed in *toplit daylight zones*.

delete and replace **C402.3.2 Minimum skylight fenestration area.**

Skylights shall be provided in enclosed spaces greater than 2,500 square feet (232 m^2) in floor area, directly under a roof with not less than 75 percent of the ceiling area with a ceiling height greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, storage space, gymnasium/exercise center, convention center, automotive service area, space where manufacturing occurs, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation depot or workshop. The total *toplit daylight zone* shall be not less than half the floor area and shall comply with one of the following:

1. A minimum skylight area to *toplit daylight zone* of not less than 3 percent where all skylights have a VT of not less than 0.40, or VT_{annual} of not less than 0.26, as determined in accordance with Section C303.1.3.

2. A minimum skylight effective aperture of not less than 1 percent, determined in accordance with Equation 4-3, of:
   2.1 Not less than 1 percent, using a skylight's VT rating; or
   2.2 Not less than 0.66 percent using a Tubular Daylighting Device's VT_{annual} rating.

$$\text{Skylight Effective Aperture} = \frac{0.85 \times \text{Skylight Area} \times \text{Skylight VT} \times \text{WF}}{\text{Toplit Zone}}$$

(Equation 4-3)

where:

Skylight area	=	Total fenestration area of skylights.
Skylight VT	=	Area weighted average visible transmittance of skylights.
WF	=	Area weighted average well factor, where well factor is 0.9 if light well depth is less than 2 feet (610 mm), or 0.7 if light well depth is 2 feet (610 mm) or greater, or 1.0 for Tubular Daylighting Devices with VT_{annual} ratings.
Light well depth	=	Measure vertically from the underside of the lowest point of the skylight glazing to the ceiling plane under the skylight.

Exception: Skylights above *daylight zones* of enclosed spaces are not required in:

1. Spaces where the designed *general lighting* power densities are less than 0.5 W/ft^2 (5.4 W/m^2).

2. Areas where it is documented that existing structures or natural objects block direct beam sunlight on not less than half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

3. Spaces where the *daylight zone* under rooftop monitors is greater than 50 percent of the enclosed space floor area.

- Spaces where the total area minus the area of sidelit *daylight zones* is less than 2,500 square feet (232 m^2), and where the lighting is controlled in accordance with Section C405.2.3.

- Spaces designed as storm shelters complying with ICC 500.

delete and replace **C402.3.2.1 Lighting controls in toplit daylight zones.**
Daylight responsive controls shall be provided in toplit daylight *zones*.

delete and replace **C402.3.2.2 Haze factor.**
Skylights in office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store and distribution/sorting area spaces shall have a glazing material or diffuser with a haze factor greater than 90 percent when tested in accordance with ASTM D1003.

Exception: Skylights and tubular daylighting devices designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of skylight and light well or the use of optical diffuser components.

delete and replace **C402.3.5 Doors.**
Opaque swinging doors shall comply with Table C402.1(2) and Table C402.1(3). Opaque nonswinging doors shall comply with Table C402.1(2) and Table C402.1(3). Opaque doors shall be considered as part of the gross area of above-grade walls that are part of the building *thermal envelope*. Opaque doors shall comply with Section C402.3.5.1 or C402.3.5.2. Other doors shall comply with the provisions of Section C402.3.3 for vertical fenestration.

add **C402.3.5.1 Opaque swinging doors.** Opaque swinging doors shall comply with Table C402.1(2) and Table C402.1(3).

add **C402.3.5.2 Nonswinging doors.** Opaque nonswinging doors that are horizontally hinged sectional doors with a single row of fenestration shall have an assembly U-factor less than or equal to 0.360, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

Exception: Other doors shall comply with the provisions of Section C402.4.3 for vertical fenestration.

delete and replace **C402.4 Air leakage—thermal envelope.**
The *building thermal envelope* shall comply with Sections C402.4.1 through C402.4.6.

delete and replace **C402.4.1 Air barriers.**
A continuous air barrier shall be provided throughout the building thermal envelope. The continuous air barriers shall be located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Section C402.4.1.1.

Exceptions:

1. For buildings larger than 250,000 ft^2 (25,000 m^2), that do not include Group R or Group I occupancies, the air barrier shall either comply with section C402.4.1.1 or Sections C402.4.1.2 through C402.4.1.8.

2. Where air barrier performance testing is determined unfeasible by the Vermont Department of Public Service, the air barrier shall comply with sections C402.4.1.2 through C402.4.1.8.

delete and replace **C402.4.1.1 Air barrier performance testing.**
The building *thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTME3158 OR ASTM E1827 or an equivalent method approved by the Vermont Department of Public Service. The measured air leakage shall not exceed 0.25 cfm/ft^2 of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.

2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.

3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: R-2 *building occupancies* six stories or less shall be tested at a pressure differential of 0.2 inch water gauge (50 Pa), and the measured air leakage shall not exceed 0.15 cfm/ft^2 of the *building thermal envelope* area.

delete and replace **C402.4.1.4.1 Materials.**

Materials with an air permeability not greater than 0.004 cfm/ft^2 (0.02 L/s • m^2) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than $^3/_8$ inch (10 mm).
2. Oriented strand board having a thickness of not less than $^3/_8$ inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
5. Closed-cell spray foam having a minimum density of 1.5 pcf (2.4 kg/m^3) and having a thickness of not less than 1$^1/_2$ inches (38 mm).
6. Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than $^1/_2$ inch (12.7 mm).
8. Cement board having a thickness of not less than $^1/_2$ inch (12.7 mm).
9. Built-up roofing membrane.
10. Modified bituminous roof membrane.
11. Single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than $^5/_8$ inch (15.9 mm).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.
16. Solid or hollow masonry constructed of clay or shale masonry units.

delete and replace **C402.4.1.4.2 Assemblies.**
Assemblies of materials and components with an average air leakage not greater

than 0.04 cfm/ft^2(0.2 L/s • m^2) under a pressure differential of 0.3 inch of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E2357, ASTM E1677, ASTM D8052 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 shall be deemed to comply, provided that joints are sealed and the requirements of Section C402.4.1.3 are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating.

2. Masonry walls constructed of clay or shale masonry units with a nominal width of 4 inches (102 mm) or more.

3. A Portland cement/sand parge, stucco or plaster not less than $^1/_2$ inch (12.7 mm) in thickness.

delete and replace **C402.4.1.6 Rooms containing fuel-burning appliances that are not direct vented.**
Where combustion air is supplied through openings in an exterior wall to a room or space containing a space-conditioning fuel-burning appliance, one of the following shall apply:

1. The room or space containing the appliance shall be located outside of the *building thermal envelope*.

2. The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the building thermal envelope. Such rooms shall comply with all of the following:

   2.1. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be insulated to be not less than equivalent to the insulation requirement of below-grade walls as specified in Table C402.1(2) and Table C402.1(3).

   2.2. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.4.1.3.

   2.3. The doors into the enclosed room or space shall be fully gasketed.

   2.4. Water lines and ducts in the enclosed room or space shall be insulated in accordance with Section C403.

   2.5. Where an air duct supplying combustion air to the enclosed room or space passes through conditioned space, the duct shall be insulated to an *R*-value of not less than R-10.

Exception: Fireplaces and stoves complying with Section 2111.14 of the *International Building Code*.

delete and replace **C402.4.2 Dwelling and sleeping unit enclosure testing.**

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.15 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one building thermal envelope, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

delete and replace **C402.4.4 Loading dock weather seals.**
Cargo door openings and loading door openings shall be equipped with weather seals that restrict infiltration and provide direct contact along the top and sides of vehicles that are parked in the doorway. If equipped with an interior dock leveler, the deck of the leveler, rear pit wall, and the deck plate shall be insulated with a minimum of 1.5 inches of sprayed closed cell foam. The side pit walls and pit slab shall be insulated in accordance with the ASTM E283 slab on grade standard found in Table C402.1(2) and Table C402.1(3). The spaces between the pit wall and the deck skirts for the leveler shall be weather-stripped. Provide each dock board with an exterior face closure curtain to reduce air infiltration under the dock board.

add **C402.4.6 Operable openings interlocking**. Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

Exceptions:
1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Warehouses that utilize overhead doors for the function of the occupancy.
3. The first entrance doors where located in the exterior wall and are part of a vestibule system.

add **C402.4.6.1 Operable controls.** Controls shall comply with Section C403.14.

add **C402.5 Solar-ready zone**

add **C402.5.1 General.**
A solar-ready zone shall be located on the roof of buildings and are oriented between 110 degrees and 270 degrees of true north or have low-slope roofs. Solar-ready zones shall comply with Sections C402.5.2 through C402.5.8.

Exceptions:

1. A building with a permanently installed, on-site renewable energy system.

2. A building with a solar-ready zone that is shaded for more than 70 percent of daylight hours annually.

3. A building where the licensed design professional certifies that the incident solar radiation available to the building is not suitable for a solar-ready zone.

4. A building where the licensed design professional certifies that the solar zone area required by Section C402.5.3 cannot be met because of extensive rooftop equipment, skylights, vegetative roof areas or other obstructions.

add **C402.5.2 Construction document requirements for a solar-ready zone.**
Construction documents shall indicate the solar-ready zone.

add **C402.5.3 Solar-ready zone area.**
The total solar-ready zone area shall be not less than 40 percent of the roof area calculated as the horizontally projected gross roof area less the area covered by skylights, occupied roof decks, vegetative roof areas and mandatory access or set back areas as required by the *International Fire Code*. The solar-ready zone shall be a single area or smaller, separated sub-zone areas. Each sub-zone shall be not less than 5 feet (1524 mm) in width in the narrowest dimension.

add **C402.5.4 Obstructions.**
Solar ready zones shall be free from obstructions, including pipes, vents, ducts, HVAC equipment, skylights and roof-mounted equipment.

add **C402.5.5 Roof loads and documentation.**
A collateral dead load of not less than 5 pounds per square foot (5 psf) (24.41 kg/m^2) shall be included in the gravity and lateral design calculations for the solar-ready zone. The structural design loads for roof dead load and roof live load shall be indicated on the construction documents.

add **C402.5.6 Interconnection pathway.**
Construction documents shall indicate pathways for routing of conduit or piping from the solar-ready zone to the electrical service panel and electrical energy storage system area or service hot water system.

add **C402.5.7 Electrical energy storage system-ready area.**
The floor area of the electrical energy storage system-ready area shall be not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm) in another dimension and located in accordance with rules adopted by Vermont fire safety code. The location and layout diagram of the electrical energy storage system-ready area shall be indicated on the construction documents.

add **C402.5.8 Electrical service reserved space.**

The main electrical service panel shall have a reserved space to allow installation of a dual-pole circuit breaker for future solar electric and a dual-pole circuit breaker for future electrical energy storage system installation. These spaces shall be labeled “For Future Solar Electric and Storage.” The reserved spaces shall be positioned at the end of the panel that is opposite from the panel supply conductor connection.

SECTION C403
BUILDING MECHANICAL SYSTEMS

delete and replace **C403.1 General.**
In addition to the mechanical requirements of Section C403, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, mechanical enhancements may be needed.

The requirements of C403 that may be affected and the corresponding C406 references are summarized in Table C403.1(1). For a full list of potential measures see Table C406.2.1 and Table C406.3.1.

add **TABLE C403.1(1)**

TABLE C403.1(1):
C406 MEASURES AFFECTING MECHANICAL SYSTEMS

ID	C406 Measure Title	C403 Reference	C406 Section
H01	HVAC Performance	n/a	C406.2.2.1
H02	Heating efficiency	C403.3.2	C406.2.2.2
H03	Cooling efficiency	C403.3.2	C406.2.2.3
H04	Residential HVAC control	C403.7.6	C406.2.2.4
H05	Energy Recovery	C403.7.3	C406.2.2.5
Q04	Fault Detection	C403.2.3	C406.2.4
G02	HVAC Load Management	n/a	C406.3.3
G05	Cooling Energy Storage	n/a	C406.3.6
G07	Building Thermal Mass	n/a	C406.3.8

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

1. Sections C403.1.1 and C403.2 through C403.14
2. Data Centers shall comply with C403.1.1, C403.1.2 and C403.6 through C403.14
3. Section C403.1.3 and Sections within Section C403 that are listed in Table C407.2

   Exception: Data center systems are exempt from the requirements of Sections C403.4 and C403.5.

add **C403.1.2 Data centers.** Data center systems shall comply with Sections 6 and 8 of **ASHRAE 90.4** with the following changes:

1. Replace maximum design mechanical load component (MLC) values specified in Table 6.2.1.1 of the ASHRAE 90.4 with the value in Table C403.1.2(1).
2. Replace maximum annualized MLC values specified in Table 6.2.1.2 of the ASHRAE 90.4 with the value in Table C403.1.2(2).

add **TABLE C403.1.2(1)**

TABLE C403.1.2(1)
MAXIMUM DESIGN MECHANICAL LOAD COMPONENT (DESIGN MLC)

CLIMATE ZONE	DESIGN MLC AT 100% AND AT 50% ITE LOAD
6A	0.22

add **TABLE C403.1.2(2)**

TABLE C403.1.2(2)
MAXIMUM ANNUALIZED MECHANICAL LOAD COMPONENT (ANNUALIZED MLC)

CLIMATE ZONE	HVAC MAXIMUM ANNUALIZED MLC AT 100% AND AT 50% ITE LOAD
6A	0.17

add **C403.1.3 HVAC total system performance ratio (HVAC TSPR).**

HVAC systems serving buildings or portions of buildings listed in C403.1.3.1 that are not served by systems listed in C403.1.3.2 shall have an HVAC total system performance ratio (HVAC TSPR) of the proposed design HVAC systems that is greater than or equal to the HVACTSPR of the standard reference design divided by the applicable mechanical performance factor (MPF) from Table C409.3.1. HVAC TSPR shall be calculated in accordance with Section C409, Calculation of HVAC Total System Performance Ratio. Systems using the HVAC TSPR method shall also meet requirements in C403.1.3.3.
C403.1.3.1 Included Building Types. HVAC systems that serve the following building use types are allowed to use the TSPR Method:

1. occupancy group B,
2. occupancy group M,
3. occupancy group A-3,
4. occupancy group E,
5. occupancy group R-1,
6. the dwelling units and common areas within occupancy group R-2 multifamily buildings.

add **C403.1.3.2 Excluded Systems.** The following HVAC systems are excluded from using the TSPR Method:

1. HVAC Systems using
   1.1 district heating water, chilled water or steam
   2.1 small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or

3.1 double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431
4.1 packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr 5.(3500 kW)
5.1 a common heating source serving both HVAC and service water heating equipment, or

2. HVAC systems that provide recovered heat for service water heating
3. HVAC systems not included in Table C409.5.2.10.1
4. HVAC systems included in table C409.5.2.10.1 with parameters in Table C409.5.2.10.2, 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 plants 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 that comply fully with ASHRAE Standard 170, including but not limited to surgical centers, or that are required by other applicable codes or standards to provide 24/7 air handling unit operation
11. HVAC systems serving laboratories with fume hoods
12. Locker rooms with more than 2 showers
13. Natatoriums and rooms with saunas
14. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h
15. Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.
16. Cafeterias and dining rooms

add **C403.1.3.3 TSPR Method Partial Prescriptive Requirements**. HVAC systems using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section C403 as follows:

1. Air economizers shall meet the requirements of Section C403.5.3.4 “relief of excess outdoor air” and Section C403.5.5 “Economizer fault detection and diagnostics.”
2. Variable-air-volume system systems shall meet requirements of Sections C403.6.5, C403.6.6, and C403.6.9.
3. Hydronic systems shall meet the requirements of C403.4.4.
4. Plants with multiple chillers or boilers shall meet the requirements of Section C403.4.5.
5. Hydronic (Water Loop) Heat Pumps and Water-Cooled Unitary Air Conditioners shall meet the requirements of Section C403.4.3.3.
6. Cooling tower turndown shall meet requirements of Section C403.10.4.
7. Heating of unenclosed spaces shall meet the requirements of Section C403.13.1.
8. Hot-gas bypass shall meet the requirements of Section C403.3.3.
9. Systems shall meet the operable openings interlock requirements of Section C402.5.11.10.
10. Refrigeration systems shall meet the requirements of Section C403.11.

delete and replace **C403.2 System design**
Mechanical systems shall be designed to comply with Sections C403.2.1 through C403.2.3 Where elements of a building's mechanical systems are addressed in Sections C403.3 through C403.14, such elements shall comply with the applicable provisions of those sections. Hydronic heating systems and associated equipment shall be sized for and operated at a maximum heating hot water temperature of 140F. Construction documents shall include submittal of a Sequence of Operations for all mechanical equipment, including a specification outlining each of the functions required by this section.

delete and replace **C403.2.2 Ventilation**
Ventilation, either natural or mechanical, shall be provided in accordance with. ASHRAE Standard 62.1. Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by ASHRAE Standard 62.1. The design professional shall utilize ventilation rates based on the expected occupancy level of the space. Life safety maximum allowable occupancy density shall not be used as a ventilation basis of design.

Exception: All Residential occupancies. See the ventilation requirements of Section 304 of the *Vermont Residential Building Energy Standards*.

delete and replace **C403.2.4 Fault detection and diagnostics.** New buildings with an HVAC system serving a gross conditioned floor area of 100,000 square feet (9290 m2) or larger shall include a fault detection and diagnostics (FDD) system to monitor the HVAC system's performance and automatically identify faults. The FDD system shall:

1. Include permanently installed sensors and devices to monitor the HVAC system's performance.
2. Sample the HVAC system's performance at least once every 15 minutes.
3. Automatically identify and report HVAC system faults.
4. Automatically notify authorized personnel of identified HVAC system faults.
5. Automatically provide prioritized recommendations for repair of identified faults based on analysis of data collected from the sampling of HVAC system performance.
6. Be capable of transmitting the prioritized fault repair recommendations to remotely located authorized personnel.

Exception: R-1 and R-2 occupancies.

add **C403.2.5 Mechanical systems commissioning and completion requirements.** Mechanical systems shall be commissioned and completed in accordance with Section C407

delete and replace **C403.3 Heating and cooling equipment efficiencies**
Heating and cooling equipment installed in mechanical systems shall be sized in accordance with Section C403.3.1 and shall be not less efficient in the use of energy than as specified in Section C403.3.2.

delete and replace **C403.3.1 Equipment sizing**
The output capacity of heating and cooling equipment shall be not greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.1.1. A single piece of equipment providing both heating and cooling shall satisfy this provision for one function with the capacity for the other function as small as possible, within

available equipment options. Heating and cooling equipment sizing is permitted to be up to 10 percent greater (to the next nearest available size) than the calculated peak heating and cooling loads to allow for building pickup and cool down after temperature setback conditions or for proper airflow volumes. Heat pump equipment shall not be sized greater than the calculated peak heating and cooling loads, as they are exempt from temperature setbacks and are significantly less efficient when oversized. Outdoor condensing units serving multiple indoor heat pump units shall be sized equal or less than the total capacity of the indoor units.

Exceptions:

1. Required standby equipment and systems provided with controls and devices that allow such systems or equipment to operate automatically only when the primary equipment is not operating.

2. Multiple units of the same equipment type with combined capacities exceeding the design load and provided with controls that are configured to sequence the operation of each unit based on load.

delete and replace **TABLE C403.3.2(1)**

TABLE C403.3.2(1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS[c, d]

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air conditioners, air cooled	< 65,000 Btu/h[b]	All	Split system, three phase	13.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/23 AHRI 210/240 – 2023 after 1/1/2023
			Single package, three phase	14.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/23	
Space constrained, aircooled	≤30,000 Btu/h[b]	All	Split System, three phase	12.0 SEER before 1/1/2023 11.7 SEER2	AHRI 210/240 – 2017 before 1/1/2023

				after 1/1/2023	AHRI 210/240 – 2023 after 1/1/2023
			Single package, three phase	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
Small duct, high-velocity, air cooled	< 65,000 Btu/h[b]	All	Split System, three phase	12.0 SEER before 1/1/2023 12.1 SEER2 after 1/1/2023	AHRI 210/240 – 2017 before 1/1/2023 AHRI 210/240 – 2023 after 1/1/2023
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.2 EER 12.9 IEER before 1/1/2023 14.8 IEER after 1/1/2023	AHRI 340/360
		All other		11.0 EER 12.7 IEER before 1/1/2023 14.6 IEER after 1/1/2023	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		11.0 EER 12.4 IEER before 1/1/2023 14.2 IEER after 1/1/2023	
		All other		10.8 EER 12.2 IEER before 1/1/2023 14.0 IEER after 1/1/2023	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)		10.0 EER 11.6 IEER before 1/1/2023 13.2 IEER after 1/1/2023	

		All other		9.8 EER 11.4 IEER before 1/1/2023 13.0 IEER after 1/1/2023	
	≥ 760,000 Btu/h	Electric resistance (or none)		9.7 EER 11.2 IEER before 1/1/2023 12.5 IEER after 1/1/2023	
		All other		9.5 EER 11.0 IEER before 1/1/2023 12.3 IEER after 1/1/2023	
Air conditioners, water cooled	< 65,000 Btu/h	All	Split system and single package	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)		12.1 EER 13.9 IEER	AHRI 340/360
		All other		11.9 EER 13.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		12.5 EER 13.9 IEER	
		All other		12.3 EER 13.7 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)		12.4 EER 13.6 IEER	
		All other		12.2 EER 13.4 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)		12.2 EER 13.5 IEER	
		All other		12.0 EER 13.3 IEER	

TABLE C403.3.2(1)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE					

	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air conditioners, evaporatively cooled	< 65,000 Btu/h[b]	All	Split system and single package	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)		12.1 EER 12.3 IEER	AHRI 340/360
		All other		11.9 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		12.0 EER 12.2 IEER	
		All other		11.8 EER 12.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)		11.9 EER 12.1 IEER	
		All other		11.7 EER 11.9 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)		11.7 EER 11.9 IEER	
		All other		11.5 EER 11.7 IEER	
Condensing units, air cooled	≥ 135,000 Btu/h	—	—	10.5 EER 11.8 IEER	AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h	—	—	13.5 EER 14.0 IEER	AHRI 365
Condensing units, evaporatively cooled	≥ 135,000 Btu/h	—	—	13.5 EER 14.0 IEER	AHRI 365

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b. Single-phase, US air-cooled air conditioners less than 65,000 Btu/h are regulated as consumer products by the US Department of Energy Code of Federal Regulations DOE 10 CFR 430. SEER and SEER2 values for single-phase products are set by the US Department of Energy.

c. DOE 10 CFR 430 Subpart B Appendix M1 includes the test procedure updates effective 1/1/2023 that will be incorporated in AHRI 210/240—2023.

d. This table is a replica of ASHRAE 90.1 Table 6.8.1-1 Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(2)**

TABLE C403.3.2(2)

ELECTRICALLY OPERATED AIR-COOLED UNITARY HEAT PUMPS

MINIMUM EFFICIENCY REQUIREMENTS[c, d]

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (cooling mode)	< 66,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	14.0 SEER before 1/1/2023 14.3 SEER2 after 1/1/2023	AHRI 210/240 – 2017 before 1/1/2023 AHRI 210/240 – 2023 after 1/1/2023
			Single package, three phase and applications outside US single phase[b]	14.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023	
Space constrained, air cooled (cooling mode)	≤ 30,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
			Single package, three phase and applications outside US single phase[b]	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
Single-duct, high-velocity, air cooled (cooling mode)	< 65,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	12.0 SEER before 1/1/2023 12.0 SEER2 after 1/1/2023	
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.0 EER 12.2 IEER before 1/1/2023 14.1 IEER after 1/1/2023	AHRI 340/360
		All other		10.8 EER 12.0 IEER before 1/1/2023 13.9 IEER after 1/1/2023	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		10.6 EER 11.6 IEER before 1/1/2023	

				13.5 IEER after 1/1/2023	
		All other		10.4 EER 11.4 IEER before 1/1/2023 13.3 IEER after 1/1/2023	
	≥ 240,000 Btu/h	Electric resistance (or none)		9.5 EER 10.6 IEER before 1/1/2023 12.5 IEER after1/1/2023	
		All other		9.3 EER 10.4 IEER before 1/1/2023 12.3 IEER after 1/1/2023	
Air cooled (heating mode)	<65,000 Btu/hr	All	Split system, three phase and applications outside US single phase[b]	8.2 HSPF before 1/1/2023 7.5 HSPF2 after 1/1/2023	AHRI 210/240 – 2017 before 1//2023 AHRI 210/240-2023 after 1/1/2023
			Single package, three phase and applications outside US single phase[b]	8.0 HSPF before 1/1/2023 6.7 HSPF2 after 1/1/2023	
Space constrained, air cooled (heating mode)	≤30,000 Btu/hr	All	Split system, three phase and applications outside US single phase[b]	7.4 HSPF before 1/1/2023 6.3 HSPF2 after 1/1/2023	AHRI 210/240 – 2017 before 1//2023 AHRI 210/240-2023 after 1/1/2023
			Single package, three phase and applications outside US single phase[b]	7.4 HSPF before 1/1/2023 6.3 HSPF2 after 1/1/2023	
Small duct, high velocity, air cooled (heating mode)	<65,000 Btu/hr	All	Split system, three phase and applications outside US single phase[b]	3.30 COP_H before 1/1/2023 3.40 COP_H after 1/1/2023	AHRI 210/240 – 2017 before 1//2023 AHRI 210/240-2023 after 1/1/2023
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling Capacity)	All	47°F db/43°F wb outdoor air	3.30 COP_H before 1/1/2023 3.40 COP_H after 1/1/2023	AHRI 340/360
			17°F db/15°F wb outdoor air	2.25 COP_H	

	≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)		47°F db/43°F wb outdoor air	3.20 COP_H before 1/1/2023 3.30 COP_H after 1/1/2023	
			17°F db/15°F wb outdoor air	2.05 COP_H	
	≥ 240,000 Btu/h (cooling capacity)		47°F db/43°F wb outdoor air	3.20 COP_H	
			17°F db/15°F wb outdoor air	2.05 COP_H	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8, wb = wet bulb, db = dry bulb.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Single-phase, US air-cooled heat pumps less than 65,000 Btu/h are regulated as consumer products by the US Department of Energy Code of Federal Regu- lations DOE 10 CFR 430. SEER, SEER2 and HSPF values for single-phase products are set by the US Department of Energy.

c. DOE 10 CFR 430 Subpart B Appendix M1 includes the test procedure updates effective 1/1/2023 that will be incorporated in AHRI 210/240—2023.

d. This table is a replica of ASHRAE 90.1 Table 6.8.1-2 Electrically Operated Air-Cooled Unitary Heat Pumps Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(3)**

TABLE C403.3.2(3)
WATER CHILLING PACKAGES – EFFICIENCY REQUIREMENTS[a, b, d]

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	Path A	Path B	TEST PROCEDURE[c]
Air-cooled chillers	< 150 Tons	EER (Btu/W)	≥ 10.100 FL	≥ 9.700 FL	AHRI 550/590
			≥ 13.700 IPLV.IP	≥ 15,800 IPLV.IP	
	≥ 150 Tons		≥ 10.100 FL	≥ 9.700 FL	
			≥ 14.000 IPLV	≥ 16.100 IPLV	
Air cooled without condenser, electrically operated	All capacities	EER (Btu/W)	Air-cooled chillers without condenser shall be rated with matching condensers and complying with air-cooled chiller efficiency requirements.		AHRI 550/590
Water cooled, electrically operated positive displacement	< 75 Tons	kW/ton	≤ 0.750 FL	≤ 0.780 FL	AHRI 550/590
			≤ 0.600 IPLV.IP	≤ 0.500 IPLV.IP	
	≥ 75 tons and < 150 tons		≤ 0.720 FL	≤ 0.750 FL	
			≤ 0.560 IPLV.IP	≤ 0.490 IPLV.IP	
			≤ 0.660 FL	≤ 0.680 FL	

	≥ 150 tons and < 300 tons		≤ 0.540 IPLV.IP	≤ 0.440 IPLV.IP	
	≥ 300 tons and < 600 tons		≤ 0.610 FL	≤ 0.625 FL	
			≤ 0.520 IPLV.IP	≤ 0.410 IPLV.IP	
	≥ 600 tons		≤ 0.560 FL	≤ 0.585 FL	
			≤ 0.500 IPLV.IP	≤ 0.380 IPLV.IP	
Water cooled, electrically operated centrifugal	< 150 Tons	kW/ton	≤ 0.610 FL	≤ 0.695 FL	AHRI 550/590
			≤ 0.550 IPLV.IP	≤ 0.440 IPLV.IP	
	≥ 150 tons and < 300 tons		≤ 0.610 FL	≤ 0.635 FL	
			≤ 0.550 IPLV.IP	≤ 0.400 IPLV.IP	
	≥ 300 tons and < 400 tons		≤ 0.560 FL	≤ 0.595 FL	
			≤ 0.520 IPLV.IP	≤ 0.390 IPLV.IP	
	≥ 400 tons and < 600 tons		≤ 0.560 FL	≤ 0.585 FL	
			≤ 0.500 IPLV.IP	≤ 0.380 IPLV.IP	
	≥ 600 Tons		≤ 0.560 FL	≤ 0.585 FL	
			≤ 0.500 IPLV.IP	≤ 0.380 IPLV.IP	
Air cooled, absorption, single effect	All capacities	COP (W/W)	≥ 0.600 FL	NA[c]	AHRI 560
Water cooled absorption, single effect	All capacities	COP (W/W)	≥ 0.700 FL	NA[c]	AHRI 560
Absorption, double effect, indirect fired	All capacities	COP (W/W)	≥ 1.000 FL	NA[c]	AHRI 560
			≥ .050 IPLV.IP		
Absorption double effect direct fired	All capacities	COP (W/W)	≥ 1.000 FL	NA[c]	AHRI 560
			≥ 1.000 IPLV		

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. The requirements for centrifugal chillers shall be adjusted for nonstandard rating conditions per Section C403.3.2.1 and are applicable only for the range of conditions listed there. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

c. Both the full-load and IPLV.IP requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.

d. NA means the requirements are not applicable for Path B, and only Path A can be used for compliance.

e. FL is the full-load performance requirements, and IPLV.IP is for the part-load performance requirements.

f. This table is a replica of ASHRAE 90.1 Table 6.8.1-3 Water-Chilling Packages—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(4)**

TABLE C403.3.2(4)

ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS, PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS, SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS - MINIMUM EFFICIENCY REQUIREMENTS[e]

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
PTAC (cooling mode) standard size	<7,000 Btu/h	95°F db/75°F wb outdoor air[c]	11.9 EER	AHRI 310/380
	≥7,000 Btu/h and ≤15,000 Btu/h		14.0 – (0.300 × Cap/1000) EER[d]	
	>15,000 Btu/h		9.5 EER	
PTAC (cooling mode) nonstandard size[a]	<7,000 Btu/h	95°F db/75°F wb outdoor air[c]	9.4 EER	AHRI 310/380
	≥7,000 Btu/h and ≤15,000 Btu/h		10.9 - (0.213 × Cap/1000) EER[d]	
	>15,000 Btu/h		7.7 EER	
PTHP (cooling mode) standard size	<7,000 Btu/h	95°F db/75°F wb outdoor air[c]	11.9 EER	AHRI 310/380
	≥7,000 Btu/h and ≤15,000 Btu/h		14.0 - (0.300 × Cap/1000) EER[d]	
	>15,000 Btu/h		9.5 EER	
PTHP (cooling mode) nonstandard size[b]	<7,000 Btu/h	95°F db/75°F wb outdoor air[c]	9.3 EER	AHRI 310/380
	≥7,000 Btu/h and ≤15,000 Btu/h		10.8 - (0.213 × Cap/1000) EER[d]	
	>15,000 Btu/h		7.6 EER	
PTHP (heating mode) standard size	<7,000 Btu/h	47°F db/43°F wb outdoor air[c]	3.3 COP_H	AHRI 310/380
	≥7,000 Btu/h and ≤15,000 Btu/h		3.7 - (0.052 × Cap/1000) COP_H[d]	
	>15,000 Btu/h		2.9 COP_H	
PTHP (heating mode) nonstandard size[b]	<7,000 Btu/h	47°F db/43°F wb outdoor air[c]	2.7 COP_H	AHRI 310/380
	≥7,000 Btu/h and ≤15,000 Btu/h		2.9 - (0.026 × Cap/1000) COP_H[d]	
	>15,000 Btu/h		2.5 COP_H	
SPVAC (cooling mode) single and three phase	< 65,000 Btu/h	95°F db/ 75°F wb outdoor air	11.0 EER	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h		10.0 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		10.0 EER	
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/ 75°F wb outdoor air	11.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h		10.0 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		10.1 EER	
SPVHP (heating mode)	< 65,000 Btu/h	47°F db/ 43°F wb outdoor air	3.3 COP_H	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h		3.0 COP_H	
	≥ 135,000 Btu/h and < 240,000 Btu/h		3.0 COP_H	
Room air conditioners without reverse cycle with louvered sides	< 6,000 Btu/h	—	11.0 CEER	ANSI/ AHAM RAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h	—	11.0 CEER	
	≥ 8,000 Btu/h and < 14,000 Btu/h	—	10.9 CEER	
	≥ 14,000 Btu/h and < 20,000 Btu/h	—	10.7 CEER	

	≥ 20,000 Btu/h and ≤ 28,000 Btu/h	—	9.4 CEER	
	> 28,000 Btu/h	—	9.0 CEER	
Room air conditioners without louvered sides	< 6,000 Btu/h	—	10.0 CEER	ANSI/ AHAM RAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h	—	10.0 CEER	
	≥ 8,000 Btu/h and < 11,000 Btu/h	—	9.6 CEER	
	≥ 11,000 Btu/h and < 14,000 Btu/h	—	9.5 CEER	
	≥ 14,000 Btu/h and < 20,000 Btu/h	—	9.3 CEER	
	≥ 20,000 Btu/h	—	9.4 CEER	
Room airconditioners with reverse cycle, with louvered sides for applications outside US	< 20,000 Btu/h	—	9.8 CEER	ANSI/ AHAM RAC-1
	≥ 20,000 Btu/h	—	9.3 CEER	
Room air-conditioners with reverse cycle without louvered sides for applications outside US	< 14,000 Btu/h	—	9.3 CEER	ANSI/ AHAM RAC-1
	≥ 14,000 Btu/h	—	8.7 CEER	

(continued)

**TABLE C403.3.2(4)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS,
PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS,
SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Room air conditioners, casement only for applications outside US	All	—	9.5 CEER	ANSI/ AHAM RAC-1
Room air conditioners, casement slider for applications outside US	All	—	10.4 CEER	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8, wb = wet bulb, db = dry bulb. “Cap” = The rated cooling capacity of the project in Btu/h. Where the unit’s capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. Where the unit’s capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculations.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Nonstandard size units must be factory labeled as follows: “MANUFACTURED FOR NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW STANDARD PROJECTS.” Nonstandard size efficiencies apply only to units being installed in existing sleeves having an external wall opening of less than 16 inches (406 mm) high or less than 42 inches (1067 mm) wide and having a cross-sectional area less than 670 square inches (0.43 m2).

c. The cooling-mode wet bulb temperature requirement only applies for units that reject condensate to the condenser coil.

d. “Cap” in EER and COPH equations for PTACs and PTHPs means cooling capacity in Btu/h at 95°F outdoor dry-bulb temperature.

e. This table is a replica of ASHRAE 90.1 Table 6.8.1-4 Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single- Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(5)**

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[g]

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[d, e]	TEST PROCEDURE[a]
Warm-air furnaces, gas fired	< 225,000 Btu/h	Maximum capacity[c]	80% E_t[b,d] before 1/1/2023 81%E_t[d] after 1/1/2023	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnaces, oil fired	< 225,000 Btu/h	Maximum capacity[c]	80% E_t before 1/1/2023 82%E_t[d] after 1/1/2023	Section 42, Combustion, UL 727
Warm-air duct furnaces, gas fired	All capacities	Maximum capacity[c]	80%E_c[e]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, gas fired	All capacities	Maximum capacity[c]	80%E_c[e,f]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, oil fired	All capacities	Maximum capacity[c]	80%E_c[e,f]	Section 40, Combustion, UL 731

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. Combination units (i.e., furnaces contained within the same cabinet as an air conditioner) not covered by DOE 10 CFR 430 (i.e., three-phase power or with cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating. All other units greater than 225,000 Btu/h sold in the US must meet the AFUE standards for consumer products and test using USDOE’s AFUE test procedure at DOE 10 CFR 430, Subpart B, Appendix N.

c. Compliance of multiple firing rate units shall be at the maximum firing rate.

d. Et = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

e. Ec = combustion efficiency (100 percent less flue losses). See test procedure for detailed discussion.

f. Units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

g. This table is a replica of ASHRAE 90.1 Table 6.8.1-5 Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(6)**

TABLE C403.3.2(6)
GAS- AND OIL-FIRED BOILERS: MINIMUM EFFICIENCY REQUIREMENTS[i]

EQUIPMENT TYPE[a]	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY[d, e]	EFFICIENCY AS OF 3/2/2022	TEST PROCEDURE
Boilers, hot water	Gas fired	< 300,000 Btu/h[g, h]	82% AFUE	82% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	80% E_t[d]	80% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	82% E_c[c]	82% E_c[c]	
	Oil fired[f]	< 300,000 Btu/h[g]	84% AFUE	84% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[b]	82% E_t[d]	82% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[a]	84% E_c[c]	84% E_c[c]	
Boilers, steam	Gas fired	< 300,000 Btu/h[g]	80% AFUE	80% AFUE	DOE 10 CFR 430 Appendix N
	Gas fired- all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	79% *v*	79% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	79% E_t[d]	79% E_t[d]	
	Gas fired-natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	77% E_t[d]	79% E_t[d]	
		> 2,500,000 Btu/h[b]	77% E_t[d]	79% E_t[d]	
	Oil-fired[f]	< 300,000 Btu/h[g]	82% AFUE	82% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	81% E_t[d]	81% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	81% E_t[a]	81% E_t[a]	

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.

b. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum effi- ciency requirements for boilers cover all capacities of packaged boilers.

c. Ec = Combustion efficiency (100 percent less flue losses).

d. Et = Thermal efficiency.
e. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
f. Includes oil-fired (residual).
g. Boilers shall not be equipped with a constant burning pilot light.
h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
i. This table is a replica of ASHRAE 90.1 Table 6.8.1-6 Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements

delete and replace **TABLE C403.3.2(7)**

TABLE C403.3.2(7)

PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE[a]	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION[i]	PERFORMANCE REQUIRED[b, c, d, g, h]	TEST PROCEDURE[e, f]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥ 40.2 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥ 20.0 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥ 16.1 gpm/hp	CTI ATC-105S and CTI STD-201 RS
Centrifugal fan closed- circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥ 7.0 gpm/hp	CTI ATC-105S and CTI STD-201 RS
Propeller or axial fan dry coolers (Air-cooled fluid coolers)	All	115°F entering water 105°F leaving water 95°F entering wb	≥ 4.5 gpm/hp	CTI ATC-105DS
Propeller or axial fan evaporative condensers	All	R-448A Test Fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥ 160,000 Btu/hr x hp	CTI ATC-106

Propeller or axial fan evaporative condensers	All	Ammonia Test Fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥ 134,000 Btu/h × hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-448A Test Fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥137,000 Btu/h × hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia Test Fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥ 110,000 Btu/h × hp	CTI ATC-106
Air-cooled condensers	All	125°F Condensing Temperature 190°F Entering Gas Temperature 15°F subcooling 95°F entering db	≥ 176,000 Btu/h × hp	AHRI 460

For SI: °C = [(°F) – 32]/1.8, L/s × kW = (gpm/hp)/(11.83), COP = (Btu/h × hp)/(2550.7), db = dry bulb temperature, wb = wet bulb temperature.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. For purposes of this table, open-circuit cooling tower performance is defined as the water-flow rating of the tower at the thermal rating condition listed in the table divided by the fan motor nameplate power.

c. For purposes of this table, closed-circuit cooling tower performance is defined as the process water-flow rating of the tower at the thermal rating condition listed in the table divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

d. For purposes of this table, dry-cooler performance is defined as the process water-flow rating of the unit at the thermal rating condition listed in the table divided by the total fan motor nameplate power of the unit, and air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the total fan motor nameplate power of the unit.

e. The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field-erected cooling towers.

f. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.

g. For purposes of this table, evaporative condenser performance is defined as the heat rejected at the specified rating condition in the table, divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.

h. Requirements for evaporative condensers are listed with ammonia (R-717) and R-448A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-448A must meet the minimum efficiency requirements listed with R-448A as the test fluid. For ammonia, the condensing temperature is defined as the saturation temperature corresponding to the refrigerant pressure at the condenser entrance. For R-448A, which is a zeotropic refrigerant, the condensing temperature is defined as the arithmetic average of the dew point and the bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance.

i. This table is a replica of ASHRAE 90.1 Table 6.8.1-7 Performance Requirements for Heat Rejection Equipment—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(8)**

TABLE C403.3.2(8) ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS – MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
VRF air conditioners, air cooled	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.2 EER 15.5 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.0 EER 14.9 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.0 EER 13.9 IEER	

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.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-8 Electrically Operated Variable-Refrigerant-Flow Air Conditioners—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(9)**

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

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
VRF air cooled (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.0 EER14.6 IEER	
			VRF multisplit system with heat recovery	10.8 EER 14.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		VRF multisplit system	10.6 EER 13.9 IEER	
			VRF multisplit system with	10.4 EER	

	≥ 240,000 Btu/h		heat recovery	13.7 IEER	
			VRF multisplit system	9.5 EER 12.7 IEER	
			VRF multisplit system with heat recovery	9.3 EER 12.5 IEER	
VRF water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system 86°F entering water	12.0 EER 16.0 IEER	AHRI 1230
			VRF multisplit system 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	
VRF groundwater source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 59°F entering water	16.2 EER	AHRI 1230
			VRF multisplit system with heat recovery 59°F entering water	16.0 EER	

	≥ 135,000 Btu/h		VRF multisplit system 59°F entering water	13.8 EER	
			VRF multisplit system with heat recovery 59°F entering water	13.6 EER	
VRF ground source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 77°F entering water	13.4 EER	AHRI 1230
			VRF multisplit system with heat recovery 77°F entering water	13.2 EER	
	≥ 135,000 Btu/h		VRF multisplit system 77°F entering water	11.0 EER	
			VRF multisplit system with heat recovery 77°F entering water	10.8 EER	
VRF air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)		VRF multisplit system	7.7 HSPF	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb outdoor air	3.3 COPh	
			17°F db/15°F wb outdoor air	2.25 COPh	
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb outdoor air	3.2 COPh	
			17°F db/15°F wb outdoor air	2.05 COPh	
VRF water source (heating mode)	<65,000 Btu/hr (cooling capacity)		VRF multisplit system 68°F entering water	4.2 COPh 4.3 COPh	AHRI 1230
	≥ 65,000 Btu/hr and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.2 COPh 4.3 COPh	
	≥ 135,000 Btu/h and <240,000		VRF multisplit system	3.9 COPh 4.0 COPh	

	Btu/h (cooling capacity)		68°F entering water		
	≥240,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	3.9 COPh	

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

EQUIPMENT aTYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
VRF groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	All	VRF multisplit system 50°F entering water	3.6 COPh	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 50°F entering water	3.3 COPh	
VRF groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering water	3.1 COPh	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering water	2.8 COPh	

For SI: °C = [(°F) – 32]/1.8, 1 British thermal unit per hour = 0.2931 W, db = dry bulb temperature, wb = wet bulb temperature.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-9 Electrically Operated Variable-Refrigerant-Flow and Applied Heat Pumps—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(10)**

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

EQUIPMENT TYPE	STANDARD MODEL	NET SENSIBLE COOLING CAPACITY	MINIMM NET SENSIBLE COP	RATING CONDITIONS RETURN AIR (dry bulb/dew point)	TEST PROCEDURE[a]
Air cooled	Downflow	<80,000 Btu/h	2.70	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.58		
		≥295,000 Btu/h	2.36		
	Upflow-ducted	<80,000 Btu/h	2.67		
		≥80,000 Btu/h and <295,000 Btu/h	2.55		
		≥295,000 Btu/h	2.33		
	Upflow-nonducted	65,000 Btu/h	2.16		

		≥65,000 Btu/h and <240,000 Btu/h	2.04	75°F/52°F (Class 1)	
		≥240,000 Btu/h	1.89		
	Horizontal	<65,000 Btu/h	2.65	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.55		
		≥240,000 Btu/h	2.47		
Air cooled with fluid economizer	Downflow	<80,000 Btu/h	2.70	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.58		
		≥295,000 Btu/h	2.36		
	Upflow-ducted	<80,000 Btu/h	2.67		
		≥80,000 Btu/h and <295,000 Btu/h	2.55		
		≥295,000 Btu/h	2.33		
	Upflow-nonducted	65,000 Btu/h	2.16	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	2.04		
		≥240,000 Btu/h	1.89		
	Horizontal	<65,000 Btu/h	2.65	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.55		
		≥240,000 Btu/h	2.47		
Water cooled	Downflow	<80,000 Btu/h	2.82	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.73		
		≥295,000 Btu/h	2.67		
	Upflow-ducted	<80,000 Btu/h	2.79		
		≥80,000 Btu/h and <295,000 Btu/h	2.70		
		≥295,000 Btu/h	2.64		
	Upflow-nonducted	65,000 Btu/h	2.43	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	2.32		
		≥240,000 Btu/h	2.20		
	Horizontal	<65,000 Btu/h	2.79	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.70		
		≥240,000 Btu/h	2.64		
Water cooled with fluid economizer	Downflow	<80,000 Btu/h	2.77	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.68		
		≥295,000 Btu/h	2.61		
	Upflow-ducted	<80,000 Btu/h	2.74		
		≥80,000 Btu/h and <295,000 Btu/h	2.65		
		≥295,000 Btu/h	2.58		
	Upflow-nonducted	65,000 Btu/h	2.35	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	2.24		
		≥240,000 Btu/h	2.12		
	Horizontal	<65,000 Btu/h	2.71	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.60		
		≥240,000 Btu/h	2.54		
Glycol cooled	Downflow	<80,000 Btu/h	2.56	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.24		
		≥295,000 Btu/h	2.21		
	Upflow-ducted	<80,000 Btu/h	2.53		
		≥80,000 Btu/h and <295,000 Btu/h	2.21		

		≥295,000 Btu/h	2.18		
	Upflow-nonducted	65,000 Btu/h	2.08	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	1.90		
		≥240,000 Btu/h	1.81		
	Horizontal	<65,000 Btu/h	2.48	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.18		
		≥240,000 Btu/h	2.18		
Glycol cooled with fluid economizer	Downflow	<80,000 Btu/h	2.51	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.19		
		≥295,000 Btu/h	2.15		
	Upflow-ducted	<80,000 Btu/h	2.48		
		≥80,000 Btu/h and <295,000 Btu/h	2.16		
		≥295,000 Btu/h	2.12		
	Upflow-nonducted	65,000 Btu/h	2.00	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	1.82		
		≥240,000 Btu/h	1.73		
	Horizontal	<65,000 Btu/h	2.44	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.10		
		≥240,000 Btu/h	2.10		

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8, COP = (Btu/h × hp)/(2,550.7).

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-10 Floor-Mounted Air Conditioners and Condensing Units Serving Computer Rooms—Minimum Effi- ciency Requirements.

delete and replace **TABLE C403.3.2(11)**

Table C403.3.2(11)
VAPOR-COMPRESSION BASED INDOOR POOL DEHUMIDIFIERS – MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[b]
Single package indoor (with or without economizer)	Rating Conditions: A or C	3.5 MRE	AHRI 910
Single package indoor water cooled (with or without economizer)	Rating Conditions: A, B or C	3.5 MRE	
Single package indoor air cooled (with or without economizer)	Rating Conditions: A, B or C	3.5 MRE	
Single package indoor air cooled (with or without economizer)	Rating Conditions: A, B or C	2.5 MRE	

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-12 Vapor-Compression-Based Indoor Pool Dehumidifiers—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(12)**

TABLE C403.3.2(12)
ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITHOUT ENERGY RECOVERY– MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (dehumidification mode)	-	4.0 ISMRE	AHRI 920
Air-source heat pumps (dehumidification mode)	-	4.0 ISMRE	AHRI 920
Water cooled (dehumidification mode)	Cooling tower condenser water	4.9 ISMRE	AHRI 920
	Chilled water	6.0 ISMRE	
Air-source heat pump (dehumidification mode)	-	2.7 ISCOP	AHRI 920
Water-source heat pump (dehumidification mode)	Ground source, closed loop	4.8 ISMRE	AHRI 920
	Ground-water source	5.0 ISMRE	
	Water source	4.0 ISMRE	
Water-source heat pump (heating mode)	Ground source, closed loop	2.0 ISCOP	AHRI 920
	Ground-water source	3.2 ISCOP	
	Water source	3.5 ISCOP	

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.
b. This table is a replica of ASHRAE 90.1 Table 6.8.1-13 Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, without Energy Recovery—Minimum Efficiency Requirements.

add **TABLE C403.3.2(13)**

Table C403.3.2(13)
ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITH ENERGY RECOVERY– MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (dehumidification mode)	-	5.2 ISMRE	AHRI 920
Air-source heat pumps (dehumidification mode)	-	5.2 ISMRE	AHRI 920
Water cooled (dehumidification mode)	Cooling tower condenser water	5.3 ISMRE	AHRI 920
	Chilled water	6.6 ISMRE	
Air-source heat pump (dehumidification mode)	-	3.3 ISCOP	AHRI 920
Water-source heat pump (dehumidification mode)	Ground source, closed loop	5.2 ISMRE	AHRI 920

	Ground-water source	5.8 ISMRE	
	Water source	4.8 ISMRE	
Water-source heat pump (heating mode)	Ground source, closed loop	3.8 ISCOP	AHRI 920
	Ground-water source	4.0 ISCOP	
	Water source	4.8 ISCOP	

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.
b. This table is a replica of ASHRAE 90.1 Table 6.8.1-14 Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, with Energy Recovery—Minimum Efficiency Requirements.

add **TABLE C403.3.2(14)**

TABLE C403.3.2(14) ELECTRICALLY OPERATED WATER-SOURCE HEAT PUMPS– MINIMUM EFFICIENCY REQUIREMENTS[c]

EQUIPMENT TYPE	SIZE CATEGORY[b]	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Water-to-air, water loop (cooling mode)	<17,000 Btu/h	All	86°F entering water	12.2 EER	**ISO 13256-1**
	≥17,000 Btu/h and <65,000 Btu/h			13.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h			13.0 EER	
Water-to-air, ground water (cooling mode)	<135,000 Btu/h (cooling capacity)	All	59°F entering water	18.0 EER	**ISO 13256-1**
Brine-to-air, ground loop (cooling mode)	<135,000 Btu/h (cooling capacity)	All	77°F entering water	14.1 EER	**ISO 13256-1**
Water-to-water, water loop (cooling mode)	<135,000 Btu/h (cooling capacity)	All	86°F entering water	10.6 EER	**ISO 13256-2**
Water-to-water, ground water (cooling mode)	<135,000 Btu/h (cooling capacity)	All	59°F entering water	16.3 EER	**ISO 13256-2**
Brine-to-water, ground loop (cooling mode)	<135,000 Btu/h (cooling capacity)	All	77°F entering water	12.1 EER	**ISO 13256-2**
Water-to-water, water loop (heating mode)	<135,000 Btu/h (cooling capacity)	-	68°F entering water	4.3 COP_H	**ISO 13256-1**
Water-to-air, ground water (heating mode)	<135,000 Btu/h (cooling capacity)	-	50°F entering water	3.7 COP_H	**ISO 13256-1**
Brine-to-air, ground loop	<135,000 Btu/h (cooling capacity)	-	32°F entering water	3.2 COP_H	**ISO 13256-1**

(heating mode)					
Water-to-water, water loop (heating mode)	<135,000 Btu/h (cooling capacity)	-	68°F entering water	3.7 COP_H	**ISO 13256-1**
Water-to-water, ground water (heating mode)	<135,000 Btu/h (cooling capacity)	-	50°F entering water	3.1 COP_H	**ISO 13256-1**
Brine-to-water, ground loop (heating mode)	<135,000 Btu/h (cooling capacity)	-	32°F entering water	2.5 COP_H	**ISO 13256-1**

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Single-phase, US air-cooled heat pumps less than 19 kW are regulated as consumer products by DOE 10 CFR 430. SCOPC, SCOP2C, SCOPH and SCOP2H values for single-phase products are set by the USDOE.

c. This table is a replica of ASHRAE 90.1 Table 6.8.1-15 Electrically Operated Water-Source Heat Pumps—Minimum Efficiency Requirements.

add **TABLE C403.3.2(15)**

TABLE C403.3.2(15)
HEAT-PUMP AND HEAT RECOVERY CHILLER PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS

Heating Operation													
EQUIPMENT TYPE	SIZE CATEGORY, ton_R	COOLING-ONLY OPERATION COOLING EFFICIENCY[c] AIR_SOURCE EET (FL/IPLV), Btu/W x h WATER-SOURCE POWER INPUT PER CAPACITY (FL/IPLV), kW/ton_R		HEATING SOURCE CONDITIONS (entering/ leaving water) OR OAT (db/wb), °F	HEAT-PUMP HEATING FULL-LOAD EFFICIENCY (COPH)b, W/W				HEAT RECOVERY CHILLER FULL-LOAD EFFICIENCY (COPHR)c,d, W/W SIMULTANEOUS COOLING AND HEATING FULL-LOAD EFFICIENCY (COPSHC)c, W/W				Test Procedure[a]
					Leaving Heating Water Temperature				Leaving Heating Water Temperature				
					Low	Medium	High	Boost	Low	Medium	High	Boost	
		Path A	Path B		105°F	120°F	140°F	140°F	105°F	120°F	140°F	140°F	
Air source	All sizes	≥ 9.595 FL	≥ 9.595 FL	47 db	≥ 3.290	≥ 2.770	≥ 2.310	NA	NA	NA	NA	NA	AHRI 550/590
		≥ 13.02 IPLV.IP	≥ 13.02 IPLV.IP	43 wb[e]	≥ 2.230	≥ 1.950	≥ 1.630	NA	NA	NA	NA	NA	
Water-source electrically operated positive displacement	<75	≤ 0.7885 FL	≤ 0.7875 FL ≤ 0.5145 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	AHRI 550/590
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	6.150	
	≥75 and <150	≤ 0.6316 IPLV.IP	≤ 0.7140 FL ≤ 0.4620 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	6.150	
	≥150 and<300	≤ 0.7579 FL ≤ 0.5895 IPLV.IP	≤ 0.7140 FL ≤ 0.4620 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	6.150	
	≥300 and <600	≤ 0.6947 FL ≤ 0.5684 IPLV.IP	≤ 0.6563 FL ≤ 0.4305 IPLV.IP	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000	NA	
				75/65[f]	NA	NA	NA	≥ 3.900	NA	NA	NA	≥ 6.850	
	≥600	≤ 0.6421	≤ 0.6143	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000		

		FL ≤ 0.5474 IPLV.IP	FL ≤ 0.3990 IPLV.IP	75/65[f]	NA	NA	NA	≥ 3.900	NA	NA	NA	≥ 6.850	
Water-source electrically operated centrifugal	<75	≤ 0.6421 FL ≤ 0.5789 IPLV.IP	≤ 0.7316 FL ≤ 0.4632 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	AHRI 550/590
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	≥ 6.150	
	≥75 and <150	≤ 0.5895 FL ≤ 0.5474 IPLV.IP	≤ 0.6684 FL ≤ 0.4211 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	≥ 6.150	
	≥150 and<300	≤ 0.5895 FL ≤ 0.5263 IPLV.IP	≤ 0.6263 FL ≤ 0.4105 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	≥ 6.150	
	≥300 and <600	≤ 0.5895 FL ≤ 0.5263 IPLV.IP	≤ 0.6158 FL ≤ 0.4000 IPLV.IP	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000	NA	
				75/65[f]	NA	NA	NA	≥ 3.900	NA	NA		≥ 6.850	
	≥600	≤ 0.5895 FL ≤ 0.5263 IPLV.IP	≤ 0.6158 FL ≤ 0.4000 IPLV.IP	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000	NA	
				75/65[f]	NA	NA	NA	≥ 3.900	NA	NA	NA	≥ 6.850	

For SI: °C = [(°F) – 32]/1.8.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Cooling-only rating conditions are standard rating conditions defined in AHRI 550/590, Table 1.

c. Heating full-load rating conditions are at rating conditions defined in AHRI 550/590, Table 1.

d. For water-cooled heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser, the COPHR applies to operation at full load with 100 percent heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table C403.3.2(3).

e. Outdoor air entering dry-bulb (db) temperature and wet-bulb (wb) temperature.

f. Source-water entering and leaving water temperature.

g. This table is a replica of ASHRAE 90.1 Table 6.8.1-16 Heat-Pump and Heat Recovery Chiller Packages—Minimum Efficiency Requirements.

add **TABLE C403.3.2(16)**

TABLE C403.3.2(16)
CEILING-MOUNTED COMPUTER-ROOM AIR CONDITIONERS-MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	STANDARD MODEL	NET SENSIBLE COOLING CAPACITY	MINIMM NET SENSIBLE COP	RATING CONDITIONS RETURN AIR (dry bulb/dew point)	TEST PROCEDURE[a]
Air cooled with freeair discharge condenser	Ducted	<29,000 Btu/h	2.05	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	2.02		
		≥65,000 Btu/h	1.92		
		<29,000 Btu/h	2.08		
		≥29,000 Btu/h and <65,000 Btu/h	2.05		
		≥65,000 Btu/h	1.94		
	Nonducted	<29,000 Btu/h	2.01		

		≥29,000 Btu/h and <65,000 Btu/h	1.97		
		≥65,000 Btu/h	1.87		
		<29,000 Btu/h	2.04		
		≥29,000 Btu/h and <65,000 Btu/h	2.00		
		≥65,000 Btu/h	1.89		
Air cooled with freeair discharge condenser with fluid economizer	Ducted	<29,000 Btu/h	1.86	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.83		
		≥65,000 Btu/h	1.73		
		<29,000 Btu/h	1.89		
		≥29,000 Btu/h and <65,000 Btu/h	1.86		
		≥65,000 Btu/h	1.75		
	Nonducted	<29,000 Btu/h	1.82		
		≥29,000 Btu/h and <65,000 Btu/h	1.78		
		≥65,000 Btu/h	1.68		
		<29,000 Btu/h	1.85		
		≥29,000 Btu/h and <65,000 Btu/h	1.81		
		≥65,000 Btu/h	1.70		
Air cooled with ducted condenser	Ducted	<29,000 Btu/h	2.38	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	2.28		
		≥65,000 Btu/h	2.18		
		<29,000 Btu/h	2.41		
		≥29,000 Btu/h and <65,000 Btu/h	2.31		
		≥65,000 Btu/h	2.20		
	Nonducted	<29,000 Btu/h	2.05		
		≥29,000 Btu/h and <65,000 Btu/h	2.02		
		≥65,000 Btu/h	1.92		
		<29,000 Btu/h	2.08		
		≥29,000 Btu/h and <65,000 Btu/h	2.05		
		≥65,000 Btu/h	1.94		
Air cooled with fluid economizer and ducted condenser	Ducted	<29,000 Btu/h	2.01	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.97		
		≥65,000 Btu/h	1.87		
		<29,000 Btu/h	2.04		
		≥29,000 Btu/h and <65,000 Btu/h	2.00		
		≥65,000 Btu/h	1.89		
	Nonducted	<29,000 Btu/h	1.86		

		≥29,000 Btu/h and <65,000 Btu/h	1.83		
		≥65,000 Btu/h	1.73		
		<29,000 Btu/h	1.89		
		≥29,000 Btu/h and <65,000 Btu/h	1.86		
		≥65,000 Btu/h	1.75		
Water cooled	Ducted	<29,000 Btu/h	1.82	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.78		
		≥65,000 Btu/h	1.68		
		<29,000 Btu/h	1.85		
		≥29,000 Btu/h and <65,000 Btu/h	1.81		
		≥65,000 Btu/h	1.70		
	Nonducted	<29,000 Btu/h	2.38		
		≥29,000 Btu/h and <65,000 Btu/h	2.28		
		≥65,000 Btu/h	2.18		
		<29,000 Btu/h	2.41		
		≥29,000 Btu/h and <65,000 Btu/h	2.31		
		≥65,000 Btu/h	2.20		
Water cooled with fluid economizer	Ducted	<29,000 Btu/h	2.33	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	2.23		
		≥65,000 Btu/h	2.13		
		<29,000 Btu/h	2.36		
		≥29,000 Btu/h and <65,000 Btu/h	2.26		
		≥65,000 Btu/h	2.16		
	Nonducted	<29,000 Btu/h	1.97		
		≥29,000 Btu/h and <65,000 Btu/h	1.93		
		≥65,000 Btu/h	1.78		
		<29,000 Btu/h	2.00		
		≥29,000 Btu/h and <65,000 Btu/h	1.98		
		≥65,000 Btu/h	1.81		
Glycol cooled	Ducted	<29,000 Btu/h	1.92	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.88		
		≥65,000 Btu/h	1.73		
Glycol cooled with fluid economizer	Nonducted	<29,000 Btu/h	1.95		
		≥29,000 Btu/h and <65,000 Btu/h	1.93		
		≥65,000 Btu/h	1.76		

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8, COP = (Btu/h × hp)/(2,550.7).

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This is a replica of ASHRAE 90.1 Table 6.8.1-17 Ceiling-Mounted Computer-Room Air Conditioners—Minimum Efficiency Requirements.

delete and replace **C403.3.2.1 Water-cooled centrifugal chilling packages**

Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F (7°C) leaving chilled-water temperature and 2.4 gpm/ton evaporator fluid flow and 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 l/s • kW) condenser water flow shall have maximum full-load kW/ton (FL) and part-load ratings requirements adjusted using Equations 4-5 and 4-6.

$$FL_{adj} = FL/K_{adj}$$ **(Equation 4-5)**

$$PLV_{adj} = IPLV.IP/K_{adj}$$ **(Equation 4-6)**

K_{adj}	=	A × B
FL	=	Full-load kW/ton value as specified in Table C403.3.2(3).
FL_{adj}	=	Maximum full-load kW/ton rating, adjusted for nonstandard conditions.
IPLV.IP	=	IPLV.IP value from Table C403.3.2(2).
PLV_{adj}	=	Maximum *NPLV* rating, adjusted for nonstandard conditions.
A	=	$0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.93073$
B	=	$0.0015 \times L_{vg}E_{vap} + 0.934$
LIFT	=	$L_{vg}Cond - L_{vg}E_{vap}$
$L_{vg}Cond$	=	Full-load condenser leaving fluid temperature (°F).
$L_{vg}E_{vap}$	=	Full-load evaporator leaving temperature (°F).

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

1. $36.00°F \le L_{vg}E_{vap} \le 60.00°F$

2. Maximum condenser leaving temperature: 115°F.

3. 20°F ≤ LIFT ≤ 80°F.

Manufacturers shall calculate the FL_{adj} and PLV_{adj} before determining whether to label the chiller. Centrifugal chillers designed to operate outside of these ranges are not covered by this code.

add **C403.3.2.2 Positive Displacement (Air- and water-cooled) chilling packages**
Equipment with a leaving fluid temperature higher than 32°F (0°C) and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115°F (46°C) shall meet the requirements of Table C403.3.2(7) when tested or certified with water at standard rating conditions, in accordance with the referenced test procedure.

delete and replace **C403.3.3 Hot gas bypass limitation.**
Cooling systems shall not use hot gas bypass or other evaporator pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of the hot gas bypass shall be limited as indicated in Table C403.3.3. as limited by Section 403.5.1.

add **Table C403.3.3**

Table C403.3.3
MAXIMUM HOT GAS BYPASS CAPACITY

RATED CAPACITY	MAXIMUM HOT GAS BYPASS CAPACITY (% of total capacity)
≤ 240,000 Btu/h	50
> 240,000 Btu/h	25

delete **(Mandatory)** from **C403.4.1 Thermostatic controls (Mandatory)**

delete and replace **C403.4.1.1 Heat pump supplementary heat**
Heat pumps having supplementary electric resistance heat shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1. The vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
2. The heat pump is operating in defrost mode.
3. Only for buildings that require heat for health and safety: the vapor compression cycle malfunctions.
4. Only for buildings that require heat for health and safety: the thermostat malfunctions.

delete **(Mandatory)** from **C403.4.1.2 Deadband (Mandatory)**
delete **(Mandatory)** from **C403.4.1.3 Setpoint overlap restriction (Mandatory)**
delete **or cooled** and **(Mandatory)** from **C403.4.1.4 Heated or cooled vestibules (Mandatory)**
delete **(Mandatory)** from **C403.4.1.5 Hot water boiler outdoor temperature setback control (Mandatory)**

delete **(Mandatory)** from **C403.4.2 Off-hour controls (Mandatory)**
delete **(Mandatory)** from **C403.4.2.1 Thermostatic setback (Mandatory)**
delete **(Mandatory)** from **C403.4.2.2 Automatic setback and shutdown (Mandatory)**

delete and replace **C403.4.2.3 Automatic start and stop**
Automatic start controls shall be provided for each HVAC system. The automatic start controls shall be configured to automatically adjust the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy. Automatic stop controls shall be provided for each HVAC system with direct digital control of individual zones. The automatic stop controls shall be configured to reduce the HVAC system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 2°F (0.555ºC) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.

Exception: Cold-climate heat pump systems

delete and replace **C403.4.3.3.2 Heat rejection.**
The following shall apply to hydronic water loop heat pump systems:

1. Where a closed-circuit cooling tower is used directly in the heat pump loop, either an automatic valve shall be installed to bypass the flow of water around the closed-circuit cooling tower, except for any flow necessary for freeze protection, or low-leakage positive-closure dampers shall be provided.

2. Where an open-circuit cooling tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the open-circuit cooling tower.

3. Where an open-circuit or closed-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the open-circuit cooling tower from the heat pump loop, heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

Exception: Where it can be demonstrated that a heat pump system will be required to reject heat throughout the year.

delete and replace **C403.4.3.3.3 Two-position valve.**
Each hydronic heat pump on the hydronic system shall have a two-position automatic valve interlocked to shut off the water flow when the compressor is off.

delete and replace **C403.5 Economizers.**
Economizers shall comply with Sections C403.5.1 through C403.5.5.

An air or water economizer shall be provided for the following cooling systems:

1. Chilled water systems with a total cooling capacity, less cooling capacity provided with air economizers, as specified in Table C403.5.

2. Individual fan systems with cooling capacity greater than or equal to 54,000 Btu/h (15.8 kW) in buildings having other than a *Group R* occupancy.

3. Individual fan systems with cooling capacity greater than or equal to 270,000 Btu/h (79.1 kW) in buildings having a *Group R* occupancy.

Exception: Economizers are not required for the following systems.

1. In hospitals and ambulatory surgery centers, where more than 75 percent of the air designed to be supplied by the system is to spaces that are required to be humidified above 35°F (1.7°C) dew-point temperature to comply with applicable codes or accreditation standards.

2. Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F (1.7°C) dew-point temperature to satisfy process needs.

3. Systems expected to operate less than 20 hours per week.

4. Systems that include a heat recovery system in accordance with Section C403.9.5.

VRF systems installed with a dedicated outdoor air system.

delete and replace **C403.5.3.3 High-limit shutoff.**
Air economizers shall be configured to automatically reduce *outdoor air* intake to the design minimum *outdoor air* quantity when *outdoor air* intake will not reduce cooling energy usage. High-limit shutoff control types shall be chosen from Table C403.5.3.3. High-limit shutoff control settings for these control types shall be those specified in Table C403.5.3.3.

delete and replace **C403.5.5 Economizer fault detection and diagnostics.**
Air-cooled unitary direct-expansion units listed in the tables in Section C403.3.2 and variable refrigerant flow (VRF) units that are 10 tons (120,000 Btu/h) or greater and equipped with an economizer in accordance with Section C403.5 through C403.5.4 shall include a fault detection and diagnostics system complying with the following:

1. The following temperature sensors shall be permanently installed to monitor system operation:

   1.1. Outside air.

   1.2. Supply air.

   1.3. Return air.

2. Indoor temperature sensors shall have an accuracy of ±2°F (1.1°C) over the range of 40°F to 80°F (4°C to 26.7°C). Outdoor temperature sensors shall have an accuracy of ±2°F (1.1°C) over the range of -40°F to 100°F (-40°C to 37.8°C).

3. Refrigerant pressure sensors, where used, shall have an accuracy of ±3 percent of full scale.

4. The unit controller shall be configured to provide system status by indicating the following:

   4.1. Free cooling available.

   4.2. Economizer enabled.

   4.3. Compressor enabled.

   4.4. Heating enabled.

   4.5. Mixed air low limit cycle active.

   4.6. The current value of each sensor.

5. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.

6. The unit shall be configured to report faults to a fault management application available for *access* by day-to-day operating or service personnel or annunciated locally on zone thermostats.

7. The fault detection and diagnostics system shall be configured to detect the following faults:

   7.1. Air temperature sensor failure/fault.

   7.2. Not economizing when the unit should be economizing.

   7.3. Economizing when the unit should not be economizing.

   7.4. Damper not modulating.

   7.5. Excess outdoor air.

delete and replace **C403.6.1 Variable air volume and multiple-zone systems.**
Supply air systems serving multiple zones shall be variable air volume (VAV) systems that have zone controls configured to reduce the volume of air that is reheated, recooled or mixed in each zone to one of the following:

1. Twenty percent of the zone design peak supply for systems with direct digital control (DDC) and 30 percent for other systems.

2. Systems with DDC where all of the following apply:

2.1. The airflow rate in the deadband between heating and cooling does not exceed 20 percent of the zone design peak supply rate or higher allowed rates under Items 3, 4 and 5 of this section.

2.2. The first stage of heating modulates the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the deadband flow rate.

2.3. The second stage of heating modulates the airflow rate from the deadband flow rate up to the heating maximum flow rate that is less than 50 percent of the zone design peak supply rate.

3. The outdoor airflow rate required to meet the minimum ventilation requirements of ASHRAE Standard 62.1.

4. Any higher rate that can be demonstrated to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system as approved by the code official.

5. The airflow rate required to comply with applicable codes or accreditation standards such as pressure relationships or minimum air change rates.

6. Zones where special humidity levels are required to satisfy process needs.

Exception: The following individual zones or entire air distribution systems are exempted from the requirement for VAV control:

1. *Zones* or supply air systems where not less than 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered, including condenser heat, or site-solar energy source.

2. Systems that prevent reheating, recooling, mixing or simultaneous supply of air that has been previously cooled, either mechanically or through the use of economizer systems, and air that has been previously mechanically heated.

delete and replace **C403.6.3 Supply-air temperature reset controls.**
Multiple-*zone* HVAC systems shall include controls that are capable of and configured to automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperature. The controls shall be configured to reset the supply air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room air temperature. Controls that adjust the reset based on zone humidity are allowed. HVAC zones that are expected to experience relatively constant loads, shall have maximum airflow designed to accommodate the fully reset supply-air temperature.

Exceptions:

1. Systems that prevent reheating, recooling or mixing of heated and cooled supply air.

2. Seventy-five percent of the energy for reheating is from site-recovered or site-solar energy sources.

delete **(Mandatory)** from **C403.7 Ventilation and exhaust systems (Mandatory)**

delete and replace **C403.7.1 Demand control ventilation.**
Demand control ventilation (DCV) shall be provided for all single-zone systems required to comply with Sections C403.5 through C403.5.3 and spaces larger than 500 square feet (46.5 m^2) and with an average occupant load of 15 people or greater per 1,000 square feet (93 m^2) of floor area, as established in Table 6.1 of ASHRAE 62.1, and served by systems with one or more of the following:

1. An air-side economizer.

2. Automatic modulating control of the outdoor air damper.

3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

Exceptions:

1. Systems with energy recovery complying with Section C403.7.4.2.

2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.

3. Spaces where more than 75 percent of the space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air that is required for makeup air that is exhausted from other spaces.

4. Spaces with one of the following occupancy classifications as defined in Table 403.3.1.1 of the International Mechanical Code: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas.

delete and replace **C403.7.2 Enclosed parking garage ventilation controls.**
Enclosed parking garages used for storing or handling automobiles operating under their own power shall employ carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors and automatic controls configured to stage fans or modulate fan average airflow rates as stipulated in the Vermont Fire and Building Safety Code enforced by the Vermont Department of Public Safety's Division of Fire Safety. Failure of contamination-sensing devices shall cause the exhaust fans to operate continuously at design airflow.

Exceptions:
1. Garages with a total exhaust capacity less than 4,000 cfm (1,888 L/s) with ventilation systems that do not utilize heating or mechanical cooling.
2. Garages that have a garage area to ventilation system motor nameplate power ratio that exceeds 1,125 cfm/hp (710 L/s/kW) and do not utilize heating or mechanical cooling.

delete **(Mandatory)** from **C403.7.3 Ventilation air heating control (Mandatory)**

delete and replace **C403.7.4 Energy recovery ventilation systems.** Energy recovery ventilation systems shall be provided as specified in either Section C403.7.4.1 or C403.7.4.2, as applicable.

Energy recovery ventilation systems that utilize dehumidification, not fewer than one humidity control device shall be provided for each humidity control system. A humidity control device is a device that measures relative humidity or enthalpy (dry bulb temperature sensors do not qualify as humidity control devices).

add **C403.7.4.1 Nontransient dwelling units.** Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems with an enthalpy recovery ratio of not less than 60 percent at cooling design condition and not less than 70 percent at heating design condition.

Exception:
1. Systems with a minimum sensible recovery efficiency (SRE) of 75 percent at 32°F (0°C), determined in accordance with HVI Publication 920 at an airflow greater than or equal to the design airflow.

add **C403.7.4.2 Spaces other than nontransient dwelling units.**
Where the supply airflow rate of a fan system serving a space other than a nontransient dwelling unit exceeds the values specified in Tables C403.7.4.2, the system shall include an energy recovery system. The energy recovery system shall provide an enthalpy recovery ratio of not less than 50 percent of the difference between the outdoor air and return air enthalpies, at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by ASHRAE Standard 62.1.
2. Laboratory fume hood systems that include not fewer than one of the following features:
   - 2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
   - 2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.
4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy.
5. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
6. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.

7. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.

8. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

delete and replace **TABLE C403.7.4**

TABLE C403.7.4
ENERGY RECOVERY REQUIREMENT
(Ventilation systems operating not less than 3,000 hours per year

PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE							
≥ 10% and < 20%	**≥ 20% and < 30%**	**≥ 30% and < 40%**	**≥ 40% and < 50%**	**≥ 50% and < 60%**	**□ ≥ 60% and < 70%**	**≥ 70% and < 80%**	**□ ≥ 80%**
Design Supply Fan Airflow Rate (cfm)							
≥ 10,500	≥ 6,500	≥ 5,500	≥ 4,500	≥ 3,500	≥ 2,000	≥ 1,000	> 120

For SI: 1 cfm = 0.4719 L/s.

delete **(Mandatory)** from **C403.7.5 Kitchen exhaust systems (Mandatory)**
delete **(Mandatory)** from **C403.7.6 Automatic control of HVAC systems serving guestrooms (Mandatory)**

delete and replace **C403.7.6.1 Temperature setpoint controls.**
Controls shall be provided on each HVAC system that are capable of and configured with three modes of temperature control.

1. When the guestroom is rented but unoccupied, the controls shall automatically raise the cooling setpoint and lower the heating setpoint by not less than 4°F (2°C) from the occupant setpoint within 30 minutes after the occupants have left the guestroom.
2. When the guestroom is unrented and unoccupied, the controls shall automatically raise the cooling setpoint to not lower than 80°F (27°C) and lower the heating setpoint to not higher than 60°F (16°C). Unrented and unoccupied guestroom mode shall be initiated within 16 hours of the guestroom being continuously occupied or where a networked guestroom control system indicates that the guestroom is unrented and the guestroom is unoccupied for more than 20 minutes. A networked guestroom control system that is capable of returning the thermostat setpoints to default occupied setpoints 60 minutes prior to the time a guestroom is scheduled to be occupied is not precluded by this section. Cooling that is capable of limiting relative humidity with a setpoint not lower than 65- percent relative humidity during unoccupied periods is not precluded by this section.
3. When the guestroom is occupied, HVAC setpoints shall return to their occupied setpoints once occupancy is sensed.

   Exceptions: Zones served exclusively by cold-climate heat pumps.

delete and replace **C403.7.6.2 Ventilation controls.**
Controls shall be provided on each HVAC system that are capable of and configured to

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

Exception: Guestroom ventilation systems are not precluded from having an automatic daily pre-occupancy purge cycle that provides daily outdoor air ventilation during unrented periods at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change.

delete **(Mandatory)** from **C403.7.7 Shutoff dampers (Mandatory)**
delete **(Mandatory)** from **C403.8.1 Allowable fan horsepower (Mandatory)**

delete and replace **C403.8.2 Motor nameplate horsepower.**
For each fan, the fan brake horsepower shall be indicated on the construction documents and the selected motor shall be not larger than the first available motor size greater than the following:

1. For fans less than 6 bhp (4476 W), 1.5 times the fan brake horsepower.

2. For fans 6 bhp (4476 W) and larger, 1.3 times the fan brake horsepower.

Exceptions:
1. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.
2. Fans with a fan nameplate electrical input power of less than 0.89 kW.
3. Systems complying with Section C403.8.1 fan system motor nameplate hp (Option 1).
4. Fans with motor nameplate horsepower less than 1 hp (746 W)

delete and replace **C403.8.3 Fan efficiency.**
Each fan and fan array shall have a fan energy index (FEI) of not less than 1.00 at the design point of operation, as determined in accordance with AMCA 208 by an *approved*, independent testing laboratory and labeled by the manufacturer. Each fan and fan array used for a variable-air-volume system shall have an FEI of not less than 0.95 at the design point of operation as determined in accordance with the AMCA 208 by an approved independent testing laboratory and labeled by the manufacturer. The FEI for fan arrays shall be calculated in accordance with AMCA 208 Annex C.

Exceptions: The following fans are not required to have a fan energy index:

1. Fans that are not embedded fans with motor nameplate horsepower of less than 1.0 hp (0.75 kW) or with a nameplate electrical input power of less than 0.89 kW.

2. Embedded fans that have a motor nameplate horsepower of 5 hp (3.7 kW) or less, or with a fan system electrical input power of 4.1 kW or less

3. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.

4. Fans that are part of equipment covered in Section C403.3.2.

5. Fans included in an equipment package certified by an *approved agency* for air or energy performance.

6. Ceiling fans, which are defined as nonportable devices suspended from a ceiling or overhead structure for circulating air via the rotation of the blades.

7. Fans used for moving gases at temperatures above 425°F (250°C)

8. Fans used for operation in explosive atmospheres.

9. Reversible fans used for tunnel ventilation.

10. Fans that are intended to operate only during emergency conditions.
11. Fans outside the scope of AMCA 208.

delete **(Mandatory)** from **C403.8.4 Fractional hp fan motors (Mandatory)**

delete and replace **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.

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.

Add **TABLE C403.8.5**

TABLE C403.8.5
LOW-CAPACITY VENTILATION FAN EFFICACYa

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

For SI: 1 cfm/ft = 47.82 W.

a. Airflow shall be tested in accordance with HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. 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. 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.

delete and replace **C403.8.6 Fan control.**
Controls shall be provided for fans in accordance with Section C403.8.5.1 and as required for specific systems provided in Section C403.

delete and replace **C403.8.6.1 Fan airflow control.**
Each cooling system listed in Table C403.8.6.1 shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

1. Direct expansion (DX) and chilled water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have not fewer than two stages of fan control. Low or minimum speed shall not be greater than 66 percent of full speed. At low or minimum speed, the fan system shall draw not more than 40 percent of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

2. Other units including DX cooling units and chilled water units that control the space temperature by modulating the airflow to the space shall have modulating fan control. Minimum speed shall be not greater than 50 percent of full speed. At minimum speed the fan system shall draw not more than 30 percent of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

3. Units that include an air-side economizer in accordance with Section C403.5 shall have modulating fan control during economizer operation.

Exceptions:

1. Modulating fan control is not required for chilled water and evaporative cooling units with fan motors of less than 1 hp (0.746 kW) where the units are not used to provide *ventilation air* and the indoor fan cycles with the load.

2. Where the volume of outdoor air required to comply with the ventilation requirements of ASHRAE Standard 62.1 at low speed exceeds the air that would be delivered at the speed defined in Section C403.8.5, the minimum speed shall be selected to provide the required v*entilation air*.

renumber **TABLE C403.8.5.1** to **TABLE C403.8.6.1**

add **C403.9 Large-diameter ceiling fans.** Where provided, large-diameter ceiling fans shall be tested and labeled in accordance with AMCA 230.

renumber **C403.9 Heat rejection equipment** to **C403.10 Heat rejection equipment.**
renumber **C403.9.1 Fan speed control** to **C403.10.1 Fan speed control**
renumber **C403.9.2 Multiple-cell heat rejection equipment.**to **C403.10.2 Multiple-cell heat rejection equipment.**
renumber **C403.9.3 Limitation on centrifugal fan open-circuit cooling towers.**to **C403.10.3 Limitation on centrifugal fan open-circuit cooling towers.**
renumber **C403.9.4 Tower flow turndown.**to **C403.10.4 Tower flow turndown.**
renumber **C403.9.5 Heat recovery for service water heating.**to **C403.10.5 Heat recovery for service water heating.**

delete **C403.10 Refrigeration equipment performance** *and replace* **C403.11 Refrigeration equipment performance**

Refrigeration equipment performance shall be determined in accordance with Sections C403.11.1 and C403.11.2 for commercial refrigerators, freezers, refrigerator-freezers, walk-in coolers, walk-in freezers and refrigeration equipment. The energy use shall be verified through certification under an approved certification program or, where a certification program does not exist, the energy use shall be supported by data furnished by the equipment manufacturer.

> **Exception:** Walk-in coolers and walk-in freezers regulated under federal law in accordance with Subpart R of DOE 10 CFR 431

delete **C403.10.1Commercial refrigerators, refrigerator-freezers and refrigeration** *and replace* **C403.11.1Commercial refrigerators, refrigerator-freezers and refrigeration**

Refrigeration equipment, defined in DOE 10 CFR Part 431.62, shall have an energy use in kWh/day not greater than the values of Table C403.11.1 when tested and rated in accordance with AHRI Standard 1200.

Delete **TABLE C403.10.1 (1) and replace TABLE C403.11.1 (1)**

TABLE C403.11.1 (1)
MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL REFRIGERATORS AND FREEZERS AND REFRIGERATION

EQUIPMENT CATEGORY	CONDENSING UNIT CONFIGURATION	EQUIPMENT FAMILY	RATING TEMP., °F	OPERATING TEMP., °F	EQUIPMENT CLASSIFICATION[a,c]	MAXIMUM DAILY ENERGY CONSUMPTION, kWh/day[d,e]	TEST STANDARD
Remote condensing commercial refrigerators and commercial freezers	Remote (RC)	Vertical open (VOP)	38 (M)	≥32	VOP.RC.M	0.64 x TDA + 4.07	AHRI 1200
			0 (L)	<32	VOP.RC.L	2.20 x TDA + 6.85	
		Semivertical open (SVO)	38 (M)	≥32	SVO.RC.M	0.66 x TDA + 3.18	
			0 (L)	<32	SVO.RC.L	2.20 x TDA + 6.85	
		Horizontal open (HZO)	38 (M)	≥32	HZO.RC.M	0.35 x TDA + 2.88	
			0 (L)	<32	HZO.RC.L	0.55 x TDA + 6.88	
		Vertical closed transparent (VCT)	38 (M)	≥32	VCT.RC.M	0.15 x TDA + 1.95	
			0 (L)	<32	VCT.RC.L	0.49 x TDA + 2.61	
		Horizontal closed transparent (HCT)	38 (M)	≥32	HCT.RC.M	0.16 x TDA + 0.13	
			0 (L)	<32	HCT.RC.L	0.34 x TDA + 0.26	
		Vertical closed solid (VCS)	38 (M)	≥32	VCS.RC.M	0.10 x V + 0.26	
			0 (L)	<32	VCS.RC.L	0.21 x V + 0.54	
		Horizontal closed solid (HCS)	38 (M)	≥32	HCS.RC.M	0.10 x V + 0.26	
			0 (L)	<32	HCS.RC.L	0.21 x V + 0.54	
		Service over counter (SOC)	38 (M)	≥32	SOC.RC.M	0.44 x TDA + 0.11	
			0 (L)	<32	SOC.RC.L	0.93 x TDA + 0.22	
Self-contained commercial refrigerators and commercial freezers with and without doors	Self-contained (SC)	Vertical open (VOP)	38 (M)	≥32	VOP.SC.M	0.64 x TDA + 4.07	AHRI 1200
			0 (L)	<32	VOP.SC.L	2.20 x TDA + 6.85	
		Semivertical open (SVO)	38 (M)	≥32	SVO.SC.M	0.66 x TDA + 3.18	
			0 (L)	<32	SVO.SC.L	2.20 x TDA + 6.85	
		Horizontal open (HZO)	38 (M)	≥32	HZO.SC.M	0.35 x TDA + 2.88	
			0 (L)	<32	HZO.SC.L	0.55 x TDA + 6.88	
		Vertical closed transparent (VCT)	38 (M)	≥32	VCT.SC.M	0.15 x TDA + 1.95	
			0 (L)	<32	VCT.SC.L	0.49 x TDA + 2.61	
		Horizontal closed transparent (HCT)	38 (M)	≥32	HCT.SC.M	0.16 x TDA + 0.13	
			0 (L)	<32	HCT.SC.L	0.34 x TDA + 0.26	
		Vertical closed solid (VCS)	38 (M)	≥32	VCS.SC.M	0.10 x V + 0.26	
			0 (L)	<32	VCS.SC.L	0.21 x V + 0.54	
		Horizontal closed solid (HCS)	38 (M)	≥32	HCS.SC.M	0.10 x V + 0.26	
			0 (L)	<32	HCS.SC.L	0.21 x V + 0.54	
			38 (M)	≥32	SOC.SC.M	0.44 x TDA + 0.11	

		Service over counter (SOC)	0 (L)	<32	SOC.SC.L	0.93 x TDA + 0.22	
Self-contained commercial refrigerators with transparent doors for pull-down temperature applications	Self-contained (SC)	Pull-down (PD)	38 (M)	≥32	PD.SC.M	0.11 x V + 0.81	AHRI 1200
Commercial ice cream freezers	Remote (RC)	Vertical open (VOP)	-15 (I)	≤-5[b]	VOP.RC.I	2.79 x TDA + 8.70	AHRI 1200
		Semivertical open (SVO)			SVO.RC.I	2.79 x TDA + 8.70	
		Horizontal open (HZO)			HZO.RC.I	0.70 x TDA + 8.74	
		Vertical closed transparent (VCT			VCT.RC.I	0.58 x TDA + 3.05	
		Horizontal closed transparent (HCT)			HCT.RC.I	0.40 x TDA + 0.31	
		Vertical closed solid (VCS)			VCS.RC.I	0.25 x V + 0.63	
		Horizontal closed solid (HCS			HCS.RC.I	0.25 x V + 0.63	
		Service over counter (SOC)			SOC.SC.I	1.09 x TDA + 0.26	
	Self-contained (SC)	Vertical open (VOP)			VOP.SC.I	5.40 x TDA + 15.02	AHRI 1200
		Semivertical open (SVO)			SVO.SC.I	5.41 x TDA + 14.63	
		Horizontal open (HZO)			HZO.SC.I	2.42 x TDA + 9.00	
		Vertical closed transparent (VCT			VCT.SC.I	0.62 x TDA + 3.29	
		Horizontal closed transparent (HCT)			HCT.SC.I	0.56 x TDA + 0.43	
		Vertical closed solid (VCS)			VCS.SC.I	0.34 x V + 0.88	
		Horizontal closed solid (HCS			HCS.SC.I	0.34 x V + 0.88	
		Service over counter (SOC)			SOC.SC.I	1.53 x TDA + 0.36	

For SI: 1 square foot = 0.0929 m2, 1 cubic foot = 0.02832 m3, °C = (°F – 32)/1.8.

a. The meaning of the letters in this column is indicated in the columns to the left.

b. Ice cream freezer is defined in DOE 10 CFR 431.62 as a commercial freezer that is designed to operate at or below -5 °F and that the manufacturer designs, markets or intends for the storing, displaying or dispensing of ice cream.

c. Equipment class designations consist of a combination [in sequential order separated by periods (AAA).(BB).(C)] of the following:

- (AAA)—An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed transparent doors, VCS = vertical closed solid doors, HCT = horizontal closed transparent doors, HCS = horizontal closed solid doors, and SOC = service over counter);
- (BB)—An operating mode code (RC = remote condensing and SC = self-contained); and
- (C)—A rating temperature code [M = medium temperature (38°F), L = low temperature (0°F), or I = ice cream temperature (-15°F)].
- For example, “VOP.RC.M” refers to the “vertical open, remote condensing, medium temperature” equipment class.

d. V is the volume of the case (ft3) as measured in AHRI 1200, Appendix C.

e. TDA is the total display area of the case (ft2) as measured in AHRI 1200, Appendix D.

add **C403.11.2 Walk-in coolers and walk-in freezers.**

Walk-in cooler and walk-in freezer refrigeration systems, except for walk-in process cooling refrigeration systems as defined in DOE 10 CFR 431.302, shall meet the requirements of Tables C403.11.2.1(1), C403.11.2.1(2), and C403.11.2.1(3).

add **C403.11.2.1 Performance standards.**

Walk-in coolers and walk-in freezers shall meet the requirements of Tables C403.11.2.1(1), C403.11.2.1(2) and C403.11.2.1(3).

delete **TABLE C403.10.1(2)**

delete **TABLE C403.10.1(3)** *and replace* **TABLE C403.11.1(2)**

TABLE C403.11.1(2)
WALK-IN COOLER AND FREEZER DISPLAY DOOR EFFICIENCY REQUIREMENTS[a]

CLASS DESCRIPTOR	CLASS	MAXIMUM ENERGY CONSUMPTION (kWh/day)[a]
Display door, medium temperature	DD, M	$0.04 \times A_{dd} + 0.41$
Display door, low temperature	DD, L	$0.15 \times A_{dd} + 0.29$

a. A_{dd} is the surface area of the display door.

delete **TABLE C403.10.1(4)** *and replace* **TABLE C403.11.1(3)**

TABLE C403.11.1(3)
WALK-IN COOLER AND FREEZER NONDISPLAY DOOR EFFICIENCY REQUIREMENTS[a]

CLASS DESCRIPTOR	CLASS	MAXIMUM ENERGY CONSUMPTION (kWh/day)[a]
Passage door, medium temperature	PD, M	$0.05 \times A_{nd} + 1.7$
Passage door, low temperature	PD, L	$0.14 \times A_{nd} + 4.8$
Freight door, medium temperature	FD, M	$0.04 \times A_{nd} + 1.9$
Freight door, low temperature	FD, L	$0.12 \times A_{nd} + 5.6$

a. A_{nd} is the surface area of the nondisplay door.

delete **TABLE C403.10.1(5)** *and replace* **TABLE C403.11.1(4)**

TABLE C403.11.1(4)
WALK-IN COOLER AND FREEZER REFRIGERATION SYSTEM EFFICIENCY REQUIREMENTS

CLASS DESCRIPTOR	CLASS	MINIMUM ANNUAL WALK-IN ENERGY FACTOR AWEF (Btu/W-h)[a]	TEST PROCEDURE
Dedicated condensing, medium temperature, indoor system	DC.M.I	5.61	AHRI 1250
Dedicated condensing, medium temperature, outdoor system	DC.M.O	7.60	
Dedicated condensing, low temperature, indoor system, net capacity (q_{net}) <6,500 Btu/h	DC.L.I, <6,500	$9.091 \times 10^{-5} \times q_{net} + 1.81$	
Dedicated condensing, low temperature, indoor system, net capacity (q_{net}) ≥6,500 Btu/h	DC.L.I, ≥6,500	2.40	

Dedicated condensing, low temperature, outdoor system, net capacity (q_{net}) <6,500 Btu/h	DC.L.O, <6,500	$6.522 \times 10^{-5} \times q_{net} + 2.73$	
Dedicated condensing, low temperature, outdoor system, net capacity (q_{net}) ≥6,500 Btu/h	DC.L.O, ≥6,500	3.15	
Unit cooler, medium	UC.M	9.00	
Unit cooler, low temperature, net capacity (q_{net}) <15,500 Btu/h	UC.L, < 15,500	$1.575 \times 10^{-5} \times q_{net} + 3.91$	
Unit cooler, low temperature, net capacity (q_{net}) ≥15,500 Btu/h	UC.L, ≥15,500	4.15	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. q_{net} is net capacity (Btu/h) as determined in accordance with **AHRI 1250**.

delete **C403.10.2 Refrigerated display cases (Mandatory).**

delete **C403.10.3 Refrigeration systems** *and replace* **C403.11.3 Refrigeration systems.** Refrigerated display cases, *walk-in coolers* or *walk-in freezers* that are served by remote compressors and remote condensers not located in a condensing unit, shall comply with Sections C403.11.3.1 and C403.11.3.2.

Exception: Systems where the working fluid in the refrigeration cycle goes through both subcritical and super-critical states (transcritical) or that use ammonia refrigerant are exempt.

delete **C403.10.3.1 Condensers serving refrigeration systems** *and replace* **C403.11.3.1 Condensers serving refrigeration systems.**

delete **C403.10.3.2 Compressor systems.** *and replace* **C403.11.3.2 Compressor systems.**

delete **C403.11 Construction of HVAC system elements (Mandatory)** *and replace* **C403.12 Construction of HVAC system elements.**

delete **C403.11.1 Duct and plenum insulation and sealing (Mandatory)** *and replace* **C403.12.1 Duct and plenum insulation and sealing.**
Supply and return air ducts and plenums shall be insulated with not less than R-12 insulation where located in unconditioned spaces and where located outside the building with not less than R-20 insulation. Where located in conditioned space or semi-conditioned space, any duct that will transport or hold air at temperature differentials greater than 40F between inside and outside the duct shall be insulated with not less than R-12 insulation. Buried ducts shall be insulated to a minimum of R-6.

Exceptions:

1. Where located within equipment.
2. Where the design temperature difference between the interior and exterior of the duct or plenum is not greater than 15°F (8°C).

Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with the ANSI/SMACNA 006 HVAC Duct Construction Standards.

delete **C403.11.2 Duct construction (Mandatory)** *and replace* **C403.12.2 Duct construction.**
delete **C403.11.2.1 Low-pressure duct systems (Mandatory)** *and replace* **C403.12.2.1 Low-pressure duct systems.**
delete **C403.11.2.2 Medium-pressure duct systems (Mandatory)** *and replace* **C403.12.2.2 Medium-pressure duct systems.**

delete **C403.11.2.3 High-pressure duct systems (Mandatory)** *and replace* **C403.12.2.3 High-pressure duct systems.**
Ducts and plenums designed to operate at static pressures equal to or greater than 3 inches water gauge (747 Pa) shall be insulated and sealed in accordance with Section C403.11.1. In addition, ducts and plenums shall be leak tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual and shown to have a rate of air leakage (CL) less than or equal to 4.0 as determined in accordance with Equation 4-7.

$CL = F/P^{0.65}$ **(Equation 4-7)**

where:

F	=	The measured leakage rate in cfm per 100 square feet of duct surface.
P	=	The static pressure of the test.

Documentation shall be furnished demonstrating that representative sections totaling not less than 25 percent of the duct area have been tested and that all tested sections comply with the requirements of this section.

delete **C403.11.3 Piping insulation (Mandatory)** *and replace* **C403.12.3 Piping insulation.**
Piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.12.3.

Exceptions:

1. Factory-installed piping within HVAC equipment tested and rated in accordance with a test procedure referenced by this code.

2. Factory-installed piping within room fan-coils and unit ventilators tested and rated according to AHRI 440 (except that the sampling and variation provisions of Section 6.5 shall not apply) and AHRI 840, respectively.

3. Piping that conveys fluids that have a design operating temperature range between 60°F (15°C) and 85°F (29°C).

4. Strainers, control valves, and balancing valves associated with piping 1 inch (25 mm) or less in diameter.

5. Direct buried piping that conveys fluids at or below 60°F (15°C).

6. In radiant heating systems, sections of piping intended by design to radiate heat.

7. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.

renumber **TABLE C403.11.3** *to* **TABLE C403.12.3**

delete **C403.11.3.1 Protection of piping insulation (Mandatory)** *and replace* **C403.12.3.1 Protection of piping insulation.**

delete **C403.12 Mechanical systems located outside of the building thermal envelope. (Mandatory)** *and replace* **C403.13 Mechanical systems located outside of the building thermal envelope.**

delete **C403.12.1 Heating outside a building** *and replace* **C403.13.1 Heating outside a building**

delete **C403.12.2 Snow- and ice-melt system controls** *and replace* **C403.13.2 Snow- and ice-melt system controls.**

delete **C403.12.3 Freeze protection system controls** *and replace* **C403.13.3 Freeze protection system controls.**

SECTION C404
SERVICE WATER HEATING

delete and replace **C404.1 General.**
In addition to the service water heating requirements of Section C404, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, service water heating enhancements may be needed.

The requirements of C404 that may be affected and the corresponding C406 references are summarized in Table C404.1(1). For a full list of potential measures see Table C406.2.1 and Table C406.3.1.

add **TABLE C404.1(1):**

TABLE C404.1(1):

C406 MEASURES AFFECTING SERVICE WATER HEATING

ID	C406 Measure Title	C404 Reference	C406 Section
W01	SHW preheat recovery	C403.10.5	C406.2.3.1.1
W02	Heat pump water heater	n/a	C406.2.3.1.2
W04	SHW pipe insulation	C404.4	C406.2.3.3.1

W05	Point of use water heaters	n/a	C406.2.3.3.2
W06	Thermostatic bal. valves	n/a	C406.2.3.3.3
W07	SHW heat trace system	C404.6.2	C406.2.3.3.4
W08	SHW submeters	n/a	C406.2.3.4
W09	SHW distribution sizing	n/a	C406.2.3.5
W10	Shower heat recovery	C404.7	C406.2.3.6
G06	SHW Energy Storage	n/a	C406.3.7

This section covers the minimum efficiency of, and controls for, service water-heating equipment and insulation of service hot water piping.

delete and replace **C404.2.1 High input service water-heating systems.**
Gas-fired water-heating equipment installed in new buildings shall be in compliance with this section. Where a singular piece of water-heating equipment serves the entire building and is 1,000,000 Btu/h (293 kW) or greater, such equipment shall have a thermal efficiency, E_t , of not less than 92 percent. Where multiple pieces of water-heating equipment serve the building and the combined input rating of the water-heating equipment is 1,000,000 Btu/h (293 kW) or greater, the combined input-capacity-weighted-average thermal efficiency, E_t, shall be not less than 92 percent.

Exceptions:

1. 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 thermal efficiency requirements of this section shall not apply.

2. 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.

3. The input rating of water heaters with an input rating of not greater than 100,000 Btu/h (29.3 kW) shall not be required to be included in the total input rating of *service water-heating* equipment for a building.

delete and replace **C404.3 Heat traps for hot water storage tanks.**
Vertical pipe risers serving storage water heaters and storage tanks not having integral heat traps and serving a nonrecirculating system shall have heat traps on both the inlet and outlet piping as close as practical to the storage tank. Tank inlets and outlets associated with solar water heating system circulation loops shall not be required to have heat traps.

delete and replace **C404.4 Insulation of piping.**
Piping from a water heater to the termination of the heated water fixture supply pipe shall be insulated in accordance with Table C403.12.3. On both the inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 8 feet (2438 mm) of piping, whichever is less, shall be insulated. Piping that is heat traced shall be insulated in accordance with Table C403.12.3 or the heat trace manufacturer's instructions. Tubular pipe insulation shall be

installed in accordance with the insulation manufacturer's instructions. Pipe insulation shall be continuous except where the piping passes through a framing member. The minimum insulation thickness requirements of this section shall not supersede any greater insulation thickness requirements necessary for the protection of piping from freezing temperatures or the protection of personnel against external surface temperatures on the insulation.

Exception: Tubular pipe insulation shall not be required on the following:

1. The tubing from the connection at the termination of the fixture supply piping to a plumbing fixture or plumbing appliance.

2. Valves, pumps, strainers and threaded unions in piping that is 1 inch (25 mm) or less in nominal diameter.

3. Piping from user-controlled shower and bath mixing valves to the water outlets.

4. Cold-water piping of a demand recirculation water system.

5. Tubing from a hot drinking-water heating unit to the water outlet.

6. Piping at locations where a vertical support of the piping is installed.

7. Piping surrounded by building insulation with a thermal resistance (*R*-value) of not less than R-3.

delete **C404.7 Demand recirculation controls.**

delete **C404.8 Drain water heat recovery units** *and replace with* **C404.7 Drain water heat recovery units.**

delete **C404.9 Energy consumption of pools and permanent spas (Mandatory)** *and replace with* **C404.8 Energy consumption of pools and permanent spas.**

delete **C404.9.1 Heaters** *and replace with* **C404.8.1 Heaters.**

delete **C404.9.2 Time switches** *and replace with* **C404.8.2 Time switches.**

delete **C404.9.3 Covers** *and replace with* **C404.8.3 Covers.**
Outdoor heated pools and outdoor permanent spas shall be provided with a vapor-retardant cover or other *approved* vapor-retardant means. Hot tubs and spas capable of being heated to more than 90°F (32°C) shall be provided with a cover having a minimum insulation value of R-12.

Exception: Where more than 75 percent of the energy for heating, computed over an operating season of not fewer than 3 calendar months, is from a heat pump or an on-site renewable energy system, covers or other vapor-retardant means shall not be required.

delete **C404.10 Energy Consumption of portable spas (Mandatory)** *and replace with* **C404.9**

Portable spas.

delete **C404.11 Service water-heating system commissioning and completion requirements** *and replace with* **C404.10 Service water-heating system commissioning and completion requirements.**

SECTION C405
ELECTRICAL POWER AND LIGHTING SYSTEMS

delete and replace **C405.1 General.**
In addition to the electrical power and lighting systems requirements of Section C405, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, electrical power and lighting enhancements may be needed.

The requirements of C405 that may be affected and the corresponding C406 references are summarized in Table C405.1. For a full list of potential measures see Table C406.2.1 and Table C406.3.1.

add **TABLE C405.1**

TABLE C405.1

C406 MEASURES AFFECTING ELECTRICAL POWER AND LIGHTING SYSTEMS

ID	C406 Measure Title	C405 Reference	C406 Section
P01	Energy monitoring	C405.12	C406.2.4
L02	Enhanced digital lighting controls	C405.2	C406.2.5.2
L03	Increase occupancy sensor	C405.2.1, C405.2.2	C406.2.5.3
L04	Increase daylight area	C405.2.3	C406.2.5.4
L05	Residential light control	C405.2.1.1	C406.2.5.5
L06	Reduced lighting power	C405.3.2.2, C405.2	C406.2.5.6
Q01	Efficient elevator equipment	C405.9	C406.2.6.1
Q02	Commercial kitchen equip.	n/a	C406.2.6.2
Q03	Residential kitchen equip.	n/a	C406.2.6.3
R01	On-Site Renewable Energy	n/a	C406.3.1
G01	Lighting Load Management	n/a	C406.3.2
G04	Electric Energy Storage	n/a	C406.3.5

Lighting system controls, the maximum lighting power for interior and exterior applications and electrical energy consumption shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with either Section C405.1.1 or C405.3. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

add **C405.1.1 Lighting for dwelling and sleeping units.** All permanently installed lighting serving dwelling units and sleeping units, excluding kitchen appliance lighting, shall contain only high-efficacy lighting sources.

Exception: Buildings other than multifamily dwellings shall comply with Section C405.1.1 or Sections C405.2.4 and C405.3.

delete and replace **C405.2 Lighting controls.**
Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.

2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:

   2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.

   2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.

   2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

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

2. Interior exit stairways, interior exit ramps and exit passageways.

3. Emergency egress lighting that is normally off.

4. *Dwelling units* and *sleeping units* within Group R-2 buildings (see *occupancy classifications*).

5. *Dwelling units* within buildings other than Group R-2, provided that all of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps and all of the permanently installed lighting fixtures shall be high-efficacy fixtures or contain only high-efficacy lamps.

6. Industrial or manufacturing process areas, as may be required for production and safety.

delete and replace **C405.2.1 Occupant sensor controls.**
Occupant *sensor controls* shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.

2. Conference/meeting/multipurpose rooms.

3. Copy/print rooms.

4. Lounges/breakrooms.

5. Enclosed offices.

6. Open plan office areas.

7. Restrooms.

8. Storage rooms.

9. Locker rooms.

10. Corridors.

11. Warehouse storage areas.

12. Other spaces 300 square feet (28 m^2) or less that are enclosed by floor-to-ceiling height partitions.

Exception: Luminaires that are required to have specific application controls in accordance with Section C405.2.5.

delete and replace **C405.2.1.1 Occupant sensor control function.**
Occupant sensor controls in warehouses shall comply with Section C405.2.1.2. Occupant sensor controls in open plan office areas shall comply with Section C405.2.1.3. Occupant sensor controls in corridors shall comply with Section C405.2.1.4. Occupant sensor controls for egress illumination shall comply with Section C405.2.1.5. Occupant sensor controls for all other spaces specified in Section C405.2.1 shall comply with the following:

1. They shall automatically turn off lights within 20 minutes after all occupants have left the space.

2. They shall be manual on or controlled to automatically turn on the lighting to not more than 50-percent power.

3. They shall incorporate a manual control to allow occupants to turn off lights.

Exception: Full automatic-on controls with no manual control shall be permitted in corridors, stairways, restrooms, locker rooms, lobbies, library stacks and areas where manual operation would endanger occupant safety or security.

delete and replace **C405.2.1.2 Occupant sensor control function in warehouse storage areas.** Lighting in warehouse storage areas shall be controlled as follows:

1. Lighting in each aisleway shall be controlled independently of lighting in all other aisleways and open areas.

2. Occupant sensors shall automatically reduce lighting power within each controlled area to an occupied setpoint of not more than 50 percent within 20 minutes after all occupants have left the controlled area.

3. Lights that are not turned off by occupant sensors shall be turned off by time-switch control complying with Section C405.2.2.1.

4. A manual control shall be provided to allow occupants to turn off lights in the space.

delete and replace **C405.2.1.3 Occupant sensor control function in open plan office areas.** Occupant sensor controls in open plan office spaces less than 300 square feet (28 m^2) in area shall comply with Section C405.2.1.1. Occupant sensor controls in all other open plan office spaces shall comply with all of the following:

1. The controls shall be configured so that general lighting can be controlled separately in control zones with floor areas not greater than 600 square feet (55 m^2) within the open plan office space.

2. General lighting in each control zone shall be permitted to automatically turn on upon occupancy within the control zone. General lighting in other unoccupied zones within the open plan office space shall be permitted to turn on to not more than 20 percent of full power or remain unaffected.

3. The controls shall automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the open plan office space.

Exception: Where general lighting is turned off by time-switch control complying with Section C405.2.2.1.

4. General lighting in each control zone shall turn off or uniformly reduce lighting power to an unoccupied setpoint of not more than 20 percent of full power within 20 minutes after all occupants have left the control zone.

add **C405.2.1.4 Occupant sensor control function in corridors.**
Occupant sensor controls in corridors shall uniformly reduce lighting power to not more than 50 percent of full power within 20 minutes after all occupants have left the space.
Exception: Corridors provided with less than two footcandles of illumination on the

floor at the darkest point with all lights on.

delete **C405.2.1.4 Occupant sensor control function for egress illumination** *and replace with* **C405.2.1.5 Occupant sensor control function for egress illumination**

delete and replace **C405.2.2 Time-switch controls.**
Each area of the building that is not provided with *occupant sensor controls* complying with Section C405.2.1.1 shall be provided with *time-switch controls* complying with Section C405.2.2.1.

Exceptions:

1. Luminaires that are required to have specific application controls in accordance with Section C405.2.4.
2. Spaces where patient care is directly provided.
3. Spaces where an automatic shutoff would endanger occupant safety or security.
4. Lighting intended for continuous operation.
5. Shop and laboratory classrooms.

delete and replace **C405.2.2.1 Time-switch control function.**
Time-switch con*trols* shall comply with all of the following:

1. Automatically turn off lights when the space is scheduled to be unoccupied.
2. Have a minimum 7-day clock.
3. Be capable of being set for seven different day types per week.
4. Incorporate an automatic holiday “shutoff” feature, which turns off all controlled lighting loads for not fewer than 24 hours and then resumes normally scheduled operations.
5. Have program backup capabilities, which prevent the loss of program and time settings for not fewer than 10 hours, if power is interrupted.
6. Include an override switch that complies with the following:

6.1. The override switch shall be a manual control.

6.2. The override switch, when initiated, shall permit the controlled lighting to remain on for not more than 2 hours.

6.3. Any individual override switch shall control the lighting for an area not larger than 5,000 square feet (465 m^2).

Exception: Within mall concourses, auditoriums, sales areas, manufacturing facilities and sports arenas:

1. The time limit shall be permitted to be greater than 2 hours, provided that the switch is a captive key device.

2. The area controlled by the override switch shall not be limited to 5,000 square feet (465 m^2) provided that such area is less than 20,000 square feet (1860 m^2).

delete **C405.2.2.2 Light-reduction controls** *and replace with* **C405.2.3 Light-reduction controls**
Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.3.1.

Exceptions:

1. Luminaires controlled by daylight responsive controls complying with Section C405.2.4.

2. Luminaires controlled by special application controls complying with Section C405.2.5.

3. Where provided with manual control, the following areas are not required to have light-reduction control:

3.1. Spaces that have only one luminaire with a rated power of less than 50 watts.

3.2. Spaces that use less than 0.3 watts per square foot (3.2 W/m^2).

3.3. Corridors, lobbies, electrical and/or mechanical rooms.

delete **C405.2.3 Daylight-responsive controls** *and replace with* **C405.2.4 Daylight-responsive controls**
Daylight-responsive controls complying with Section C405.2.4.1 shall be provided to control the within *daylight zones* in the following spaces:

1. Spaces with a total of more than 150 watts of gen*eral lighting* within sidelit zones complying with Section C405.2.4.2.

2. Spaces with a total of more than 300 watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.

3. Spaces with a total of more than 150 watts of *general lighting* within toplit daylight zones complying with Section C405.2.4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.

2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies.

3. Daylight zones where the total proposed lighting power density is less than 35 percent of the lighting power allowance in accordance with Section C405.3.2.

4. New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPA_{adj}) calculated in accordance with Equation 4-8:

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)] \quad \textbf{(Equation 4-8)}$$

where:

LPA_{adj}	=	Adjusted building interior lighting power allowance in watts.
LPA_{norm}	=	Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.2.5.6 where reduced lighting power is used to comply with the requirements of Section C406.
$UDZFA$	=	Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.4.2 and C405.2.4.3, that do not have daylight responsive controls.
$TBFA$	=	Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.

delete **C405.2.3.1 Daylight-responsive control function** *and replace with* **C405.2.4.1 Daylight-responsive control function**

Where required, *daylight-responsive controls* shall be provided within each space for control of lights in that space and shall comply with all of the following:

1. Lights in *toplit daylight zones* in accordance with Section C405.2.4.3 shall be controlled independently of lights in sidelit daylight zones in accordance with Section C405.2.4.2.

2. Lights in the primary sidelit daylight zone shall be controlled independently of lights in the secondary sidelit daylight zone.

3. *Daylight responsive controls* within each space shall be configured so that they can be calibrated from within that space by authorized personnel.

4. Calibration mechanisms shall be in a location with *ready access*.

5. D*aylight responsive controls* shall dim lights continuously from full light output to 15 percent of full light output or lower.

6. *Daylight responsive controls* shall be configured to completely shut off all controlled lights.

7. When occupant sensor controls have reduced the lighting power to an unoccupied setpoint in accordance with Sections C405.2.1.2 through C405.2.1.4, daylight responsive controls shall continue to adjust electric light levels in response to available daylight, but shall be configured to not increase the lighting power above the specified unoccupied setpoint.

8. Lights in *sidelit daylight zones* in accordance with Section C405.2.4.2 facing different cardinal orientations [within 45 degrees (0.79 rad) of due north, east, south, west] shall be controlled independently of each other.

Exceptions:
1. Within each space, up to 150 watts of lighting within the primary sidelit daylight zone is permitted to be controlled together with lighting in a primary sidelit daylight zone facing a different cardinal orientation.

2. Within each space, up to 150 watts of lighting within the secondary sidelit daylight zone is permitted to be controlled together with lighting in a secondary sidelit daylight zone facing a different cardinal orientation.

delete **C405.2.3.1.1 Dimming.**

delete **C405.2.3.2 Sidelit daylight zone** *and replace with* **C405.2.4.2 Sidelit daylight zone**
The sidelit daylight zone is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Where the fenestration is located in a wall, the sidelit daylight zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1).

2. Where the fenestration is located in a rooftop monitor, the sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.4.2(2) and C405.2.4.2(3).

3. The secondary sidelit daylight zone is directly adjacent to the primary sidelit daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the fenestration or to the nearest full height wall, whichever is less, and longitudinally from the edge of the fenestration to the nearest full height

wall, or up to 2 feet, whichever is less, as indicated in Figure C405.2.4.2(1). The area of secondary sidelit zones shall not be considered in the calculation of the daylight zones in Section C402.4.1.1.

4. The area of the fenestration is not less than 24 square feet (2.23 m^2).

5. The distance from the fenestration to any building or geological formation that would block *access* to daylight is greater than the height from the bottom of the fenestration to the top of the building or geologic formation.

6. The visible transmittance of the fenestration is not less than 0.20.

7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection that is shading the fenestration is not greater than 1.0 for fenestration oriented 45 degrees or less from true north and not greater than 1.5 for all other orientations.

8. If the rough opening area of a vertical fenestration assembly is less than 10 percent of the calculated primary daylight zone area for this fenestration, it does not qualify as a daylight zone.

9. Where located in existing buildings, the visible transmittance of the fenestration is no less than 0.20.

10. In parking garages with floor area adjacent to perimeter wall openings, the daylight zone shall include the area within 20 feet of any portion of a perimeter wall that has a net opening to wall ratio of at least 40 percent.

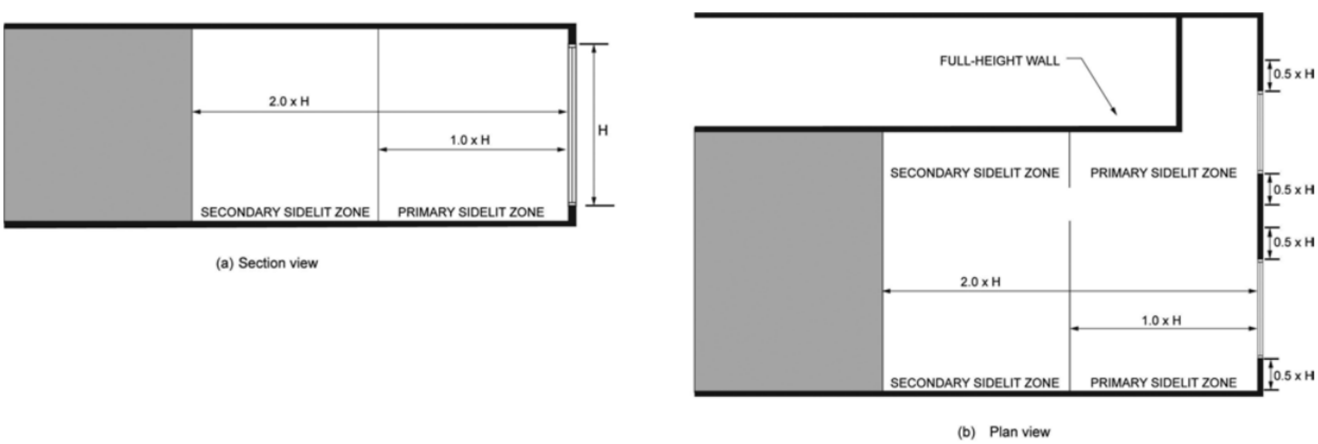


FIGURE C405.2.4.2(1)
PRIMARY AND SECONDARY SIDELIT DAYLIGHT ZONES

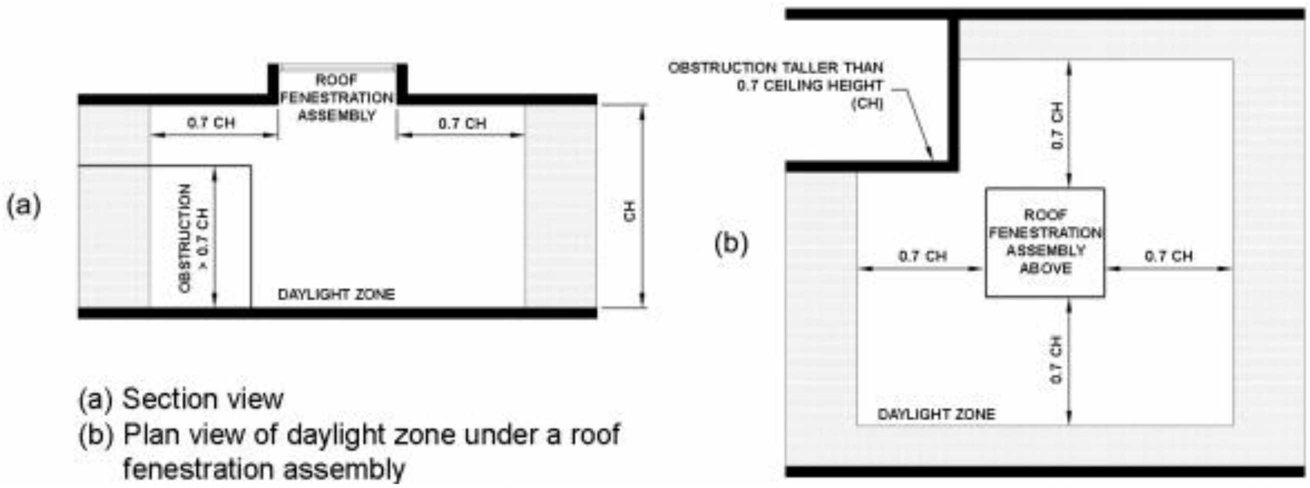


FIGURE C405.2.4.2(2)
DAYLIGHT ZONE UNDER A ROOFTOP MONITOR

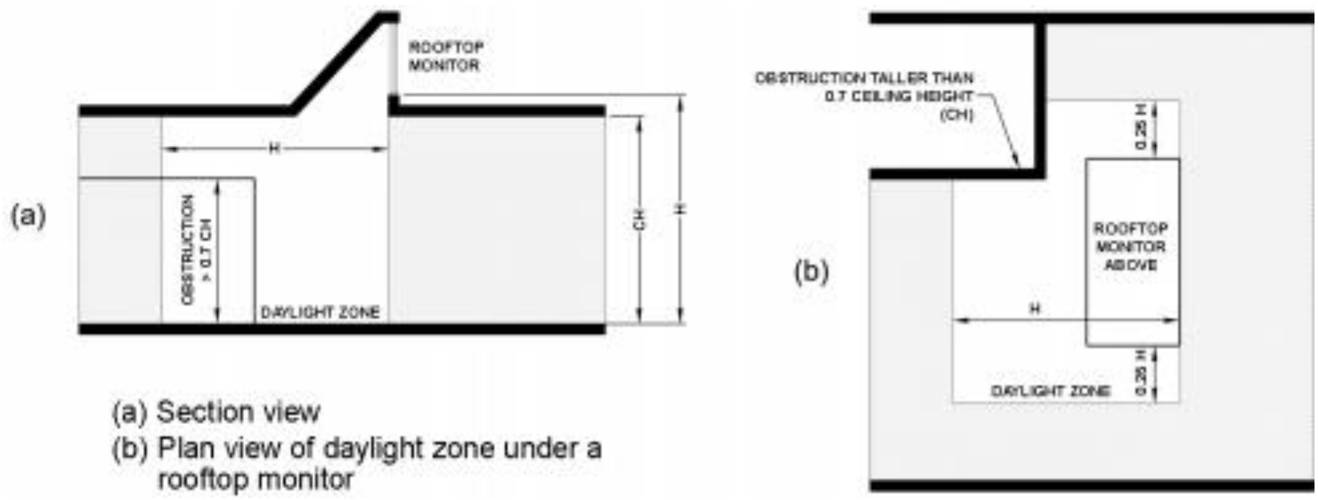


FIGURE C405.2.4.2(3)
DAYLIGHT ZONE UNDER A SLOPED ROOFTOP MONITOR

Delete C405.2.3.3 Toplit zone and replace with C405.2.4.3 Toplit daylight zone
The *toplit daylight zone* is the floor area underneath a roof fenestration assembly that complies with all of the following:

1. The *toplit daylight zone* shall extend laterally and longitudinally beyond the edge of the roof fenestration assembly to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.7 times the ceiling height, whichever is less, as indicated in Figure C405.2.4.3.

2. Direct sunlight is not blocked from hitting the roof fenestration assembly at the peak solar angle on the summer solstice by buildings or geological formations.

3. The product of the visible transmittance of the roof fenestration assembly and the area of the rough opening of the roof fenestration assembly divided by the area of the *toplit* zone is not less than 0.008.

4. Where toplight daylight zones overlap with sidelight daylight zones, lights within the overlapping area shall be assigned to the toplight daylight zone.

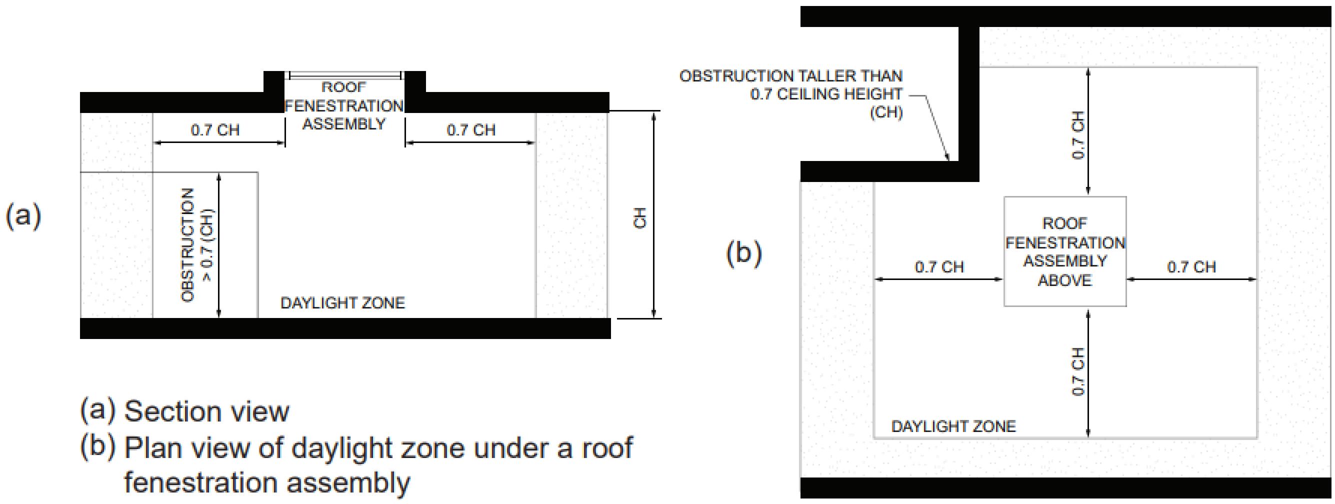
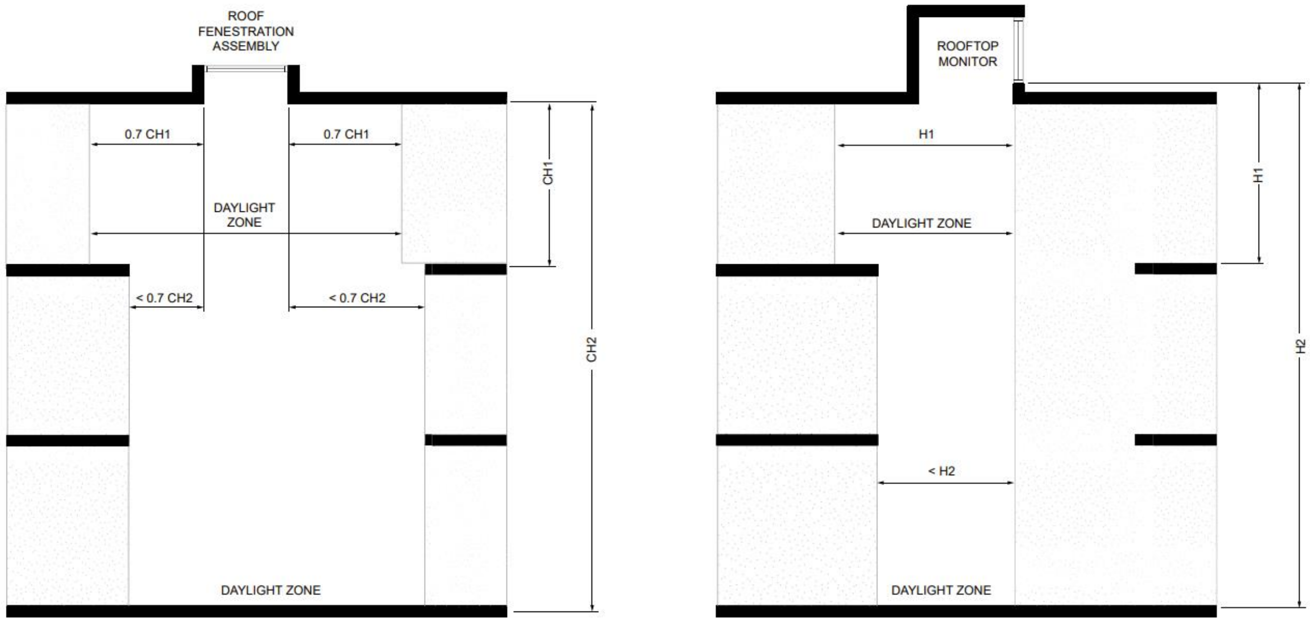


FIGURE C405.2.4.3
TOPLIT DAYLIGHT ZONE

add **C405.2.4.4 Atriums.** Daylight zones at atrium spaces shall be established at the top floor surrounding the atrium and at the floor of the atrium space, and not on intermediate floors, as indicated in Figure C405.2.4.4.



(a) Section view of roof fenestration assembly at atrium

(b) Section view of roof monitor at atrium

FIGURE C405.2.4.4
DAYLIGHT ZONES AT A MULTISTORY ATRIUM

delete **C405.2.4 Specific application controls** *and replace with* **C405.2.5 Specific application controls**
Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:

    1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.

    1.2 Display and accent.

    1.3. Lighting in display cases.

    1.4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.

    1.5. Lighting equipment that is for sale or demonstration in lighting education.

    1.6 Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

   Exceptions:

   1. Lighting and switched receptacles controlled by card key controls.
   2. Spaces where patient care is directly provided.
   3. Permanently installed luminaires within *dwelling units* shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.
   4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.
   5. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

delete **C405.2.5 Manual controls** *and replace with* **C405.2.6 Manual controls.**

delete **C405.2.6 Exterior lighting controls** *and replace with* **C405.2.7 Exterior lighting controls.**
Exterior lighting systems shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4.

Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.
2. Lighting controlled from within dwelling units.

delete **C405.2.6.1 Daylight shutoff** *and replace with* **C405.2.7.1 Daylight shutoff.**

delete **C405.2.6.2 Decorative lighting shutoff** *and replace with* **C405.2.7.2 Building façade and landscape lighting.**

delete **C405.2.6.3 Lighting setback** *and replace with* **C405.2.7.3 Lighting setback.**
Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:

1.1. From not later than midnight to not earlier than 6 a.m.
1.2. From not later than one hour after business closing to not earlier than one hour before business opening.

1.3. During any time where activity has not been detected for 15 minutes or more.

2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

delete **C405.2.6.4 Exterior time-switch control function** *and replace with* **C405.2.7.4 Exterior time-switch control function.**

add **C405.2.8 Parking garage lighting control.**
Parking garage lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a *time-switch control* complying with Section C405.2.2.1. Additional lighting controls shall be provided as follows:

1. Lighting power of each luminaire shall be automatically reduced by not less than 30 percent when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be not larger than 3,600 square feet (334.5 m2).

   Exception: Lighting zones provided with less than 1.5 footcandles of illumination on the floor at the darkest point with all lights on are not required to have automatic light-reduction controls.

2. Where lighting for eye adaptation is provided at covered vehicle entrances and exits from buildings and parking structures, such lighting shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent from sunset to sunrise.

3. The power to luminaires within 20 feet (6096 mm) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

   Exceptions:
   1. Where the opening-to-wall ratio is less than 40 percent as viewed from the interior and encompassing the vertical distance from the driving surface to the lowest structural element.

   2. Where the distance from the opening to any exterior daylight blocking obstruction is less than one-half the height from the bottom of the opening or fenestration to the top of the obstruction.

   3. Where openings are obstructed by permanent screens or architectural elements restricting daylight entering the interiorspace.

delete and replace **C405.3 Interior lighting power requirements.**

A building complies with this section where its total connected interior lighting power calculated under Section C405.3.1 is not greater than the interior lighting power allowance calculated under Section C405.3.2.

delete and replace **C405.3.1 Total connected interior lighting power.**
The total connected interior lighting power shall be determined in accordance with Equation 4-9.

$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$ **(Equation 4-9)**

where:

TCLP	=	Total connected lighting power (watts).
SL	=	Labeled wattage of luminaires for screw-in lamps.
LVL	=	For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.
BLL	=	For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.
LED	=	For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.
TRK	=	For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following: 1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m). 2. The wattage limit of the permanent current-limiting devices protecting the system. 3. The wattage limit of the transformer supplying the system.
Other	=	The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power. Additionally, for multiple systems installed in circadian rhythm systems, only include the maximum power that would be on at any one time.

1. Television broadcast lighting for playing areas in sports arenas.

2. Emergency lighting automatically off during normal building operation.

3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.

4. Casino gaming areas.

5. Mirror lighting in dressing rooms.

6. Task lighting for medical and dental purposes that is in addition to general lighting.

7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

8. Lighting for theatrical purposes, including performance, stage, film production and video production.

9. Lighting for photographic processes.

10. Lighting integral to equipment or instrumentation and installed by the manufacturer.

11. Task lighting for plant growth or maintenance provided it is limited to no more than 75 W per square foot of Canopy Area.

12. Advertising signage or directional signage.

13. Lighting for food warming.

14. Lighting equipment that is for sale.

15. Lighting demonstration equipment in lighting education facilities.

16. Lighting approved because of safety considerations.

17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.

18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.

19. Exit signs.

20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

delete and replace **C405.3.2 Interior lighting power allowance.**
The total interior lighting power allowance (watts) for an entire building shall be determined according to Table C405.3.2(1) using the Building Area Method, or Table C405.3.2(2) using the Space-by-Space Method. The interior lighting power allowance for projects that involve only portions of a building shall be determined according to Table C405.3.2(2) using the Space-by-Space Method. Buildings with unfinished spaces shall use the Space-by-Space Method.

delete and replace **TABLE C405.3.2(1)**

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

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	0.56
Convention center	0.55
Courthouse	0.64
Dining: bar lounge/leisure	0.64
Dining: cafeteria/fast food	0.59
Dining: family	0.58
Dormitory[a,b]	0.41
Exercise center	0.54
Fire station[a]	0.43
Gymnasium	0.58
Health care clinic	0.62
Hospital[a]	0.74
Hotel/Motel[a, b]	0.50
Library	0.66
Manufacturing facility	0.68
Motion picture theater	0.44
Multifamily[c]	0.38
Museum	0.55
Office	0.53
Parking garage	0.13
Penitentiary	0.54
Performing arts theater	0.77
Police station	0.55
Post office	0.52
Religious building	0.60
Retail	0.73
School/university	0.57
Sports arena	0.61
Town hall	0.56
Transportation	0.42
Warehouse	0.36

Workshop	0.72

For SI: 1 watt per square foot = 10.76 W/m2.

a. Where sleeping units are excluded from lighting power by application of Section C405.1.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

b. Where dwelling units are excluded from lighting power by application of Section C405.1.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

c. Dwelling units and sleeping units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

All permanently installed lighting serving dwelling units, excluding kitchen appliance lighting, shall contain only high-efficacy lighting sources

delete and replace **TABLE C405.3.2(2)**

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

COMMON SPACE TYPES[a]	LPD (watts/ft^2)
Atrium	
Less than 40 feet in height	0.48
Greater than 40 feet in height	0.60
Audience seating area	
In an auditorium	0.46
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.22
In a performing arts theater	1.16
In a religious building	0.72
In a sports arena	0.28
Otherwise	0.28
Banking activity area	0.56
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.81
Otherwise	0.65
Computer room, data center	0.89
Conference/meeting/multipurpose room	0.78
Copy/print room	0.31
Corridor	
In a facility for the visually impaired (and	0.71

not used primarily by the staff)[b]	
In a hospital	0.62
Otherwise	0.41
Courtroom	1.01
Dining area	
In bar/lounge or leisure dining	0.68
In cafeteria or fast food dining	0.38
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.27
In family dining	0.51
In a penitentiary	0.42
Otherwise	0.39
Electrical/mechanical room	0.43
Emergency vehicle garage	0.37
Food preparation area	0.82
Guestroom[c, d]	0.36
Laboratory	
In or as a classroom	0.89
Otherwise	1.08
Laundry/washing area	0.39
Loading dock, interior	0.42

(continued)

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

COMMON SPACE TYPES[a]	LPD (watts/sq.ft)
Lobby	
For an elevator	0.49
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.54
In a hotel	0.51
In a motion picture theater	0.23
In a performing arts theater	1.12
Otherwise	0.66

Locker room	0.41
Lounge/breakroom	
In a healthcare facility	0.42
Otherwise	0.47
Office	
Enclosed	0.64
Open plan	0.55
Parking area, interior	0.12
Pharmacy area	1.17
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b])	1.26
Otherwise	0.56
Sales area	0.89
Seating area, general	0.23
Stairway (see Space containing stairway)	
Stairwell	0.41
Storage room	0.33
Vehicular maintenance area	0.45
Workshop	0.96
BUILDING TYPE SPECIFIC SPACE TYPESa	**LPD (watts/sq.ft)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.61
Dormitory – living quarters[c,d]	0.50
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.70
In a recreation room (and not used primarily by the staff)	1.42
Fire Station—sleeping quarters[c]	0.16
Gymnasium/fitness center	
In an exercise area	0.48
In a playing area	0.68
Healthcare facility	
In an exam/treatment room	1.13
In an imaging room	0.81
In a medical supply room	0.46

In a nursery	0.69
In a nurse's station	0.61
In an operating room	1.69
In a patient room[c]	0.48
In a physical therapy room	0.66
In a recovery room	0.87
Library	
In a reading area	0.70
In the stacks	0.96

(continued)

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

BUILDING TYPE SPECIFIC SPACE TYPES[a]	LPD (watts/sq.ft)
Manufacturing facility	
In a detailed manufacturing area	0.69
In an equipment room	0.54
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	0.84
In a high-bay area (25–50 feet floor-to-ceiling height)	0.75
In a low-bay area (less than 25 feet floor-to ceiling height)	0.71
Museum	
In a general exhibition area	0.31
In a restoration room	0.74
Performing arts theater—dressing room	0.32
Post office—sorting area	0.58
Religious buildings	
In a fellowship hall	0.42
In a worship/pulpit/choir area	0.85
Retail facilities	
In a dressing/fitting room	0.41
In a mall concourse	0.67
Sports arena—playing area	

For a Class I facility[e]	2.10
For a Class II facility[f]	1.46
For a Class III facility[g]	1.02
For a Class IV facility[h]	0.64
Transportation facility	
In a baggage/carousel area	0.37
In an airport concourse	0.27
At a terminal ticket counter	0.34
Warehouse—storage area	
For medium to bulky, palletized items	0.28
For smaller, hand-carried items	0.55

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 W/m2

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply

b. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Where sleeping units are excluded from lighting power calculations by application of Section C405.1.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

d. Where dwelling units are excluded from lighting power calculations by application of Section C405.1.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

e. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

f. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high-school facilities with seating for more than 2,000 spectators.

g. Class III facilities consist of club, amateur league and high-school facilities with seating for 2,000 or fewer spectators.

h. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high-school facilities without provision for spectators.

delete and replace **C405.3.2.1 Building Area Method.**

For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an "area" shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.

2. Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the lighting power (watts) for each building area type.

3. The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

delete and replace **C405.3.2.2 Space-by-Space Method.**

Where a building has unfinished spaces, the lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.2 watts per square foot (10.76 w/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.

2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the lighting power (watts) for each space type.

3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

delete and replace **C405.3.2.2.1 Additional interior lighting power.**

Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.5. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-10.

   Additional interior lighting power allowance = 500 W + (Retail Area 1 × 0.22 W/ft^2) + (Retail Area 2 × 0.22W/ft^2) + (Retail Area 3 × 0.52 W/ft^2) + (Retail Area 4 × 0.93 W/ft^2)

   For SI units:

   Additional interior lighting power allowance = 500 W + (Retail Area 1 × 2.4 W/m^2) + (Retail Area 2 × 2.42 W/m2) + (Retail Area 3 × 5.5 W/m^2) + (Retail Area 4 × 10 W/m^2)

(Equation 4-10)

where:

Retail Area 1	=	The floor area for all products not listed in Retail Area 2, 3 or 4.
Retail Area 2	=	The floor area used for the sale of vehicles, sporting goods and small electronics.
Retail Area 3	=	The floor area used for the sale of furniture, clothing, cosmetics and artwork.
Retail Area 4	=	The floor area used for the sale of jewelry, crystal and china.

Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is approved by the code official.

delete **C405.4 Exterior lighting power requirements** *and replace with* **C405.4 Lighting for plant growth and maintenance.**
Not less than 95 percent of the permanently installed luminaires used for plant growth and maintenance shall have a photon efficiency of not less than 1.7 μmol/J for greenhouses or 1.9 μmol/J for indoor facilities as defined in accordance with ANSI/ASABE S640.

delete and replace **C405.5 Exterior lighting power requirements.**
The total connected exterior lighting power calculated in accordance with Section C405.5.1 shall be not greater than the exterior lighting power allowance calculated in accordance with Section C405.5.2. Appropriate exterior lighting designs including maximum exterior illuminance levels may be required by the District Environmental Commission for Act 250 projects.

delete **C405.4.1 Total connected exterior building exterior lighting power** *and replace with* **C405.5.1 Total connected exterior building exterior lighting power**
The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.

4. Specialized signal, directional and marker lighting associated with transportation.

5. Advertising signage or directional signage.

6. Integral to equipment or instrumentation and installed by its manufacturer.

7. Theatrical purposes, including performance, stage, film production and video production.

8. Athletic playing areas.

9. Temporary lighting.

10. Industrial production, material handling, transportation sites and associated storage areas.

11. Theme elements in theme/amusement parks.

12. Used to highlight features of art, public monuments, and the national flag.

13. Lighting for water features and swimming pools.

14. Lighting controlled from within dwelling units, where the lighting complies with Section C405.1.1.

delete **C405.4.2 Exterior lighting power allowance** *and replace with* **C405.5.2 Exterior lighting power allowance**

The exterior lighting power allowance (watts) is calculated as follows:

1. Determine the Lighting Zone (LZ) for the building according to Table C405.5.2(1), unless otherwise specified by the code official.
2. For each exterior area that is to be illuminated by lighting that is powered through the energy service for the building, determine the applicable area type from Table C405.5.2(2). For area types not listed, select the area type that most closely represents the proposed use of the area.
3. Determine the total area or length of each area type and multiply by the value for the area type in Table C405.5.2(2) to determine the lighting power (watts) allowed for each area type.
4. The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.5.2(2), plus the watts from each area type.

add **C405.5.2.1 Additional exterior lighting power.**

Additional exterior lighting power allowances are available for the specific lighting applications listed in Table C405.5.2(3). These additional power allowances shall be used only for the luminaires serving these specific applications and shall not be used to increase any other lighting power allowance.

delete **TABLE C405.4.2(1)** *and replace with* **TABLE C405.5.2(1)**

TABLE C405.5.2(1)
EXTERIOR LIGHTING ZONES

LIGHTING ZONE	DESCRIPTION
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed-use areas
3	All other areas not classified as lighting zone 1 or 2

delete **TABLE C405.4.2(2)** *and replace with* **TABLE C405.5.2(2)**

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

	LIGHTING ZONES		
	Zone 1	**Zone 2**	**Zone 3**
Base Site Allowance	175 W	200 W	250 W
Uncovered Parking Areas			
Parking areas and drives	0.02 W/ft^2	0.02 W/ft^2	0.03 W/ft^2
Building Grounds			
Walkways less than 10 feet wide	0.25 W/linear foot	0.25 W/linear foot	0.30 W/linear foot
Walkways, 10 feet wide or greater, plaza areas, special feature areas	0.05 W/ft^2	0.05 W/ft^2	0.06 W/ft^2
Dining areas	0.35 W/ft^2	0.35 W/ft^2	0.40 W/ft^2
Stairways	0.30 W/ft^2	0.35 W/ft^2	0.35 W/ft^2
Pedestrian tunnels	0.06 W/ft^2	0.06 W/ft^2	0.07 W/ft^2
Landscaping	0.02 W/ft^2	0.02 W/ft^2	0.02 W/ft^2
Building Entrances and Exits			
Pedestrian and vehicular entrances and exits	7 W/linear foot of opening	7 W/linear foot of opening	11 W/linear foot of opening
Entry canopies	0.10 W/ft^2	0.12 W/ft^2	0.20 W/ft^2

Loading docks	0.20 W/ft^2	0.20 W/ft^2	0.20 W/ft^2
Sales Canopies			
Free-standing and attached	0.20 W/ft^2	0.20 W/ft^2	0.30 W/ft^2
Outdoor Sales			
Open areas (including vehicle sales lots)	0.10 W/ft^2	0.10 W/ft^2	0.18 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	4 W/linear foot	4 W/linear foot
Building façades	No allowance	0.038 W/ft^2 of gross above-grade wall area	0.057 W/ft^2 of gross above- grade wall area
Automated teller machines (ATM) and night depositories	70 W per location plus 25 W per additional ATM per location	70 W per location plus 25 W per additional ATM per location	70 W per location plus 25 W per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	0.25 W/ft^2 of covered and uncovered area	0.25 W/ft^2 of covered and uncovered area	0.25 W/ft2 of covered and uncovered area
Loading areas for law enforcement, fire, ambulance and other emer gency service vehicles	0.20 W/ft^2 of covered and uncovered area	0.20 W/ft^2 of covered and uncovered area	0.20 W/ft^2 of covered and uncovered area
Drive-up windows/doors	100 W per drive-through	100 W per drive-through	100 W per drive-through
Parking near 24-hour retail entrances	200 W per main entry	200 W per main entry	200 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 W/m^2.
W = watts.

add **TABLE C405.5.2(3)**

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

	LIGHTING ZONES		
	Zone 1	**Zone 2**	**Zone 3**
Building façades	No allowance	0.038 W/ft^2 of gross above-grade wall area	0.057 W/ft^2 of gross above- grade wall area
Automated teller	70 W per location plus	70 W per location plus	70 W per location plus 25

machines (ATM) and night depositories	25 W per additional ATM per location	25 W per additional ATM per location	W per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	0.25 W/ft^2 of covered and uncovered area	0.25 W/ft^2 of covered and uncovered area	0.25 W/ft2 of covered and uncovered area
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.20 W/ft^2 of covered and uncovered area	0.20 W/ft^2 of covered and uncovered area	0.20 W/ft^2 of covered and uncovered area
Drive-up windows/doors	100 W per drive-through	100 W per drive-through	100 W per drive-through
Parking near 24-hour retail entrances	200 W per main entry	200 W per main entry	200 W per main entry

For SI: 1 watt per square foot = 10.76 W/m^2.
W = watts.

delete **C405.4.3 Exterior fixtures** *and replace with* **C405.5.3 Exterior fixtures**
Exterior lighting shall be *full cut off* fixtures, limiting the light output to less than 10 percent at and below 10 degrees below the horizontal. Fixtures shall be independently certified by manufacturer as full cut off or meet the definition of a *fully shielded* light fixture.

delete **C404.4.4 Gas lighting** *and replace with* **C405.5.4 Gas lighting**
Gas-fired lighting appliances shall not be permitted.

delete **C405.5 Dwelling electrical meter** *and replace with* **C405.6 Dwelling electrical meter**
Each dwelling unit located in a *Group R*-2 building shall have a separate electrical meter.

Exception: Buildings where a majority of the living units serve tenants at or below 80 percent of area median income.

delete **C405.6 Electrical transformers (Mandatory)** *and replace with* **C405.7 Electrical transformers**
Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of Table C405.7 as tested and rated in accordance with the test procedure listed in DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the transformer manufacturer.

Exception: The following transformers are exempt:

1. Transformers that meet the *Energy Policy Act of 2005* exclusions based on the DOE 10 CFR 431 definition of special purpose applications.

2. Transformers that meet the *Energy Policy Act of 2005* exclusions that are not to be used in general purpose applications based on information provided in DOE 10 CFR 431.

3. Transformers that meet the *Energy Policy Act of 2005* exclusions with multiple voltage taps where the highest tap is not less than 20 percent more than the lowest tap.

4. Drive transformers.

5. Rectifier transformers.

6. Auto-transformers.

7. Uninterruptible power system transformers.

8. Impedance transformers.

9. Regulating transformers.

10. Sealed and nonventilating transformers.

11. Machine tool transformers.

12. Welding transformers.

13. Grounding transformers.

14. Testing transformers.

renumber **TABLE C405.6** *as* **TABLE C405.7**

delete **C405.7 Electric motors (Mandatory)** *and replace with* **C405.8 Electric motors.**
Electric motors shall meet the minimum efficiency requirements of Tables C405.8(1) through C405.8(4) when tested and rated in accordance with the DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the motor manufacturer.

Exception: The standards in this section shall not apply to the following exempt electric motors:

1. Air-over electric motors.

2. Component sets of an electric motor.

3. Liquid-cooled electric motors.

4. Submersible electric motors.

5. Inverter-only electric motors.

renumber **TABLE C405.7(1)** *as* **TABLE C405.8(1)**

renumber **TABLE C405.7(2)** *as* **TABLE C405.8(2)**

renumber **TABLE C405.7(3)** *as* **TABLE C405.8(3)**

renumber **TABLE C405.7(4)** *as* **TABLE C405.8(4)**

delete **C405.8 Vertical and horizontal transportation systems and equipment** *and replace with* **C405.9 Vertical and horizontal transportation systems and equipment.**

delete **C405.8.1 Elevator cabs** *and replace with* **C405.9.1 Elevator cabs.**

delete **C405.8.2 Escalators and moving walks** *and replace with* **C405.9.2 Escalators and moving walks**
Escalators and moving walks shall comply with ASME A17.1/CSA B44 and shall have automatic controls that reduce speed as permitted in accordance with ASME A17.1/CSA B44 and applicable local code.

Exception: A variable voltage drive system that reduces operating voltage in response to light loading conditions is an alternative to the reduced speed function.

delete **C405.8.2.1 Energy recovery** *and replace with* **C405.9.2.1 Energy recovery**
Escalators shall be designed to recover electrical energy when resisting overspeed in the down direction. The escalator shall be designed to recover, on average, more power than is consumed by the power recovery feature of its motor controller system.

delete **C405.9 Voltage drop in feeder and branch circuits** *and replace with* **C405.10 Voltage drop**
The total *voltage drop* across the combination of customer-owned service conductors, feeder conductors and branch circuit conductors shall not exceed 5 percent.

add **C405.11 Automatic receptacle control.**
The following shall have automatic receptacle control complying with Section C405.11.1:

1. At least 50 percent of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms, and individual workstations, including those installed in modular partitions and module office workstation systems.

2. At least 25 percent of branch circuit feeders installed for modular furniture not shown on the construction documents.

add **C405.11.1 Automatic receptacle control function.**
Automatic receptacle controls shall comply with the following:

1. Either split controlled receptacles shall be provided with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches (304.8 mm) of each uncontrolled receptacle.

2. One of the following methods shall be used to provide control:

    2.1. A scheduled basis using a time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building of not more than 5,000 square feet (464.5 m^2) and not more than one floor. The occupant shall be able to manually override an area for not more than 2 hours. Any individual override switch shall control the receptacles of not more than 5,000 feet (1524 m).

    2.2. An occupant sensor control that shall turn off receptacles within 20 minutes of all occupants leaving a space.
    2.3. An automated signal from another control or alarm system that shall turn off receptacles within 20 minutes after determining that the area is unoccupied.

3. All controlled receptacles shall be permanently marked in accordance with NFPA 70 and be uniformly distributed throughout the space.

4. Plug-in devices shall not comply.

Exceptions: Automatic receptacle controls are not required for the following:

1. Receptacles specifically designated for equipment requiring continuous operation (24 hours per day, 365 days per year).
2. Spaces where an automatic control would endanger the safety or security of the room or building occupants.
3. Within a single modular office workstation, noncontrolled receptacles are permitted to be located more than 12 inches (304.8 mm), but not more than 72 inches (1828 mm) from the controlled receptacles serving that workstation.

add **C405.12 Energy monitoring.**
New buildings with a gross conditioned floor area of 25,000 square feet (2322 m^2) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

Exception:
R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet (464.5 m^2) of conditioned floor area.

add **C405.12.1 Electrical energy metering.**
For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its

occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

add **C405.12.2 End-use metering categories.**
Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:
1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.12.3 is provided.

TABLE C405.12.2
ENERGY USE CATEGORIES

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

add **C405.12.3 Meters.**
Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.12.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.12.4 and C405.12.5.

add **C405.12.4 Data acquisition system.**
A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.12.2.

add **C405.12.5 Graphical energy report.**
A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the energy consumption for each end-use category required by Section C405.12.2 at least every hour, day, month and year for the previous 36 months.

delete **C405.10 Electric vehicle** *and replace with* **C405.13 Electric vehicle Power Transfer Infrastructure.**
New parking facilities shall be provided with *electric vehicle* power transfer infrastructure in compliance with Sections C405.13.1 through C405.13.7.

add **C405.13.1 Quantity.**
The number of required *EVSE spaces*, *EV capable spaces* and *EV ready spaces* shall be determined in accordance with this Section and Table C405.13.1 based on the total number of *automobile parking spaces* and shall be rounded up to the nearest whole number.

1. Where more than one parking facility is provided on a building site, the number of required *automobile parking spaces* required to have *EV* power transfer infrastructure shall be calculated separately for each parking facility.

2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.

3. Each installed *EVSE* space with an *EV fast charger* shall count as four (4) *EVSE* spaces in Table C405.13.1.

4. Installed *EVSE* spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV ready spaces* and *EV capable spaces*.

5. Installed *EV ready spaces* that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV capable spaces*.

6. The quantity shall never exceed the number of *automobile parking spaces* or require more *automobile parking spaces* to be constructed.

Exceptions:

1. Parking facilities, serving occupancies other than R-2 with fewer than 10 automobile parking spaces.

2. Stand-alone retail stores with fewer than 50 spaces are exempt from the requirement to provide EVSE spaces but are still required to provide EV Ready and EV Capable spaces in Table C405.13.1 if there are 10 or more automobile parking spaces.

3. Motor liquid fuel-dispensing facilities including gas stations.

4. Parking spaces are not counted in Table 405.13.1 if one of the following conditions apply:

    1. Parking spaces intended exclusively for storage of vehicles for retail sale or vehicle service.

    2. Parking spaces that are separated from the meter by a public right-of-way.

    3. Parking spaces that are limited to parking durations of less than an hour.

delete **TABLE C405.11** *and replace with* **TABLE C405.13.1**

TABLE C405.13.1
REQUIRED EV POWER TRANSFER INFRASTRUCTURE

COMMERCIAL BUILDING OCCUPANCY[a]	EVSE SPACES	EV READY SPACES	EV CAPABLE SPACES
Groups A, M	2%	0%	20%
Group B	6%	0%	30%
Group E	4%	0%	20%
Groups F, H, S	2%	0%	10%
Groups I, R-3, R-4	3%	0%	10%
Group R-1	8%	7%	50%
Group R-2	0%	0%	Determined in Equation 4-11

a. See *occupancy classification* in Section C202.

$$R2EVC = D/SU + 0.25 * (APS - D/SU) \qquad \textbf{(Equation 4-11)}$$

where:

R2EVC = Total requirement for EV Capable Spaces in R-2 building occupancies.
D/SU = Total number of dwelling and sleeping units in the R-2 building.
APS = Total number of *automobile parking spaces* provided.

add **C405.13.2 EV Capable Spaces.**

Each *EV capable space* used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the *EV capable space* and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with C405.13.5.
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future *electric vehicle supply equipment* (EVSE)."
5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each *EV capable space.*

   Exceptions:

   1. R-2 Occupancies with Multifamily building garage or covered parking, should provide on electrical drawings the appropriate sized pathway to the building electrical room to accommodate a future electrical upgrade for Level 2 EVSE electric vehicle charging; provide adequate wall and floor space in the building electrical room for future EV charging related electrical equipment; provide the appropriate sized pathways to exterior on-grade surface parking spaces for future Level 2 EVSE electric vehicle charging; provide a line diagram on the electrical drawings demonstrating a pathway for future Level 2 EVSE electric vehicle charging

add **C405.13.3 EV Ready Spaces.**

Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each *EV ready space* it serves.
2. Have a minimum circuit capacity in accordance with C405.13.5.
3. The panelboard or other electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

add **C405.13.4 EVSE Spaces.**

An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of Section C405.13.1, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.13.5.
2. Have a minimum charging rate in accordance with C405.13.4.1.
3. Be located within 3 feet (914 mm) of each *EVSE space* it serves.
4. Be installed in accordance with Section C405.13.6.

add **C405.13.4.1 EVSE Minimum Charging Rate.**

Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
2. When serving multiple *EVSE spaces* and controlled by an energy management system providing load management, be capable of simultaneously charging each *EVSE space* at a minimum rate of no less than 3.3 kVA.
3. When serving *EVSE spaces* allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.13.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each *ESVE space* at a minimum rate of no less than 2.1 kVA.

add **C405.13.5 Circuit Capacity.**

The capacity of electrical infrastructure serving each *EV capable space*, *EV ready space*, and *EVSE space* shall comply with one of the following:

1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each *EV ready space* or *EVSE space* it serves.
2. The requirements of C405.13.5.1.

add **C405.13.5.1 Circuit Capacity Management.**

The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.

2. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE space* for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be *EV ready spaces* or *EVSE spaces*.

3. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE spaces* for a building site when all (100%) of the *automobile parking spaces* are designed to be *EV ready* or *EVSE spaces*.

add **C405.13.6 EVSE Installation.**

EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. *EVSE* shall be accessible in accordance with International Building Code Section 1107.

add **C405.13.7 EVSE Parking Restrictions.**

Automobile parking spaces required by Table C405.13.1 to be equipped with *EVSE* shall be marked for EV use only.

Exceptions:

1. In Group R-2 buildings the number of parking spaces with EVSE that are marked for "EV use only" need not exceed the number of EV cars driven by occupants of the building. This exception does not reduce the number of EVSE spaces, just the number that are marked for EV use only.

2. In structured parking lots $^1/_2$ of parking spaces, rounded up, with EVSE shall be marked for "EV use only," while the remainder need not be marked for "EV use only." This exception does not reduce the number of EVSE spaces, just the number that are marked for EV use only.

add **C405.14 Additional electric infrastructure.** Buildings that contain *combustion equipment* and end-uses shall be required to install electric infrastructure in accordance with this section*.*

Exception: Buildings with R-2 *occupancy classifications*.

add **C405.14.1 Combustion space heating.** Spaces containing *combustion equipment* for space heating shall comply with either C405.14.1.1 or C405.14.1.2

add **C405.14.1.1 Low-capacity heating.** Spaces containing warm-air furnaces with a capacity less than 225,000 Btu/h and gas- and oil-fired boilers with a capacity less than 400,000 Btu/h shall be provided with a designated exterior location(s) that complies with the following:

1. Natural drainage for condensate from cooling equipment operation or a condensate drain located within 3 feet (914 mm) of the location of the space heating equipment, and

2. A dedicated branch circuit in compliance with NFPA70 Section 424.4 based on heat pump space heating equipment sized in accordance with the requirements of Section C403.1.1 and terminating within 3 feet (914 mm) of the location of the space heating equipment with no obstructions. Both ends of the branch circuit shall be labeled "For Future Heat Pump Space Heater."

   Exception: Where an electrical circuit in compliance with NFPA70 Sections 440.4(B) and 440.35 exists for space cooling equipment.

add **C405.14.1.2 High-capacity heating.** Spaces containing all other space heating *equipment* shall be provided with conduit only that is continuous between a junction box located within 3 feet (914 mm) of the *equipment* and an electrical panel. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate a future branch circuit with sufficient capacity for an equivalent electric *equipment* with an equivalent equipment capacity. The electrical junction box and electrical panel shall have labels stating, “For Future Electric Space Heating Equipment”.

add **C405.14.2 Combustion water heating.** Spaces containing *combustion equipment* for water heating shall comply with either C405.14.2.1 or C405.14.2.2

add **C405.14.2.1 Low-capacity water heating.** Spaces containing water heaters with a capacity less than 300,000 Btu/h (88 kW) shall comply with the following:

1. Conduit sufficient for a 208/240-volt branch circuit with a minimum capacity of 30 amps terminating within 3 feet (914 mm) from the water heater shall be provided and be accessible to the water heater with no obstructions. Both ends of the branch circuit shall be labeled with the words "For Future Heat Pump Water Heater" and be electrically isolated,

2. A condensate drain that is no more than 2 inches (51 mm) higher than the base of the installed water heater and allows natural draining without pump assistance shall be installed within 3 feet (914 mm) of the water heater,

3. The space shall meet minimum dimensions of 3 feet (914 mm) by 3 feet (914 mm) by 7 feet (2134 mm) high, and

4. The space shall meet a minimum volume of 700 cubic feet (20,000 L) or the equivalent of one 16-inch (406 mm) by 24-inch (610 mm) grill to a heated space and one 8-inch (203 mm) duct of no more than 10 feet (3048 mm) in length for cool exhaust air.

    Exception: Where items 1 and 2 are be provided at an exterior location capable of serving an outdoor compressor for a split-system heat pump water heater and a chase that is sized to accommodate refrigerant lines is provided between the outdoor location and the space required in item 3.

add **C405.14.2.2 High-capacity water heating.** Spaces containing water heaters with a capacity greater than or equal to 300,000 Btu/h (88 kW) shall comply with the following:

1. Conduit that is continuous between a junction box located within 3 feet (914 mm) of the *equipment* and an electrical panel shall be provided. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate a branch circuit with sufficient capacity for an equivalent electric *equipment* with an equivalent equipment capacity. The electrical junction box and electrical panel shall have labels stating, “For Future Electric Water Heating Equipment”, and

2. A condensate drain that is no more than 2 inches (51 mm) higher than the base of the installed water heater and allows natural draining without pump assistance shall be installed within 3 feet (914 mm) of the water heater,

add **C405.14.3 Combustion cooking.** Spaces containing combustion equipment for cooking shall comply with either C405.14.3.1 or C405.14.3.2

add **C405.14.3.1 Commercial cooking.** Spaces containing *commercial cooking appliances* shall be provided with a dedicated branch circuit with a minimum capacity of 12 kVA per 1 kBtu of appliance input capacity. The branch circuit shall terminate within 3 feet (914 mm) of the appliance with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Cooking Equipment” and be electrically isolated.

add **C405.14.3.2 Light and medium duty cooking.** Spaces containing light- and medium duty cooking *equipment* not designated as *commercial cooking appliances* shall be provided with a dedicated branch circuit with a minimum capacity of 40 amps in compliance with NFPA 70 Section 422.10. The branch circuit shall terminate within 6 feet (1829 mm) of fossil fuel ranges, cooktops and ovens and be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Cooking Equipment” and be electrically isolated.

add **C405.14.4 Combustion clothes drying.** Spaces containing combustion equipment for clothes drying shall comply with either C405.14.4.1 or C405.14.4.2

add **C405.14.4.1 Commercial drying.** Spaces containing clothes drying *equipment,* and end-uses for commercial laundry applications shall be provided with conduit that is continuous between a junction box located within 3 feet (914 mm) of the *equipment* and an electrical panel. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate a branch circuit with sufficient capacity for an equivalent electric *equipment* with an equivalent equipment capacity. The electrical junction box and electrical panel shall have labels stating, “For Future Electric Clothes Drying Equipment”, and

add **C405.14.4.2 Residential drying.** Spaces containing clothes drying *equipment, appliances,* and end-uses serving multiple *dwelling units* or sleeping areas with a capacity less than or equal to 9.2 cubic feet shall be provided with a conduit sufficient for a dedicated 240-volt branch circuit with a minimum capacity of 30 amps shall terminate within 6 feet (1829 mm) of fossil fuel clothes dryers and shall be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Clothes Drying Equipment” and be electrically isolated.

delete **SECTION C406 ADDITIONAL PACKAGES** *in its entirety and replace with* **SECTION C406 ADDITIONAL EFFICIENCY, RENEWABLE, AND LOAD MANAGEMENT REQUIREMENTS**

SECTION C406 ADDITIONAL EFFICIENCY, RENEWABLE, AND LOAD MANAGEMENT REQUIREMENTS

C406.1 Compliance.

Buildings shall comply as follows:

1. Buildings with greater than 1000 square feet (190 m2) of floor area shall comply with Section C406.1.1.

2. Buildings with greater than 2500 square feet (465 m2) of conditioned floor area shall comply with Sections C406.1.1 and C406.1.2.

3. Build-out construction greater than 500 square feet (93 m2) of conditioned floor area that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.3.

Exception: Core and shell buildings where no less than 20 percent of the net floor area is without final lighting or final HVAC shall comply with all of the following:

1. Buildings with greater than 2500 square feet (465 m2) of conditioned floor area shall comply with Section C406.1.2

2. Portions of the building where the net floor area is without final lighting or final HVAC shall comply with Section C406.1.3

3. Portions of the building where the net floor area has final lighting and final HVAC systems shall comply with C406.1.1.

C406.1.1 Additional energy efficiency credit requirements.

Buildings shall comply with measures from C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1 based on building occupancy group.
Where a project contains multiple occupancies, credits in Table C406.1.1 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 purposes of Section C406.

Exceptions:

1. Unconditioned parking garages that achieve 50% of the credits required for use groups S-1 and S-2 in Table C406.1.1.

2. Portions of buildings devoted to manufacturing or industrial use.

TABLE C406.1.1
ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

	Building Occupancy Group								
	R-2, R-4, and I-1	I-2	R-1	B	A-2	M	E	S-1 and S-2	All Other
Energy Credit Requirements	79	46	83	30	60	75	90	65	36

C406.1.2 Additional renewable and load management credit requirements.

Buildings shall comply with measures from C406.3 to achieve not less than the number of required renewable and load management credits from Table C406.1.2 based on building occupancy group. Where a project contains multiple occupancies, credits in Table C406.1.2 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406.

Exceptions:

1. Where a building achieves an additional 70% of the required points from Table C406.1.1, only 50% (round up to nearest whole number) of points from Table C406.1.2 are required.
2. Where a building achieves an additional 120% of the required points from Table C406.1.1, 0 points from Table C406.1.2 are required.

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

	Building Occupancy Group								
	R-2, R-4, and I-1	I-2	R-1	B	A-2	M	E	S-1 and S-2	All Other
Renewable and Load Management Credit Requirements	16	11	14	24	4	25	22	20	17

C406.1.3 Core and Shell Buildings and Build-Out Construction.

Where separate permits are issued for core and shell buildings and build-out construction, compliance shall be in accordance with the following requirements.

1. Core and shell buildings or portions of buildings shall comply with one of the following:

   1.1. Where the permit includes a central HVAC system or service water heating system with chillers, heat pumps, boilers, service water heating equipment, or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required in Table C406.1.1 in accordance with Section C406.2.

   1.2. Alternatively, the project shall achieve not less than 33 percent of the energy credits required in Table C406.1.1.

2. For core and shell buildings or portions of buildings the energy credits achieved shall be subject to the following adjustments:

   2.1. Lighting measure credits shall be determined only for areas with final lighting installed.

   2.2. Where HVAC or service water heating systems are designed to serve the entire building, full HVAC or service water heating measure credits shall be achieved

   2.3. Where HVAC or service water heating systems are designed to serve individual areas, HVAC or service water heating measure credits achieved shall be reduced in proportion to the floor area with final HVAC systems or final service water heating systems installed

3. Build-out construction shall be deemed to comply with Section C406.1 where either

   3.1. Where heating and cooling generation are provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required in Table C406.1.1

3.2. Where heating and cooling generation are provided by an HVAC system installed in the build out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required in Table C406.1.

3.3. Where the core and shell building was approved in accordance with C408.

C406.2 Additional Energy Efficiency Credits Achieved.

Each energy efficiency credit measure used to meet credit requirements for the project shall have efficiency that is greater than the requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the base credits listed for the measure and occupancy type in Table C406.2.1 or, where calculations required by Sections C406.2.1 through C406.2.6 create or modify the table credits, the credits achieved shall be based upon the calculations. Energy credits achieved for measures shall be determined by one of the following, as applicable:

1. The measure's energy credit shall be the base energy credit for the measure where no adjustment factor or calculation is included in the description of the measure in Section C406.2.
2. The measure's energy credit shall be the base energy credit for the measure adjusted by a factor or equation as stated in the description of the measure in Section C406.2. Where adjustments are applied, each measure's energy credit shall be rounded to the nearest whole number.
3. The measure's energy credit shall be by calculation as stated in the measure's description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

Energy credits achieved for the project shall be the sum of the individual measure's energy credits. Credits are available for the measures listed in this Section. Where a project contains multiple building occupancy groups:

1. Credits achieved for each occupancy group shall be summed and then weighted by the floor area of each occupancy group to determine the weighted average project energy credits achieved.
2. Credits for improved envelope efficiency and lighting reduction (L06) shall be determined for the building or permitted floor area as a whole. Credits for other measures shall be taken from applicable tables or calculations weighted by the building occupancy group floor area.

TABLE C406.2.1
ENERGY EFFICIENCY MEASURES AND CREDITS BY OCCUPANCY GROUP [a,b]

ID	Energy Credit Measure	Building Occupancy Group								
		R-2, R-4, and I-1	I-2	R-1	B	A-2	M	E	S-1 and S-2	All Other
E01	Envelope Performance	Determined in accordance with Section C406.2.1.1								
E02	UA Reduction	19	5	13	20	33	28	25	37	28
E03	Envelope Leak Reduction	13	9	28	6	42	13	8	68	41
E04	Add Roof Insulation	7	2	3	3	2	24	23	10	9
E05	Add Wall Insulation	13	3	5	8	2	16	7	7	9

E06	Improve Fenestration	42	6	13	21	4	10	34	6	17
H01	HVAC Performance	6	6	6	6	x	9	8	x	8
H02	Heating Efficiency	14	11	6	9	19	29	15	44	18
H03	Cooling Efficiency	3	x	x	1	x	7	4	x	x
H04	Residential HVAC Control	21	x	x	x	x	x	x	x	x
H05	Energy Recovery	46	65	41	114	84	242	43	180	90
W01	SHW Preheat Recovery	93	6	36	12	34	13	13	3	26
W02	Heat Pump Water Heater	81	3	30	5	25	4	10	1	20
W04	SHW Pipe Insulation	6	1	4	4	2	4	4	1	3
W05	Point of Use Water Heaters	x	x	x	18	x	x	4	x	11
W06	Thermostatic Balance Valves	3	0	2	1	1	1	1	1	1
W07	SHW Heat Trace System	11	1	7	5	3	5	5	2	5
W08	SHW Submeters	17	x	x	x	x	x	x	x	17
W09	SHW Distribution Sizing	68	x	26	x	x	x	x	x	47
W10	Shower Heat Recovery	25	1	9	x	x	x	3	x	10
P01	Energy Monitoring	3	3	2	3	2	5	3	5	3
L01	Lighting Performance	x	x	x	x	x	x	x	x	x
L02	Enhanced Digital Lighting Controls	1	4	1	4	1	5	4	3	3
L03	Increase Occupancy Sensors	1	4	2	4	1	6	3	4	3
L04	Increase Daylight Area	2	5	3	6	1	8	5	4	4
L05	Residential Light Control	3	x	x	x	x	x	x	x	x
L06	Reduced Lighting Power	1	5	1	5	1	6	5	4	4
Q01	Efficient Elevator Equipment	4	2	2	4	0	3	4	5	3
Q02	Commercial Kitchen Equipment	x	x	x	x	21	x	x	x	x
Q03	Residential Kitchen Equipment	13	x	10	x	x	x	x	x	x
Q04	Fault Detection	3	3	2	3	3	3	4	6	4

[a]. "x" indicates credit is not available for that measure
[b]. Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

C406.2.1 More Efficient Building Envelope.

A project shall achieve credits for improved envelope performance by complying with of one of the following measures:

1. Section C406.2.1.1: E01
2. Section C406.2.1.2: E02
3. Section C406.2.1.3: E03
4. Both EO2 and E03
5. Any combination of:

   5.1 Section C406.2.1.3: E03

5.2 Section C406.2.1.4: E04

5.3 Section C406.2.1.5: E05

5.4 Section C406.2.1.6: E06

C406.2.1.1 E01 Improved envelope performance 90.1 Appendix C.

Building envelope measures shall be installed to improve the energy performance of the project. The achieved energy credits shall be determined using Equation 4-13.

$$EC_{env} = 1000 \times (EPF_B - EPF_P)/EPF_B \qquad \text{(Equation 4-13)}$$

where:

EC_{ENV} = E01 energy credits

EPF_B = base envelope performance factor calculated in accordance with ASHRAE 90.1 Appendix C.

EPF_P = proposed envelope performance factor calculated in accordance with ASHRAE 90.1-Appendix C.

C406.2.1.2 E02 Total UA envelope reduction.

Energy credits shall be achieved where the total UA of the building thermal envelope as designed is not less than 15 percent below the total UA of the building thermal envelope in accordance with Section C402.1.3.

C406.2.1.3 E03 Reduced air leakage.

Energy credits shall be achieved where tested building air leakage is less than 0.15 cfm/ft2 provided the building is tested in accordance with the applicable method in Section C402.4.1.1.

C406.2.1.4 E04 Add Roof Insulation.

Energy credits shall be achieved in conditioned spaces for insulation that is in addition to the required insulation in Table C402.1(2). All roof areas in the project shall have additional R-10 continuous insulation included in the roof assembly. For attics this is permitted to be achieved with fill or batt insulation rated at R-10 that is continuous and not interrupted by ceiling or roof joists. Where interrupted by joists, the added insulation shall be not less than R-13. Alternatively, one-half of the base credits shall be achieved where the added R-value is one-half of the additional R-value required by this section.

C406.2.1.5 E05 Added Wall Insulation.

Energy credits shall be achieved in conditioned spaces for insulation applied to not less than 90 percent of all opaque wall area in the project that is in addition to the required insulation in Table C402.1(2).

Opaque walls shall have additional R-5 continuous insulation included in the wall assembly. Alternatively, one-half of the base credits shall be achieved where the added R-value is R-2.5.

C406.2.1.6 E06 Improve Fenestration

Energy credits shall be achieved for improved energy characteristics of all vertical fenestration in the project meeting this requirement. The area-weighted average U-factor of all vertical fenestration shall be equal to or less than U-0.22.

C406.2.2 More Efficient HVAC Equipment Performance.

All heating and cooling systems shall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to minimum efficiencies listed in Tables referenced by Section C403.3.2. Where multiple efficiency requirements are listed, equipment shall meet the seasonal or part-load efficiencies including SEER, EER/integrated energy efficiency ratio (IEER), integrated part load value (IPLV), or AFUE. Equipment that is larger than the maximum capacity range indicated in Tables referenced by Section C403.3.2 shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted average improvement based on individual system capacity.
Systems are permitted to achieve HVAC energy credits by meeting the requirements of either:

1. C406.2.2.1 H01
2. C406.2.2.2 H02
3. C406.2.2.3 H03
4. C406.2.2.4 H04
5. C406.2.2.5 H05
6. Any combination of H02, H03, H04 and H05
7. The combination of H01 and H04

C406.2.2.1 H01 HVAC Performance (TSPR).

H01 energy credits shall be achieved for systems allowed to use Section C403.1.3, HVAC total system performance ratio, where the proposed TSPR exceeds the minimum TSPR requirement by 5 percent. If improvement is greater, base energy credits from Table C406.2.1 are permitted to be prorated up to a 20 percent improvement using Equation 4-15. Energy credits for H01 may not be combined with energy credits from HVAC measures H02, H03 and H05.

H01 energy credit = H01 base energy credit x TSPRs / 0.05 (Equation 4-15)

where:

TSPRs = the lessor of 0.20 and (1 – (TSPRp / TSPRt))

where:

TSPRt	=	TSPRr / MPF
TSPRp	=	HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.
TSPRr	=	HVAC TSPR of the reference building design calculated in accordance with Sections C409.4, C409.5 and C409.6.
MPF	=	Mechanical Performance Factor from Table C409.4 based on climate zone and building use type. Where a building has multiple building use types, MPF shall be area weighted in accordance with Section C409.4

C406.2.2.2 H02 More efficient HVAC equipment heating performance.

No less than 90 percent of the total HVAC capacity serving the total conditioned floor area of the entire building, or tenant space in accordance with Section C406.1.1, shall comply with the requirements of this Section.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2. Electric resistance heating capacity shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating.

2. Equipment shall exceed the minimum heating efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-16 rounded to the nearest whole number.

$$EEC_{HEH} = EEC_{H5} \times (HEI / 0.05) \qquad \text{(Equation 4-16)}$$

where:

EEC_{HEH}	=	energy efficiency credits for heating efficiency improvement
EEC_{H5}	=	C406.2.2.2 credits from Table C406.2.1
HEI	=	the lesser of: the improvement (as a fraction) above minimum heating efficiency requirements, or 20 percent (0.20). Where heating equipment with different minimum efficiencies are included in the building, a heating capacity weighted average improvement shall be used. Where electric resistance primary heating or reheat is included in the building it shall be included in the weighted average improvement with an HEI of 0. Supplemental gas and electric heat for heat pump systems shall be excluded from the weighted HEI. For heat pumps rated at multiple ambient temperatures, the efficiency at 47 F (8.3 C) shall be used. For metrics that increase as efficiency increases, HEI shall be calculated as follows: $HEI = (HM_{DES}/HM_{MIN}) - 1$ Where: HM_{DES} = Design heating efficiency metric, part-load or annualized where available HM_{MIN} = Minimum required heating efficiency metric, part-load or annualized where available from Section C403.3.2

C406.2.2.3 H03 More efficient HVAC cooling equipment and fan performance.

No less than 90 percent of the total HVAC cooling capacity serving the total conditioned floor area of the entire building or tenant space in accordance with Section C406.1.1, shall comply with all of the requirements of this section.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2.

2. Equipment shall exceed the minimum cooling efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. For water-cooled chiller plants, heat rejection equipment efficiency shall also be increased by at least the chiller efficiency improvement. Where equipment exceeds the minimum annual cooling efficiency and heat rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using Equation 4-17, rounded to the nearest whole number.

3. Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fan power or horsepower shall be less than 95 percent of the allowed fan power in Section C403.8.1.

$EEC_{HEC} = EEC_5 \times (CEI / 0.05)$ (Equation 4-17)

where:

EEC_{HEC}	=	energy efficiency credits for cooling efficiency improvement
EEC_5	=	C406.2.2.3 base energy credits from Table C406.2.1
CEI	=	the lesser of: the improvement above minimum cooling and heat rejection efficiency requirements expressed as a fraction, or 0.20 (20 percent). Where cooling equipment with different minimum efficiencies are included in the building, a cooling capacity weighted average improvement shall be used. Where multiple cooling performance requirements are provided, the equipment shall exceed the annualized energy or part-load requirement. Meeting both part-load and full-load efficiencies is not required.

For metrics that increase as efficiency increases, CEI shall be calculated as follows:

$CEI = (CM_{DES} / CM_{MIN}) - 1$

For metrics that decrease as efficiency increases, CEI shall be calculated as follows:

$CEI = (CM_{MIN} / CM_{DES}) - 1$

Where:

CM_{DES}	=	Design cooling efficiency metric, part-load or annualized where available
CM_{MIN}	=	Minimum required cooling efficiency metric, part-load or annualized where available from Section C403.3.2

For Data Centers using Standard 90.4, CEI shall be calculated as follows:

$CEI = (AMLC_{MAX} / AMLC_{DES}) - 1$

Where:

$AMLC_{DES}$	=	As-Designed Annualized Mechanical Load Component calculated in accordance with Standard 90.4, Section 6.5
$AMLC_{MAX}$	=	Maximum Annualized Mechanical Load Component from Standard 90.4, Table 6.5

C406.2.2.4 H04 Residential HVAC control.

HVAC systems serving dwelling units or sleeping units shall be controlled to automatically activate a setback at least 5°F (3°C) for both heating and cooling. The temperature controller shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall be configured to operate in conjunction with one of the following:

1. A manual main control device by each dwelling unit main entrance that initiates setback and non-ventilation mode for all HVAC units in the dwelling unit and is clearly identified as “Heating/Cooling Master Setback.”
2. Occupancy sensors in each room of the dwelling unit combined with a door switch to initiate setback and non-ventilation mode for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately after a door switch operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is configured to provide setback shall meet this requirement.
3. An advanced learning thermostat or controller that recognizes occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.
4. An automated control and sensing system that uses geographic fencing connected to the dwelling unit occupants’ cell phones and initiates the setback condition when all occupants are away from the building.

C406.2.2.5 H05 Energy Recovery.

Credits for this measure are only allowed where single zone HVAC units are not required to have multi-speed or variable-speed fan control in accordance with Section C403.8.6.1. HVAC controls and ventilation systems shall include all of the following:

1. The ventilation system shall have energy recovery with an enthalpy recovery ratio of 75 percent or more at heating design conditions . Energy recovery shall include latent recovery. Where no humidification is provided, heating energy recovery effectiveness is permitted to be based on sensible energy recovery ratio. Where energy recovery effectiveness is less than the 75 percent required for full credit, adjust the credits from Section C406.2 by the factors in Table C406.2.2.5.
2. Where the ventilation system serves multiple zones and the system is not in a latent recovery outside air dehumidification mode. partial economizer cooling through an outdoor air bypass or wheel speed control shall automatically do one of the following:
    a. Set the energy recovery leaving-air temperature 55°F (13°C) or 100 percent outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).
    b. The HVAC ventilation system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.
3. Ventilation systems providing mechanical dehumidification shall use recovered energy for reheat. This shall not limit the use of latent energy recovery for dehumidification.

Where only a portion of the building is permitted to be served by constant air volume units or the enthalpy recovery ratio or sensible energy recovery ratio is less than 65 percent, the base energy credits shown in Section C406.2 shall be prorated as follows:

$$EC_{DOAS} = EC_{base} \times FLOOR_{CAV} \times ERE_{adj} \qquad \text{(Equation 4-18)}$$

where:

EC_{DOAS}	=	Energy credits achieved for H06
EC_{base}	=	H06 base energy credits in Section C406.2
$Floor_{CAV}$	=	Fraction of whole project gross conditioned floor area not required to have variable speed or multi-speed fan airflow control in accordance with Section C403.8.6.
ERE_{adj}	=	The energy recovery adjustment from Table C406.2.2.5 based on the lower of actual cooling or heating enthalpy recovery ratio or sensible energy recovery ratio where required for the climate zone. Where recovery ratios vary, use a weighted average by supply airflow.

TABLE C406.2.2.5 – DOAS Energy Recovery Adjustments

ERE_{adj} based on lower of actual heating or cooling energy recovery effectiveness where required		
Cooling ERR is ≥	Heating *enthalpy recovery ratio* or *sensible energy recovery ratio* is ≥	Energy Recovery Effectiveness Adjustment (ERE_{adj})
65%	65%	1.00
60%	60%	0.67
55%	55% [a]	0.33
50%	50% [a]	0.25

[a]In climate zones where heating recovery is required for this measure, for dwelling units a heating recovery effectiveness below 60 percent is not allowed.

C406.2.3 Reduced Energy Use In-service Water Heating.

Projects with service water-heating equipment that serves the whole building, a building addition or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of either:

1. C406.2.3.1 by selecting one allowed measure W01, or W02
2. C406.2.3.2 W03
3. C406.2.3.3 by selecting one allowed measure of W04, W05, or W06
4. C406.2.3.4 W07
5. C406.2.3.5 W08
6. C406.2.3.6 W09
7. Any combination of measures in C402.2.3.1 through C402.2.3.6 as long as no more than one allowed measure from C406.2.3.1 and C406.2.3.3 are selected.

C406.2.3.1 Service water-heating system efficiency.

A project is allowed to achieve energy credits from only one of Sections C406.2.3.1.1 through C406.2.3.1.3.

C406.2.3.1.1 W01 Recovered or renewable water heating.

The building service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the building's annual hot water requirements, or sized to provide not less than 70 percent of the building's annual hot water requirements if the building is required to comply with Section C403.10.5:

1. Waste heat recovery from SHW, heat recovery chillers, building equipment, or process equipment.
2. A water-to-water heat pump that precools chilled water return for building cooling.
3. On-site renewable energy water-heating systems.

C406.2.3.1.2 W02 Heat pump water heater.

Air-source heat pump water heaters shall be installed according to manufacturer's instructions and at least 30 percent of design end use service water heating requirements shall be met using only heat pump heating at an ambient condition of 67.5 F, db without supplemental electric resistance or fossil fuel heating. For a heat pump water heater with supplemental electric resistance heating, the heat pump only capacity shall be deemed at 40 percent of first hour draw. Where the heat pump only capacity exceeds 50 percent of the design end use load excluding recirculating system losses, the credits from the Section C406.2 tables shall be prorated as follows:

$EC_{HPWH} = (EC_{base} / 0.5) \times \{Cap_{HPWH}/EndLoad \text{ [not greater than 2]}\}$ (Equation 4-19)

where:

EC_{HPWH}	=	Energy credits achieved for W02
EC_{base}	=	W02 base energy credits from Table C406.1.1
EndLoad	=	End use peak hot water load, excluding load for heat trace or recirculation, Btu/hr or kW
Cap_{HPWH}	=	the heat pump only capacity at 50°F (10°C) entering air and 70°F (21°C) entering potable water without supplemental electric resistance or fossil fuel heat, Btu/hr or Kw

The heat pump service water heating system shall comply with the following requirements:

1. For systems with an installed total output capacity of more than 100,000 Btu/hr (30 kW) at an ambient condition of 67.5°F (19.7°C), db a preheat storage tank with greater than or equal 0.75 gallons per 1000 Btu/hr (≥9.7 L/kW) of design end use service water heating requirements shall be heated only with heat pump heating when the ambient temperature is greater than 45°F (7.2°C)
2. For systems with piping temperature maintenance, either a heat trace system or a separate water heater in series for recirculating system and final heating shall be installed.
3. Heat pump water heater efficiency shall meet or exceed one of the following:

a. Output-capacity-weighted-average UEF of 3.0 in accordance with 10 CFR 430 Appendix E.

b. Output-capacity-weighted-average COP of not less than 4.0 tested at 50°F (10°C) entering air and 70°F (21°C) entering potable water in accordance with AHRI standard 1300.

Where the heat pump capacity at 50°F (10°C) entering air and 70°F (21°C) entering water exceeds 50 percent of the design end-use load excluding recirculating system losses, the base credits from Section C406.2 shall be prorated based on Equation 4-20.

W02 credit = base W02 table credit × (HPLF / 50%) (Equation 4-20)

where:

HPLF = Heat pump capacity as a fraction of the design end-use SHW requirements excluding recirculating system losses, not to exceed 80 percent.

C406.2.3.1.3 Combination service water heating systems

Shall achieve credits using the measure combination as follows:

1. (W01 + W02) Where service water heating employs both energy recovery and heat pump water heating, W01 may be combined with W02 and receive the sum of both credits.

C406.2.3.3 Water-heating distribution temperature maintenance.

A project is allowed to achieve energy credits from only one of the following SHW distribution temperature maintenance measures.

C406.2.3.3.1 W03: Service Hot Water Piping Insulation Increase.

Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hot water source to the fixture shutoff. Where no more than 50% of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.

C406.2.3.3.2 W04 Point of use water heaters.

Credits are available for Group B or E buildings larger than 10,000 ft2 (930 m2). Fixtures requiring hot water shall be supplied from a localized source of hot water with no recirculating system or heat trace piping. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C403.12.3 without exception. The volume from the water heater to the termination of the fixture supply pipe shall be limited as follows:

1. Non-residential lavatories: not more than 2 oz (60 mL)

2. All other plumbing fixtures or appliances: not more than 0.25 gallons (0.95 L)

Exception: Where all remotely located hot water uses meet the requirements for measure W04, separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping.

C406.2.3.3.3 W05 Thermostatic balancing valves.

Credits are available where service water heating is provided centrally and distributed throughout the building and has a recirculating system. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 120°F (49°C).

C406.2.3.3.4 W06 Heat trace system.

Credits are available for projects with gross floor area greater than 10,000 square feet (930 m2) and a central water-heating system. The energy credits achieved shall be from Table C406.2.1. This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

C406.2.3.4 W07 Water-heating system submeters.

Each individual dwelling unit in a Group R-2 occupancy served by a central service water-heating system shall be provided with a service hot water meter connected to a reporting system that provides individual dwelling unit reporting of actual domestic hot water use. Preheated water serving the cold water inlet to showers need not be metered.

C406.2.3.5 W08 Service hot water flow reduction.

Dwelling unit, sleeping unit, and guest room plumbing fixtures that are connected to the service water-heating system shall have a flow or consumption rating less than or equal to the values shown in Table C406.2.3.5.

Table C406.2.3.5

Maximum Flow Rating for Residential Plumbing Fixtures with Heated Water

Plumbing Fixture	Maximum Flow Rate
Faucet for private lavatory,[a] hand sinks, or bar sinks	1.2 gpm at 60 psi (0.095 L/s at 410 kPa)
Faucet for residential kitchen sink [a,b, c]	1.5 gpm at 60 psi 0.11 L/s at 410 kPa)
Shower head (including hand-held shower spray) a, b, d	1.5 gpm at 80 psi (0.13 L/s at 550 kPa)

a. Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)- (p).

b. Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.

c. Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (0.14 L/s at 410 kPa) and must default to the maximum flow rate listed.

d. When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.

C406.2.3.6 W9 Shower drain heat recovery.

Cold water serving building showers shall be preheated by shower drain heat recovery units that comply with Section C404.7. The efficiency of drain heat recovery units shall be

54 percent or greater measured in accordance with CSA B55.1. Full credits are applicable to the following building uses: I-2, I-4, R-1, R-2 and also group E where there are more than eight showers. Partial credits are applicable to buildings where all but ground floor showers are served where the base energy credit from Section C406.2 is adjusted by Equation 4-21.

W10 credit = W10 base energy credit × (showers with drain heat recovery)/(total showers in building) (Equation 4-21)

C406.2.4 P01 Energy Monitoring.

A project not required to comply with C405.12 can achieve energy credits for installing an energy monitoring system that complies with all the requirements of C405.12.1 through C405.12.5.

C406.2.5 Energy Savings in Lighting Systems.

Projects are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of either:

1. C406.2.5.2 L02
2. C406.2.5.3 L03
3. C406.2.5.4 L04
4. C406.2.5.5 L05
5. C406.2.5.6 L06
6. Any combination of L03, L04, L05 and L06
7. Any combination of L02, L03 and L04

C406.2.5.1 L01 Lighting system performance (reserved).

Reserved for future use

C406.2.5.2 L02 Enhanced digital lighting controls.

Measure credits shall be achieved where no less than 50 percent of the gross floor area within the project shall comply with the requirements of this section.

1. Lighting controls function. Interior general lighting shall be located, scheduled and operated in accordance with Section C405.2 and shall be configured with the following enhanced control functions:
    a. Luminaires shall be configured for continuous dimming.
    b. Each luminaire shall be individually addressed.

    Exceptions:
    1. Multiple luminaires mounted on no more than 12 linear feet of a single lighting track and addressed as a single luminaire.
    2. Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet.

    ii. No more than eight luminaires within a daylight zone are permitted to be controlled by a single daylight responsive control.

b. Luminaires shall be controlled by a digital control system configured with the following capabilities:

    i. Scheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.

    ii. Load shedding.

    iii. Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.

c. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.

d. High-end trim. Luminaires shall be initially configured with the following:

    i. High-end trim, setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of a space or area, shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by at least 15 percent from full output. The average maximum light output or power of the controlled lighting shall be documented without high-end trim and with high-end trim to verify reduction of light output or power by at least 15 percent when tuned.

    ii. Where lumen maintenance control is used, controls shall be configured to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power draw and lumen maintenance controls shall be limited to increasing lighting power by 1 percent per year.

    iii. High-end trim and lumen maintenance controls shall be accessible only to authorized personnel.

Where general lighting in more than 50 percent of the gross lighted floor area receives high-end trim, the base credits from Section C406.2 shall be prorated as follows:

[Tuned lighted floor area,%] × [Base energy credits for C406.2.5.2] / 50% (Equation 4-22)

C406.2.5.3 L03 Increase occupancy sensor.

Lighting controls shall comply with C406.2.5.3.1, C406.2.5.3.2 and C406.2.5.3.3.

C406.2.5.3.1 Occupant Sensor Controls.

Occupant sensor controls shall be installed to control lights in the following space types:

a. Courtroom
b. Electrical / mechanical room
c. Food preparation area
d. Laboratory
e. Elevator lobby

f. Pharmacy Area
g. Vehicular Maintenance Area
h. Workshop
i. Chapel in a facility for the visually impaired
j. Recreation room in a facility for the visually impaired
k. Exercise area in a fitness center
l. Playing area in a fitness center
m. Exam / treatment room in a healthcare facility
n. Imaging room in a healthcare facility
o. Physical therapy room in a healthcare facility
p. Library reading area
q. Library stacks
r. Detailed manufacturing area
s. Equipment room in a manufacturing facility
t. Low-bay area in a manufacturing facility
u. Post office sorting area
v. Religious fellowship hall
w. Religious worship / pulpit / choir area
x. Hair salon
y. Nail salon
a. Banking activity area
b. Computer room, data center
c. Laundry / washing area
d. Medical supply room in a healthcare facility
e. Telemedicine room in a healthcare facility
f. Museum restoration room

C406.2.5.3.2 Occupant Sensor Control Function.

Occupant sensor controls shall automatically turn lights off within 10 minutes after all occupants have left the space. A manual control complying with C405.2.6 shall allow occupants to turn off lights. Time-switch controls are not required.
Exception: In spaces where an automatic shutoff could endanger occupant safety or security occupant sensor controls shall uniformly reduce lighting power to not more than 20 percent of full power within 10 minutes after all occupants have left

the space. Time-switch controls complying with C405.2.2.1 shall automatically turn lights off.

C406.2.5.3.3 Occupant Sensor Time Function.

Occupant sensor controls installed in accordance with Sections C405.2.1.1, C405.2.1.2, C405.2.1.3, and C405.2.1.4 shall automatically turn lights off or reduce lighting power within 10 minutes after all occupants have left the space. Where lighting power is reduced, the unoccupied setpoint shall be 20 percent of full power or in egress areas to the power level required to meet egress light levels.

C406.2.5.4 L04 Increase daylight area.

The total daylight area of the project (DLA_{BLDG}) with continuous daylight dimming meeting the requirements of C405.2.4 shall be at least 5 percent greater than the typical daylit area (DLA_{TYP}).

Credits for measure L04 shall be determined based on Equation 4-23:

$$EC_{DL} = EC_{DL5} \times 20 \times [(DLA_{BLDG}/GLFA) - DLA_{TYP}] \qquad \text{(Equation 4-23)}$$

where:

EC_{DL}	=	C406.2.5.4 L04 measure base energy credits
DLA_{BLDG}	=	The lesser of actual area of daylight zones in the building with continuous daylight dimming, ft2 or m2 and (GLFA x DLA_{max}) see Table C406.2.5.4. Daylight zones shall meet the criteria in Sections C405.2.4.2 and C405.2.4.3 for primary sidelit daylight zones, secondary sidelit daylight zones, and toplit daylight zones.
GLFA	=	Project gross lighted floor area, ft2 or m2
DLA_{TYP}	=	Typical percentage of building area with daylight control (as a fraction) from Table C406.2.5.4
EC_{DL5}	=	C406.2.5.4 L04 base energy credits from Section C406.2

TABLE C406.2.5.4 ADDED DAYLIGHTING PARAMETERS

Building use type	DLA_{TYP}	DLA_{max}
Group B; Office ≤ 5000 ft2 (460 m2)	10%	20%
Group B; Office > 5000 ft2 (460 m2)	21%	31%
Group M; Retail with ≤ 1000 ft2 (900 m2) roof area	0%	20%
Group M; Retail with > 1000 ft2 (900 m2) roof area	60%	80%
Group E; Education	42%	52%
Groups S-1 and S-2; Warehouse	50%	70%
Group I-2, R, and other; Medical, hotel, multifamily, dormitory, and other	NA	NA

C406.2.5.5 L05 Residential light control.

In buildings with Group R-2 occupancy spaces, interior lighting systems shall comply with the following:

1. Common area Restrooms, laundry rooms, storage rooms, and utility rooms shall have automatic full OFF occupancy sensor controls that comply with the requirements of C405.2.1.1. Each additional control device shall control no more than 5,000 sq.ft.

2. Each dwelling unit shall have a main control by the main entrance that turns off all the lights and all switched receptacles in the dwelling unit. Two switched receptacles shall be provided in living and sleeping rooms or areas and clearly identified. All switched receptacles shall be located within 12 inches (30 cm) of an unswitched receptacle. The main control shall be permitted to have two controls, one for permanently wired lighting and one for switched receptacles. The main controls should be clearly identified as “lights master off” and “switched outlets master off.”

C406.2.5.6 L06 Reduced lighting power.

Interior lighting within the whole building shall comply with all the requirements of this section. The net connected interior lighting power (LPn) shall be 95 percent or less than the net interior lighting power allowance (LPAn) determined in accordance with Section C405.3.2.2. In R-1 and R-2 occupancies the credit is calculated for all common areas other than dwelling units and sleeping units. All of the permanently installed light fixtures in dwelling units and sleeping units, excluding kitchen appliance lighting, shall be provided by high efficacy lamps with a minimum efficacy of 90 lumens per watt or high efficacy luminaires that have a minimum efficacy of 80 lumens per watt. Energy credits shall not be greater than four times the L06 base credit from Section C406.2 and shall be determined using Equation 4-24:

$$EC_{LPA} = EC_5 \times 20 \times (LPA_n - LP_n) / LPA_n \qquad \text{(Equation 4-24)}$$

where:

EC_{LPA}	=	additional energy credit for lighting power reduction
LP_n	=	net connected interior lighting power calculated in accordance with Section C405.3.1, watts, excluding any additional lighting power allowed in Section C405.3.2.2.1
LPA_n	=	interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2.2, watts, less any additional interior lighting power allowed in Section C405.3.2.2.1
EC_5	=	L06 base credit from Section C406.2

C406.2.6 Efficient Equipment Credits.

Projects are permitted to achieve energy credits using any combination of Efficient Equipment Credits Q01 through Q04.

C406.2.6.1 Q01 Efficient Elevator Equipment.

Qualifying elevators in the building shall be Energy efficiency class A per ISO 25745-2, Table 7. Only buildings 3 or more floors above grade are permitted to use this credit. Credits shall be prorated based on Equation 4-25, rounded to the nearest whole credit. Projects with a compliance ratio below 0.5 do not qualify for this credit.

$$EC_e = EC_t \times CR_e \qquad \text{(Equation 4-25)}$$

where:

EC_e	=	Elevator energy credit achieved for the building
EC_t	=	C406.2.7.1 Table energy credit
CR_e	=	Compliance Ratio = (FA / FB)
F_A	=	Sum of floors served by class A elevators
F_B	=	Sum of floors served by all building elevators and escalators

C406.2.6.2 Q02 Efficient Commercial Kitchen Equipment.

For buildings and spaces designated as Group A-2, or facilities whose primary business type involves the use of a commercial kitchen where at least one gas or electric fryer is installed before the issuance of the Certificate of Occupancy all fryers, dishwashers, steam cookers and ovens installed before the issuance of the Certificate of Occupancy shall comply with all of the following:

a. Comply with the efficiency levels outlined in the Vermont Appliance Efficiency Standards

b. Achieve performance levels for select equipment that exceed the requirements in the Vermont Appliance Efficiency Standards, as outlined in Tables C406.2.7.2 (1) through C406.2.7.2 (4) when rated in accordance with the applicable test procedure.

c. Have associated performance levels listed on the construction documents submitted for permitting.

TABLE C406.2.7.2(1)
Minimum Efficiency Requirements: Commercial Fryers

	Heavy-Load Cooking Energy Efficiency	Idle Energy Rate	Test Procedure
Standard Open Deep-Fat Electric Fryers	≥ 83%	≤ 800 watts	ASTM F1361

TABLE C406.2.7.2(3)
MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS

Machine Type	High Temperature Efficiency Requirements			Low Temperature Efficiency Requirements			Test Procedure
	Idle Energy Rate[a]	Washing Energy	Water Consumption[b]	Idle Energy Rate[a]	Washing Energy	Water Consumption[b]	
Under Counter	≤ 0.30 kW	≤ 0.35 kWh/rack	≤ 0.86 GPR (≤ 3.3 LPR)	≤ 0.25 kW	≤ 0.15 kWh/rack	≤ 1.19 GPR ≤ 4.5 LPR	ASTM F1696 ASTM F1920
Stationary Single Tank Door	≤ 0.55 kW	≤ 0.35 kWh/rack	≤ 0.89 GPR (≤ 3.4 LPR)	≤ 0.30 kW	≤ 0.15 kWh/rack	≤ 1.18 GPR ≤ 4.47 LPR	
Pot, Pan, and Utensil	≤ 0.90 kW	kWh/rack ≤ 0.55 + 0.05 × SF_{rack}[c] (≤ 0.55 + 0.0046 × SM_{rack}[c)]	≤ 0.58 GPSF (≤ 2.2 LPSM)	N/A	N/A	N/A	
Single Tank Conveyor	≤ 1.20 kW	≤ 0.36 kWh/rack	≤ 0.70 GPR (≤ 2.6 LPR_	≤ 0.85 kW	≤ 0.16 kWh/rack	≤ 0.79 GPR ≤ 3.0 LPR	
Multiple Tank Conveyor	≤ 1.85 kW	≤ 0.36 kWh/rack	≤ 0.54 GPR (≤ 2.0 LPR)	≤ 1.00 kW	≤ 0.22 kWh/rack	≤ 0.54 GPR ≤ 2.0 LPR	

a. Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heaters and controls. The most energy consumptive configuration in the product family shall be selected to test the idle energy rate. Booster heater (internal or external) energy consumption shall be measured and reported separately, if possible, per ASTM F1696 and ASTM F1920 Sections 10.8 and 10.9, respectively. However, if booster energy cannot be measured separately it will be included in the idle energy rate measurements.
b. GPR = gallons per rack, LPR = Liters per rack, GPSF = gallons per square foot of rack, LPSM = liters per square fmeter of rack, GPH = gallons per hour, c = [maximum conveyor belt speed (feet/minute)] × [conveyor belt width (feet)], LPH = liters per hour, d = [maximum conveyor belt speed (m/minute)] × [conveyor belt width (m)]
c. PPU Washing Energy is still in format kWh/rack when evaluated; SF_{rack} (SM_{rack}) is Square Feet of rack area (square meters of rack area), same as in PPU water consumption metric.

Table C406.2.7.2(4)
Minimum Efficiency Requirements: Commercial Ovens

Fuel Type	Classification	Idle Rate	Cooking Energy Efficiency, %	Test Procedure
Convection Ovens				
Gas	Full-Size	≤ 12,000 Btu/h (3.5 kW)	≥ 46	ASTM F1496
Electric	Half-Size	≤ 1.0 kW	≥ 71	
	Full-Size	≤ 1.60 kW		
Combination Ovens				
Gas	Steam Mode	≤ 200 P^a + 6,511 Btu/h (≤ 0.059 P^a + 1.9 kW)	≥ 41	ASTM F2861
	Convection Mode	≤ 150 P^a + 5,425 Btu/h (≤ 0.044 P^a + 1.6 kW)	≥ 56	
Electric	Steam Mode	≤ 0.133 P^a + 0.6400 kW	≥ 55	
	Convection Mode	≤ 0.080 P^a + 0.4989 kW	≥ 76	
Rack Ovens				
Gas	Single	≤ 25,000 Btu/h (7.3 kW)	≥ 48	ASTM F2093
	Double	≤ 30,000 Btu/h (8.8 kW)	≥ 52	

[a] *P* = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495

C406.2.6.3 Q03 Efficient Residential Kitchen Equipment.

For projects with Group R-1 and R-2 occupancies, energy credits shall be achieved where all dishwashers, refrigerators, and freezers comply with all of the following:

a. Achieve the Energy Star Most Efficient 2021 label in accordance with the specifications current as of:
    i. Refrigerators and freezers 5.0, 9/15/2014
    ii. Dishwashers 6.0, 1/29/2016
b. Be installed before the issuance of the certificate of occupancy.

For Group R-1 where only some guest rooms are equipped with both refrigerators and dishwashers, the table credits shall be prorated as follows:

[Section C406.2 base credits]× (floor area of guest rooms with kitchens)/(total guest room floor area) (Equation 4-26)

C406.2.6.4 Q04 Fault detection and diagnostics system.

A project not required to comply with C403.2.3 can achieve energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with items 1 through 6 in Section C403.2.3.

C406.3 Renewable and Load Management Credits Achieved.

Renewable energy and load management measures installed in the building that comply with Sections C406.3.1 through C406.3.8 shall achieve the credits listed for the occupancy group in Table C406.3.1 or where calculations are required in Sections C406.3 to determine credits or modify the table credits, the credits achieved shall be based upon the Section C406.3 calculations. Measure credits achieved shall be determined in one of two ways, depending on the measure:

1. The measure credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the description of the measure in Section C406.3.
2. The measure credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the description of the measure in Section C406.3. Where adjustments are applied, each energy credit shall be rounded to the nearest whole number.

Load management and renewable credits achieved for the project shall be the sum of credits for individual measures included in the project. Credits are available for the measures listed in this Section. Where a project contains multiple building use groups credits achieved for each building use group shall be summed and then weighted by the gross floor area of each building use group to determine the weighted average project energy credits achieved.

The load management measures in Sections C406.3.2 (G01) through C406.3.7 (G06) require load management control sequences that are capable of automatically providing the load management operation specified based on indication of a peak period related to high short-term electric prices, grid condition, or peak building load.

TABLE C406.3.1
Renewable and Load Management Credit Requirements by Building Occupancy Group

ID	Renewable and Load Management Credit	Building Occupancy Group								
		R-2, R-4, and I-1	I-2	R-1	B	A-2	M	E	S-1 and S-2	All Other
R01	On-Site Renewable Energy	9	6	8	14	2	9	13	24	11
G01	Lighting Load Management	5	14	9	10	4	18	16	36	14
G02	HVAC Load Management	10	12	x	8	16	14	18	14	13
G03	Automated Shading	1	x	1	5	x	8	14	x	5
G04	Electric Energy Storage	14	13	13	16	4	11	20	24	14
G05	Cooling Energy Storage	7	11	12	12	2	9	16	1	9
G06	SHW Energy Storage	18	4	26	6	15	4	7	2	10
G07	Building Thermal Mass	27	26	26	8	6	13	31	20	20
C01	Insulation Embodied Carbon	5	3	4	8	1	8	7	6	5
E01	Additional Electric Infrastructure	16	x	x	x	x	x	x	x	x

C406.3.1 R01 Renewable Energy.

Projects installing on-site renewable energy systems with a capacity of at least 0.1 watts per gross square foot (1.08 W/m2) of building area or securing off-site renewable energy shall achieve energy credits for this measure calculated as follows:

$EC_R = EC_{0.1} \times R_t / (0.1 \times PGFA)$ (Equation 4-27)

where:

EC_R = C406.3.1 R01 energy credits achieved for this project

R_t	=	actual total rating of on-site renewable energy systems (W)
PGFA	=	Project gross floor area, ft2
$EC_{0.1}$	=	C406.3.1 R01 base credits from Tables C406.3(1) through C406.3(9)

C406.3.2 G01 Lighting Load Management.

Luminaires shall have dimming capability and automatic load management controls that are capable of gradually reduce general lighting power during peak periods. The load management controls shall be capable of reducing lighting power in 75 percent of the building area by at least 20 percent with continuous dimming over a period no longer than 15 minutes. Where less than 75 percent, but at least 50 percent of the project general lighting is controlled, the credits from Tables C406.3 shall be prorated as follows:

[building area with lighting load management, %] x [table credits for C406.3.2] / 75%
(Equation 4-28)

Exception: Warehouse or retail storage building areas shall be permitted to achieve this credit by switching off at least 25 percent of lighting power in 75 percent of the building area without dimming, or as adjusted by Equation 4-28.

C406.3.3 G02 HVAC Load Management.

Automatic load management controls shall be capable of:

1. Where electric cooling is in use gradually increase the cooling setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective cooling capacity to 60% of installed capacity during the peak period.

2. Where electric heating is in use gradually decrease the heating setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective heating capacity to 60% of installed capacity during the peak period.

3. Where HVAC systems are serving multiple zones and have less than 70 percent outdoor air required, include controls that are capable of providing excess outdoor air preceding the peak period and reduce outdoor air by at least 30 percent during the peak period, in accordance with ASHRAE Standard 62.1 Section 6.2.5.2 Short Term Conditions.

C406.3.4 G03 Automated Shading Load Management.

Where fenestration on east, south, and west exposures exceeds 20 percent of wall area, load management credits shall be achieved as follows:

1. Automatic exterior shading devices or dynamic glazing that are capable of reducing solar gain (SHGC) through sunlit fenestration by at least 50 percent when fully closed shall receive the full credits in Table C406.3.1. The exterior shades shall have fully open and fully closed SHGC determined in accordance with AERC 1.

2. Automatic interior shading devices with a minimum solar reflectance of 0.50 for the surface facing the fenestration shall receive 40 percent of the credits in Table C406.3.1.

3. All shading devices, dynamic glazing, or shading attachments shall:

    a. provide at least 90 percent coverage of the total fenestration on east, south, and west exposures in the building

b. be automatically controlled and shall modulate in multiple steps or continuously the amount of solar gain and light transmitted into the space in response to peak periods and either daylight levels or solar intensity

c. include a manual override located in the same enclosed space as the shaded vertical fenestration that shall override operation of automatic controls no longer than four hours. Such override shall be locked out during peak periods.

For this section, directional east, south, or west exposures shall exclude fenestration that is plus or minus 45 degrees of facing true north in the northern hemisphere. In the southern hemisphere, where the south exposure is referred to, it shall be replaced by the north exposure and the referenced south exposure shall be replaced by the north exposure.

C406.3.5 G04 Electric Energy Storage.

Electric storage devices shall be capable of charging and discharging by automatic load management controls to store energy during non-peak periods and use stored energy during peak periods to reduce building demand. Electric storage devices shall have a minimum capacity of 1.5 Wh/ft2 (87 Wh/m2) of gross building area. Base credits in Tables C406.3-1 through C406.3-8 are based on installed electric storage of 5 Wh/ft2 (54 Wh/m2) and shall be prorated for actual installed storage capacity between 1.5 and 15 Wh/ft2 (16 to 160 Wh/m2), as follows:

(electric storage capacity, Wh/ft2 (Wh/m2))/(5 (54)) × [C406.3.5 Credits from C406.3 Tables] (Equation 4-29)

Larger energy storage shall be permitted; however, credits are limited to the range of 1.5 to 15 Wh/ft2 (16 to 160 Wh/m2).

C403.3.6 G05 Cooling Energy Storage.

Automatic load management controls shall be capable of activating ice or chilled water storage equipment to reduce demand during summer peak periods. Storage tank standby loss shall be demonstrated through analysis to be no more than 2 percent of storage capacity over a 24 hour period for the cooling design day.

Base credits in Section C406.3 are based on storage capacity of the design peak hour cooling load with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 4.0 times the design day peak hour cooling load, rounded to the nearest whole credit. Larger storage shall be permitted but the associated credits are limited to the range above. Energy credits shall be determined as follows:

$EC_s = EC_{1.0} \times (1.44 \times SR + 0.71) / 2.15$ (Equation 4-30)

where:

ECs = Cooling Storage credit achieved for Project

EC1.0 = G05 base energy credit for building use type and climate zone based on 1.0 ton-hours storage per design day ton (kWh/kW) of cooling load

SR = Storage ratio in Btu storage per peak design day Btu/hr cooling load (kWh/kW) where $0.5 \le SR \le 4.0$

C406.3.7 G06 SWH Energy Storage.

Where SHW is heated by electricity, automatic load management controls that comply with ANSI/CTA-2045-B shall be capable of preheating stored SHW before the peak period and suspend electric water heating during the peak period. Storage capacity shall be provided by either:

1. Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water-heating capacity. Tempering valves shall be provided at the water heater delivery location.

2. Providing additional heated water tank storage capacity above peak SHW demand with equivalent peak storage capacity to item 1. Where heat pump water heating is used, the credits achieved shall be 1/3 of the credits in Tables C406.3.1.

C406.3.8 G07 Building Thermal Mass.

The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80 percent of gross floor area unoccupied between midnight and 6:00 a.m. The project shall meet the following requirements:

1. Interior to the building envelope insulation, provide 10 lb/ft2 (50 kg/m2) of project conditioned floor area of passive thermal mass in the building interior wall, the inside of the exterior wall, or interior floor construction. Mass construction shall have mass surfaces directly contacting the air in conditioned spaces with directly attached gypsum panels allowed. Mass with carpet or furred gypsum panels or exterior wall mass that is on the exterior of the insulation layer (e.g., the portion of CMU block on the exterior of insulation filled cell cavities) shall not be included toward the building mass required.

2. HVAC units for 80 percent or more of the supply airflow in the project shall be equipped with outdoor air economizers and fans that have variable or low speed capable of operating at 66 percent or lower airflow and be included in the night flush control sequence.

3. Night flush controls shall be capable of being configured with the following sequence or another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating, and is approved by the authority having jurisdiction.

    a. Summer mode shall be activated when outdoor air temperature exceeds 70 F (21 C) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45 F (7 C). During summer mode, the occupied cooling set point shall be set 1 F (0.6 C) higher than normal and the occupied heating set point shall be reset 2 F (1.1 C) lower than normal.

    b. When all the following conditions exist, night flush shall be activated:

        i. Summer mode is active in accordance with item 3.1

        ii. Outdoor air temperature is 5 F (2.8 C) or more below indoor average zone temperature

        iii. Indoor average zone temperature is greater than morning occupied heating set point

        iv. In climate zones 0A through 3A, outdoor dewpoint is below 50 F (10 C) or outdoor air enthalpy is less than indoor air enthalpy

        v. Local time is between 10:00 pm and 6:00 am.

    c. When night flush is active, automatic night flush controls shall operate outdoor air economizers at low fan speed not exceeding 66 percent during the unoccupied period with mechanical cooling and heating locked out.

4. The project shall demonstrate a contractual obligation for post-occupancy commissioning and control tuning in the spring or fall season to tune the summer mode activation setpoints and occupied heating setpoint or other algorithms to achieve minimal morning heating due to night flush activation while maintaining comfort conditions. Commissioning shall include monitoring of time series space temperature, heating, and cooling operation to demonstrate both night cooling and minimization of morning heating along with monitoring of post-tuning operation to verify tuned parameters. Operating manuals shall include recommendations for tuned parameters and narrative training for operating staff on night flush automated settings. Reporting shall be in compliance with C408.

C406.3.9 C01 Insulation Embodied Carbon

Complete calculation in Table C406.3.9(1) to summarize estimated embodied emissions from insulation materials used in the project. The output metric for this measure shall be global warming potential (GWP) intensity, capturing insulation GWP per square foot of conditioned floor area. To complete the basic calculation, project teams shall provide the following information for foundation, wall, and roof insulation materials:

1. Insulation material type
2. Product R-value
3. Total surface area covered by the insulation product (sf)
4. Default, industry-average GWP value, from Table C406.3.9(2) or GWP values from *Type III Product-specific Environmental Product Declaration (EPD)*
5. Total project area (conditioned square feet)

Projects may substitute product-specific data for the default GWP value if the specified product has a lower reported GWP than the default value. Product-specific data shall be substituted in Column G of the calculation Table C406.3.9(1). Substitution of default GWP values is only allowed when type III product-specific EPDs are sourced and noted in Column G. Projects shall use GWP values that include A1-A3 lifecycle stages, as documented in product-specific EPDs, with the exception of SPF and XPS products. For these products, the A5 and B1 values shall be included in the documented GWP value to account for the on-site and off-gassing impact of blowing agents. Projects shall provide the EPDs declaration number in Column G.

TABLE C406.3.9(1)
INSULATION GLOBAL WARMING POTENTIAL CALCULATION

Table 1 - Insulation Global Warming Potential Calculation

									Optional					
A	B		C		D		E		F	G		H		I
Assembly	Material *List insulation material type from Table 2*		Product R-Value		Surface Area (gross square feet)		Framing Factor ("1.0" for continuous, "0.8" for cavity)		Default Global Warming Potential (kg CO2e /sq.m. RSI-1) *Use Default GWP values from Table 2. Leave blank for products where product specific data will be provided.*	Project has sourced Type III - Product-specific Environmental Product Declaration (EPD) *EPD Declaration Number*	Product Specific Global Warming Potential (kg CO2e /sq.m. RSI-1) *Leave blank unless EPDs have been sourced. Use GWP values from product-specific EPDs.*		Conversion Factor		GWP Result (kg CO2e)
Slab edge				X		X	1.0	X				X	0.0164	=	
Under slab				X		X	1.0	X				X	0.0164	=	
Basement walls				X		X	1.0	X				X	0.0164	=	
Above grade walls, cavity				X		X	0.8	X				X	0.0164	=	
Above grade walls, continuous				X		X	1.0	X				X	0.0164	=	
Roof, flat				X		X	1.0	X				X	0.0164	=	
Roof, sloped, cavity				X		X	0.8	X				X	0.0164	=	
Roof, sloped, continuous				X		X	1.0	X				X	0.0164	=	

(blue)	Input for basic calculation
(green)	Inputs for product-specific data
(yellow)	Calculation outputs

Summary Metrics		
	Total Insulation GWP (kg CO2e)	
	Conditioned Floor Area (sf)	
	OUTPUT: Insulation GWP Intensity (kg CO2e/sf)	

TABLE C406.3.9(2)
DEFAULT INSULATION GLOBAL WARMING POTENTIAL VALUES.

All values are from Building Emissions Accounting for Materials (BEAM)[a], unless noted.

Material	Default Global Warming Potential (kg CO2e /sq.m. RSI-1)
Cellular glass - Aggregate	3.93[b]
Cellulose - Densepack	-2.10
Cellulose - Blown/loosefill	-1.10
Cork - Board	-6.80
EPS/graphite - Board, unfaced, Type II - 15psi	2.80
EPS/graphite - Board, unfaced, Type IX - 25psi, graphite	3.40
EPS - Board, unfaced, Type I - 10psi	2.80
EPS - Board, unfaced, Type II- 15psi	3.80
EPS - Board, unfaced, Type IX- 25psi	4.80
Fiberglass - Batt, unfaced	0.70
Fiberglass - Blown/loosefill	1.00
Fiberglass - Blown/spray	1.93[c]
Hemp - Batt	-0.50
HempCrete	-3.00
Mineral wool - Batt, unfaced	1.70
Mineral wool - Blown	1.60
Mineral wool - Board, unfaced, "light" density	3.30
Mineral wool - Board, unfaced, "heavy" density	8.10
Phenolic foam - Board	1.54[d]
Polyiso - Wall Board	4.10
Polyiso - Roof Board	2.90
SPF – Spray, open cell	1.40
SPF – Spray, closed cell HFO	4.20
SPF – Spray, high density HFO	4.90
SPF – Spray, closed cell HFC	13.10
SPF – Spray, high density HFC	17.00
Straw – Panel	-6.50
Vacuum Insulated Panel	7.40
Wood fiber – Board, unfaced, European	-6.50
Wood fiber – Board, unfaced, North America	-10.30
Wood fiber – Batt, unfaced	-2.40
Wool (Sheep) – Batt	1.00
Wool (Sheep) – Loosefill	0.80
XPS – Board, 25psi HFC	55.50
XPS – Board, 25psi “Low GWP” (HFO/HFC)	4.90

[a] https://www.buildersforclimateaction.org/beam-estimator.html

[b] EPD Declaration Number NEPD-2012-889-EN
[c] EPD Declaration Number 4788647002.102.1
[d] EPD Declaration Number EPD-KSI-20190072-IBC1-EN

Points shall be calculated via Table C406.3.9(3) below.

TABLE C406.3.9(3)
POINTS OPTIONS FOR INSULATION EMBODIED CARBON

COMPONENT		DESCRIPTION	POINTS
Insulation Embodied Carbon	Basic	Report the global warming potential (GWP) impact of project insulation materials as described in Section C406.3.9. Use calculation Table C406.3.9(1) to summarize insulation GWP intensity (kg CO2e/ ft2) for the project. Default global warming potential (GWP) values for common insulation products are provided in Table C406.3.9(2). The calculation may utilize Type III, product-specific environmental product declaration (EPD) in lieu of default values for insulation products. If EPD values are used for a given insulation product, include the sum of lifecycle stages A1-A3 from the sourced EPD instead of default GWP value when completing the calculation. Include A5 and B1 GWP values for SPF and XPS products.	As listed in Table C406.3.1
	Advanced	Demonstrate a calculated insulation GWP intensity (kg CO2e/sf) less than 0.5. Product-specific EPDs may be used in place of default values, subject to requirements in C406.3.9	1.5 x points listed in Table C406.3.1
	Stretch	Demonstrate a calculated insulation GWP intensity (kg CO2e/sf) less than 0. Product-specific EPDs may be used in place of default values, subject to requirements in C406.3.9.	2.0 x points listed in Table C406.3.1

C406.3.10 E01 Additional Electric Infrastructure

For R-2 occupancy only, comply with the requirements of Section C405.14 Additional electric infrastructure.

SECTION C407
MAINTENANCE INFORMATION
AND SYSTEM COMMISSIONING

delete and replace **C407.2.3.1 Equipment.**
Equipment functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function, and

maintenance serviceability for each of the commissioned systems is confirmed. Testing shall include all modes and *sequence of operation*, including under full-load, part-load and the following emergency conditions:

1. All modes as described in the *sequence* of *operation*.
2. Redundant or *automatic* back-up mode.
3. Performance of alarms.
4. Mode of operation upon a loss of power and restoration of power.

Exception: Unitary or packaged HVAC equipment listed in the tables in Section C403.3.2 that do not require supply air economizers.

Add **Section 408**

SECTION C408
CALCULATION OF HVAC TOTAL SYSTEM PERFORMANCE RATIO

C408.1 Purpose. Section 4089 establishes criteria for demonstrating compliance with the requirements of C403.1.1, HVAC total system performance ratio (HVAC TSPR)

C408.2 Scope. Section C408 applies to new HVAC systems that serve buildings in Section C403.1.3.1 and are not excluded from using HVAC TSPR by Section C403.1.3.

All applicable HVAC systems shall comply with Section C408.

C408.3 Core & Shell / Initial Build-Out, and Future System Construction Analysis. Where the building permit applies to only a portion of the HVAC system in a building and the remaining components will be designed under a future building permit or were previously installed, the future or previously installed components shall be modeled as follows:

1. Where the HVAC zones that do not include HVAC systems in the current permit will be or are served by independent systems, then the block including those zones shall not be included in the model.

2. Where the HVAC zones that do not include complete HVAC systems in the permit are intended to receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of C403.

3. Where the zone equipment in the permit receives HVAC services from previously installed systems that are not in the permit, the previously installed systems shall be modeled with equipment matching the certified value of what is installed or equipment that meets the requirements of C403.

4. Where the central plant heating and cooling equipment is completely replaced and HVAC zones with existing systems receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.

C408.4 HVAC TSPR Compliance. Systems allowed to use HVAC TSPR in accordance with C403.1.3 shall comply with all of the following:

1. Systems shall meet the applicable provisions of Section C403.1.3.3 and Sections within Section C403 that are listed in Table C407.2
2. The HVAC TSPR of the proposed design shall be greater than or equal to the HVAC TSPR of the standard reference design divided by the mechanical performance factor (MPF)using Equation 4-16.

TSPRp > TSPRr / MPF (Equation 4-16)

where:

TSPRp = HVAC TSPR of the proposed design calculated in accordance with Sections C408.4, C408.5 and C408.6.

TSPRr = HVAC TSPR of the reference building design calculated in accordance with Sections C408.4, C408.5 and C408.6.

MPF = Mechanical Performance Factor from Table C408.4 based on climate zone and building use type Where a building has multiple building use types, MPF shall be area weighted using Equation 4-17

MPF = (A1*MPF1 + A2* MPF2+...+An*MPFn)/(A1+A2+...+An) (Equation 4-17)

where:

MPF1, MPF2 through MPFn = Mechanical Performance Factors from Table C408.4 based on climate zone and building use types 1,2, through n

A1, A2through An = Conditioned floor areas for building use types 1, 2, through n

Table C408.4 Mechanical Performance Factors

Building Type	**Occupancy Group**	**Performance Factor**
Office (small and medium)[a]	B	0.865
Office (Large)[a]	B	0.73
Retail	M	0.5
Hotel/Motel	R-1	0.35
Multi-Family/ Dormitory	R-2	0.55
School/ Education and Libraries	E (A-3)	0.89

a Large office (gross conditioned floor area >150,000 ft2 (14,000 m2) or > 5 floors); all other offices are small or medium

C408.4.1 HVAC TSPR. HVAC TSPR is calculated according to Equation 4-18 .

HVAC TSPR = heating and cooling load / building HVAC system energy (Equation 4-18)

where:

building HVAC system energy = sum of the annual site energy consumption for heating, cooling, fans, energy recovery, pumps, and heat rejection in thousands of Btus

heating and cooling load = sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btus

C408.5 General. Projects shall comply with the requirements of this Section when calculating compliance using HVAC Total System Performance Ratio.

C408.5.1 Simulation Program. Simulation tools used to calculate HVAC TSPR of the Standard Reference Design shall comply with the following:

1. The simulation program shall calculate the HVACTSPR based only on the input for the proposed design and the requirements of Section 409. The calculation procedure shall not allow the user to directly modify the building component characteristics of the standard reference design.
2. Performance analysis tools meeting the applicable subsections of Section 409 and tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140, shall be permitted to be approved. The required tests shall include building thermal envelope and fabric load tests (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verification tests (Section 5.2.4), space- cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC equipment analytical verification tests (Section 5.5), along with the associated reporting (Section 6). Tools are permitted to be approved based on meeting a specified threshold for a jurisdiction. The code official shall be permitted to approve tools for a specified application or limited scope.
3. The test results and modeler reports shall be posted on a publicly available website and shall include the test results of the simulation program and input files used for generating the results along with the results of the other simulation programs included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.
4. The simulation program shall have the ability to explicitly model part-load performance curves or other part-load adjustment methods based on manufacturer's part-load performance data for mechanical equipment.

C408.5.2 Climatic Data. The simulation program shall perform the simulation using hourly values of climatic data, such as temperature and humidity, using TMY3 data for the site as specified here:

https://energycode.pnl.gov/HVACSystemPerformance/resources

C408.5.3 Documentation. Documentation conforming to the provisions of this section shall be provided to the code official.

C408.5.3.1 Compliance Report. Building permit submittals shall include:

1. A report produced by the simulation software that includes the following:

    1. Address of the building.

    2. Name of individual completing the compliance report.

    3. Name and version of the compliance software tool.

    4. The dimensions, floor heights and number of floors for each block.

    5. By block, the U-factor, C-factor, or F-factor for each simulated opaque envelope component and the U-factor and SHGC for each fenestration component.

    6. By block or by surface for each block, the fenestration area.

    7. By block, a list of the HVAC equipment simulated in the proposed design including the equipment type, fuel type, equipment efficiencies and system controls.

    8. Annual site HVAC energy use by end use for the proposed and baseline building

    9. Annual sum of heating and cooling loads for the baseline building.

    10. The HVAC total system performance ratio for both the standard reference design and the proposed design.

2. A mapping of the actual building HVAC component characteristics and those simulated in the proposed design showing how individual pieces of HVAC equipment identified above have been combined into average inputs as required by Section C408.6.1.10 including:

    1. Fans

    2. Hydronic pumps

    3. Air handlers

    4. Packaged cooling equipment

    5. Furnaces

    6. Heat pumps

    7. Boilers

    8. Chillers

    9. Heat rejection equipment (open and closed circuit cooling towers; dry coolers)

10. Electric resistance coils

11. Condensing units

12. Motors for fans and pumps

13. Energy recovery devices

3. For each piece of equipment identified above include the following as applicable:

1. Equipment name or tag consistent with that found on the design documents.

2. Rated Efficiency level.

3. Rated Capacity.

4. Where not provided by the simulation program report in item a, documentation of the calculation of any weighted equipment efficiencies input into the program

5. Electrical input power for fans and pumps (before any speed or frequency control device) at design condition and calculation of input value (W/cfm or W/gpm)

4. Floor plan of the building identifying:

1. How portions of the buildings are assigned to the simulated blocks

2. Areas of the building that are not covered under the requirements of SectionC403.1.1.

C408.6 Calculation Procedures. Except as specified by this Section, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques

C408.6.1 Simulation of the proposed building design. The proposed design shall be configured and analyzed as specified in this section.

C408.6.1.1 Block Geometry. The geometry of buildings shall be configured using one or more blocks. Each block shall define attributes including block dimensions, number of floors, floor to floor height and floor to ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent blocks. Where actual building shape does not match these pre-defined shapes, simplifications are permitted providing the following requirements are met:

1. The conditioned floor area and volume of each block shall match the proposed design within 10 percent.

2. The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.

3. The area of vertical fenestration and skylights is accounted for within 10 percent of the actual design.

4. The orientation of each component in 2 and 3 above is accounted for within 45 degrees of the actual design.

The creation of additional blocks may be necessary to meet these requirements. A more complex zoning of the building shall be allowed where all thermal zones in the reference and proposed model are the same and rules related to block geometry and HVAC system assignment to blocks are met with appropriate assignment to thermal zones.

Exception: Portions of the building that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.

C408.6.1.1.1 Number of Blocks. One or more blocks may be required per building based on the following restrictions:

1. Each block can have only one occupancy type (multifamily dwelling unit, multifamily common area, office, library, education, hotel/motel or retail). Therefore, at least one single block shall be created for each unique use type.

2. Each block can be served by only one type of HVAC system. Therefore, a single block shall be created for each unique HVAC system and use type combination. Multiple HVAC units of the same type may be represented in one block. Table D601.10.2 provides directions for combining multiple HVAC units or components of the same type into a single block.

3. Each block can have a single definition of floor to floor or floor to ceiling heights. Where floor heights differ by more than two feet, unique

4. blocks should be created for the floors with varying heights.

5. Each block can include either above grade or below grade floors. For buildings with both above grade and below grade floors, separate blocks should be created for each. For buildings

with floors partially above grade and partially below grade, if the total wall area of the floor(s) in consideration is greater than or equal to 50 percent above grade, then it should be simulated as a completely above grade block, otherwise it should be simulated as a below grade block.

6. Each wall on a façade of a block shall have similar vertical fenestration. The product of the proposed design U-factor times the area of windows (UA) on each façade of a given floor cannot differ by more than 15 percent of the average UA for that façade in each block. The product of the proposed design SHGC times the area of windows (SHGCA) on each façade of a given floor cannot differ by more than 15 percent of the average SHGCA for that façade in each block. If either of these conditions are not met, additional blocks shall be created consisting of floors with similar fenestration.

7. For a building model with multiple blocks, the blocks should be configured together to have the same adjacencies as the actual building design.

C408.6.1.2 Thermal Zoning. Each floor in a block shall be modeled as a single thermal zone or as five thermal zones consisting of four perimeter zones and a core zone. Below grade floors shall be modeled as a single thermal block. If any façade in the block is less than 45 feet in length, there shall only be a single thermal zone per floor. Otherwise each floor shall be modeled with five thermal zones. A perimeter zone shall be created extending from each façade to a depth of 15 feet. Where facades intersect, the zone boundary shall be formed by a 45 degree angle with the two facades. The remaining area or each floor shall be modeled as a core zone with no exterior walls.

C408.6.1.3 Occupancy. Building occupancies modeled in the standard reference design and the proposed design shall comply with the following requirements.

C408.6.1.3.1 Occupancy Type. The occupancy type for each block shall be consistent with the building area type as determined in accordance with C405.4.2.1. Portions of the building that are building area types other than multifamily dwelling unit, multifamily common area, office, school (education), library, or retail shall not be included in the simulation. Surfaces adjacent to such building portions shall be modeled as adiabatic in the simulation program.

C408.6.1.3.2 Occupancy schedule, density, and heat gain. The occupant density, heat gain, and schedule shall be for multifamily, office, retail, library, hotel/motel or school as specified by ASHRAE Standard 90.1 Normative Appendix C.

C408.6.1.4 Envelope Components. Building envelope components modeled in the standard reference design and the proposed design shall comply with the requirements of this Section.

C408.6.1.4.1 Roofs. Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single block, an area weighted U-factor shall be used. Roof solar absorptance shall be modeled at 0.70 and emittance at 0.90.

C408.6.1.4.2 Above grade walls. Walls will be modeled as steel frame construction. The U-factor and area of above grade walls shall be modeled as in the proposed design. If different wall constructions exist on the façade of a block an area-weighted U-factor shall be used.

C408.6.1.4.3 Below grade walls. The C-factor and area of below grade walls shall be modeled as in the proposed design. If different slab on grade floor constructions exist in a block, an area-weighted C- factor shall be used.

C408.6.1.4.4 Above grade exterior floors. Exterior floors shall be modeled as steel frame. The U-factor and area of floors shall be modeled as in the proposed design. If different wall constructions exist in the block an area-weighted U-factor shall be used.

C408.6.1.4.5 Slab on grade floors. The F-factor and area of slab on grade floors shall be modeled as in the proposed design. If different below grade wall constructions exist in a block, an area-weighted F-factor shall be used.

C408.6.1.4.6 Vertical Fenestration. The window area and area weighted U-factor and SHGC shall be modeled for each façade based the proposed design. Each exterior surface in a block must comply with Section C408.6.1.1.1 item 5. Windows will be combined into a single window centered on each façade based on the area and sill height input by the user. When different U values, SHGC or sill heights exist on a single facade, area weighted average for each shall be input by the user.

C408.6.1.4.7 Skylights. The skylight area and area weighted U-factor and SHGC shall be modeled for each floor based the proposed design. Skylights will be combined into a single skylight centered on the roof of each zone based on the area input by the user

C408.6.1.4.8 Exterior Shading. Permanent window overhangs shall be modeled. When windows with and without overhangs or windows with different overhang projection factors exist on a façade, window width weighted projection factors shall be input by the user as follows.

C408.6.1.5 Lighting. Interior lighting power density shall be equal to the allowance in Table C405.4.2(1) for multifamily, office, retail, library, or school. The lighting schedule shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls shall be modeled. Exterior lighting shall not be modeled.

C408.6.1.6 Miscellaneous equipment. The miscellaneous equipment schedule and power shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of miscellaneous equipment controls is assumed to be captured by the equipment schedule and no explicit controls shall be modeled.

Exceptions:

1. Multifamily dwelling units shall have a miscellaneous load density of 0.42 W/ft2

2. Multifamily common areas shall have a miscellaneous load density of 0 W/ft2

C408.6.1.7 Elevators. Elevators shall not be modeled.

C408.6.1.8 Service water heating equipment. Service water heating shall not be modeled.

C408.6.1.9 On-site renewable energy systems. On-site Renewable Energy Systems shall not be modeled.

C408.6.1.10 HVAC Equipment. HVAC systems shall meet the requirements of Section C403 Mechanical Systems.

C408.6.1.10.1 Supported HVAC systems. At a minimum, the HVAC systems shown in Table C408.6.1.10.1 shall be supported by the simulation program.

Table C408.6.1.10.1 PROPOSED BUILDING HVAC SYSTEMS SUPPORTED BY HVAC TSPR SIMULATION SOFTWARE

System No.	System Name	System Abbreviation
1	Packaged Terminal Air Conditioner	PTAC
2	Packaged Terminal Air Heat Pump	PTHP
3	Packaged Single Zone Gas Furnace	PSZGF
4	Packaged Single Zone Heat Pump (air to air only)	PSZHP
5	Variable Refrigerant Flow (air cooled only)	VRF
6	Four Pipe Fan Coil	FPFC
7	Water Source Heat Pump	WSHP
8	Ground Source Heat Pump	GSHP
9	Packaged Variable Air Volume (DX cooling)	PVAV
10	Variable Air Volume (hydronic cooling)	VAV
11	Variable Air Volume with Fan Powered Terminal Units	VAVFPTU
12	Dedicated Outdoor Air System (in conjunction with systems 1-8)	DOAS

C408.6.1.10.2 Proposed building HVAC system simulation. The HVAC systems shall be modeled as in the proposed design at design conditions unless otherwise stated with clarifications and simplifications as described in Tables C408.6.1.10.2(1) and C408.6.1.10.2(2). System parameters not described in the following sections shall be simulated to meet the minimum requirements of Section C403. All zones within a block shall be served by the same HVAC system type as described in Section C408.6.1.1.1 item 2. Heat loss from ducts and pipes shall not be modeled. Table C408.6.1.10.1 proposed building HVAC parameter requirements are based on input of full-load equipment efficiencies with adjustment using part-load curves integrated in the simulation program.

Where other approaches to part-load adjustment are used, it is permitted for specific input parameters to vary.

The simulation program shall model part-load HVAC equipment performance using either:

1. full-load efficiency adjusted for fan power input that is modeled separately and typical part- load performance adjustments for the proposed equipment,

2. part-load adjustments based on input of both full- load and part- load metrics, or

3. equipment- specific adjustments based on performance data provided by the equipment manufacturer for the proposed equipment.

For packaged single-zone air conditioners (cooling only), water-loop heat pumps, ground-source heat pumps and packaged rooftop heat pumps, heating COP and cooling COP, exclusive of fan power, shall be determined using the following equations:

For Systems 4, 7, and 8 heating efficiency

$$COP_{nfheating} = 1.48E\text{-}7 \times COP47 \times Q + 1.062 \times COP47$$

For System 3 heating efficiency

$$COP_{nfheating} = -0.0296 \times HSPF2 + 0.7134 \times HSPF$$

For System 4, 7, 8, and 9 cooling efficiency

$$COP_{nfcooling} = 7.84E\text{-}8 \times EER \times Q + 0.338 \times EER$$

For System 1 and 2 cooling efficiency

$$COP_{nfcooling} = -0.0076 \times SEER2 + 0.3796 \times SEER$$

For System 1 and 2 cooling efficiency

$$COP_{nfcooling} = 0.3322 \times EER - 0.2145$$

For System 2 heating efficiency

$$COP_{nfheating} = 1.1329 \times COP - 0.214$$

Where:

EER, SEER, COP and HSPF shall be at AHRI full load test conditions

Q = AHRI rated cooling capacity in BTU/h. If Q > 760,000BTU/h use 760,000 in the calculation

Where multiple system components serve a block, average values weighed by the appropriate metric as described in this section shall be used.

1. Where multiple fan systems serve a single block, fan power shall be based on weighted average using the design supply air cfm

2. Where multiple cooling systems serve a single block, COP shall be based on a weighted average using cooling capacity. DX coils shall be entered as multi-stage if more than 50% of coil capacity serving the block is multi-stage with staged controls.

3. Where multiple heating systems serve a single block, thermal efficiency or heating COP shall be based on a weighted average using heating capacity.

4. Where multiple boilers or chillers serve a heating water or chilled water loop, efficiency shall be based on a weighted average for using heating or cooling capacity.

5. When multiple cooling towers serving a condenser water loop are combined, the cooling tower efficiency, cooling tower design approach and design range are based on a weighted average of the design water flow rate through each cooling tower.

6. Where multiple pumps serve a heating water, chilled water or condenser water loop, pump power shall be based on a weighted average for using design water flow rate.

7. When multiple system types with and without economizers are combined, the economizer maximum outside air fraction of the combined system shall be based on weighted average of 100% supply air for systems with economizers and design outdoor air for systems without economizers.

8. Multiple systems with and without ERVs cannot be combined.

9. Systems with and without supply air temperature reset cannot be combined.

10. Systems with different fan control (constant volume, multi-speed or VAV) for supply fans cannot be combined.

TABLE C408.6.1.10.2(1) PROPOSED BUILDING SYSTEM PARAMETERS

Category	Parameter	Fixed or User Defined	Required	Applicable Systems
HVAC System Type	System Type	User Defined	Selected from Table CD105.2.10.1	All
System Sizing	Design Day Information	Fixed	99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design	All
	Zone Coil Capacity	Fixed	Sizing factors used are 1.25 for heating equipment and 1.15 for cooling equipment	All
	Supply Airflow	Fixed	Based on a supply-air-to-room-air temperature *set-point* difference of 20°F or	1-11
		Fixed	Equal to required outdoor air ventilation	12
Outdoor Ventilation Air	Portion of supply air with proposed Filter ≥MERV 13	User-defined	Percentage of supply air flow subject to higher filtration (Adjusts baseline Fan Power higher. Prorated)	All
	Outdoor Ventilation Air Flow Rate	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed DCV control	All
	Outdoor *Ventilation* Supply Air Flow Rate Adjustments	Fixed	Based on ASHRAE Standard 62.1 Section 6.2.4.3 System Ventilation Efficiency (Evs) is 0.75	9-11
		Fixed	System Ventilation Efficiency (Evs) is 1.0	1-8, 12
		Fixed	Basis is 1.0 Zone Air Distribution Effectiveness	All
System Operation	Space temperature Set points	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, except multifamily which shall use 68 deg. F heating and 76 deg. F cooling setpoints	1-11
	Fan Operation – Occupied	User Defined	Runs continuously during occupied hours or cycles to meet load. Multispeed fans reduce airflow related to thermal loads.	1-11
	Fan Operation – Occupied	Fixed	Fan runs continuously during occupied hours	12
	Fan Operation – Night Cycle	Fixed	Fan cycles on to meet setback temperatures	1-11

Packaged Equipment Efficiency	DX Cooling Efficiency	User Defined	Cooling COP without fan energy calculated in accordance with Section CD105.2.10.2	1, 2, 3, 4, 5,7, 8, 9, 11,12
	DX Coil Number of Stages	User-defined	Single Stage or Multistage	3, 4, 9
	Heat Pump Efficiency	User Defined	Heating COP without fan energy calculated in accordance with Section CD105.2.10.2	2, 4, 5, 7, 8
	Furnace Efficiency	User Defined	Furnace thermal efficiencyc	3, 11
Heat Pump Supplemental Heat	Control	Fixed	Supplemental electric heat locked out above 40°F. Runs In conjunction with compressor between 40°F and 0°F.	2, 4
Category	Parameter	Fixed or User Defined	Required	Applicable Systems
System Fan Power and Controls	Part-load Fan Controls	User-defined	Constant volume or two speed	1-8
	Part-load Fan Controls[a]	User-defined	Constant volume or variable air volume	12
	Part-load Fan Controls[a]	Fixed	Variable air volume. VFD with static pressure reset	9-11
	Design Fan Power (W/cfm)	User Defined	Input electric power for all fans in required to operate at fan system design conditions divided by the supply airflow rate This is a "wire to air" value including all drive, motor efficiency and other losses.	All
	Low-speed fan power	User Defined	Low speed input electric power for all fans required to operate at low speed conditions divided by the low speed supply airflow rate. This is a "wire to air" value including all drive, motor efficiency and other losses.	1-8
Variable Air Volume Systems	Supply Air Temperature (SAT) Controls	User defined	If not SAT reset then constant at 55°F. Options for reset based on outside air temperature (OAT) or warmest zone. If warmest zone, then the user can specify the minimum and maximum temperatures. If OAT reset, SAT is reset higher to 60°F at outdoor low of 50°F. SAT is 55°F at outdoor high of 70°F.	9, 10, 11

	Minimum Terminal Unit airflow percentage	User Defined	Average minimum terminal unit airflow percentage for block weighted by cfm or minimum required for outdoor air ventilation, whichever is higher.	9, 10, 11
	Terminal Unit Heating Source	User Defined	Electric or hydronic	9, 10, 11
	Dual set point minimum VAV damper position	User-defined	Heating maximum airflow fraction	9,10.
	Fan Powered Terminal Unit (FPTU) Type	User Defined	Series or parallel FPTU	11
	Parallel FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
	Series FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
Economizer	Economizer Presence	User Defined	Yes or No	3, 4, 9, 10,11
	Economizer Control Type	Fixed	Differential dry-bulb	3, 4, 9, 10,11
Energy Recovery	Sensible Effectiveness	User Defined	Heat exchanger sensible effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Latent Effectiveness	User Defined	Heat exchanger latent effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Economizer Bypass	User Defined	If ERV is bypassed during economizer conditions	3, 4, 9, 10, 11, 12
	Bypass SAT Setpoint	User Defined	If bypass, target supply air temperature	3, 4, 9, 10, 11, 12
	Fan Power Reduction during Bypass (W/cfm)	User Defined	If ERV system include bypass, static pressure set point and variable speed fan, fan power can be reduced during economizer conditions	3, 4, 9, 10, 11, 12
Demand Controlled Ventilation	DCV Application	User Defined	Percent of block floor area under DCV control	3, 4, 9, 10, 11, 12
DOAS	DOAS Fan Power W/cfm	User Defined	Fan electrical input power in W/cfm of supply airflow[a]	12
	DOAS	User Defined	Heating source, cooling source	12

	Supplemental Heating and Cooling			
	Maximum SAT Set point (Cooling)	User-defined	SAT set point if DOAS includes supplemental cooling	12
	Minimum SAT Set point (Heating)	User-defined	SAT set point if DOAS includes supplemental heating	12
Heating Plant	Boiler Efficiency[d]	User Defined	Boiler thermal efficiency	1, 6, 7, 9, 10, 11, 12
	Heating Water loop Configuration[a]	User-defined	Constant flow primary only; Variable flow primary only; Constant flow primary – variable flow secondary	1, 6, 7, 9, 10, 11, 12
	Heating Water Primary Pump Power (W/gpm)	User-defined	Heating water primary pump input W/gpm heating water flow	1, 6, 7, 9, 10, 11, 12
	Heating Water Secondary Pump Power (W/gpm)	User-defined	Heating water secondary pump input W/gpm heating water flow (if primary/secondary)	1, 6, 7, 9, 10, 11, 12
	Heating Water Loop Temperature	Fixed	180°F supply, 130°F return	1, 6, 9, 10,11
	Boiler Type	Fixed	Non-condensing boiler where input thermal efficiency is less than 86%; Condensing boiler otherwise	1, 6, 7, 9, 10, 11, 12
Chilled Water Plant	Chiller Compressor Type	User Defined	Screw/Scroll, Centrifugal or Reciprocating	6,1 0, 11, 12
	Chiller Condenser Type	User Defined	Air cooled or water cooled	6, 10, 11, 12
	Chiller Full Load Efficiencyd	User Defined	Chiller COP	6, 10, 11, 12
	Chilled Water loop Configuration[a]	User Defined	Variable flow primary only, constant flow primary – variable flow secondary	6, 10, 11, 12
	Chilled Water Primary Pump Power (W/gpm)	User-defined	Primary pump input W/gpm chilled water flow	6, 10, 11,12
	Chilled Water Secondary Pump Power (W/gpm)	User-defined	Secondary Pump input W/gpm chilled water flow (if primary/secondary)	6, 10, 11,12
	Chilled Water Temperature Reset Included	User Defined	Yes/No	6, 10, 11,12

	Chilled Water Temperature Reset Schedule (if included)	Fixed	Outdoor air reset: CHW supply temperature of 44°F at 80°F outdoor air dry bulb and above, CHW supply temperature of 54°F at 60°F outdoor air dry bulb temperature and below, ramped linearly between	6, 10, 11,12
	Condenser Water Pump Power (W/gpm)	User Defined	Pump input W/gpm condenser water flow	6, 7, 8, ,10, 11, 12
	Condenser Water Pump Control	User Defined	Constant speed or variable speed	6, 7, 8, 10, 11,12
	Cooling Tower Efficiency	User Defined	gpm/hp tower fan	6, 7, 10, 11,12
	Cooling Tower Fan Control	User Defined	Constant or variable speed	6, 7, 10, 11,12
	Cooling Tower Approach and Range	User Defined	Design cooling tower approach and range temperature	6, 7, 10, 11,12
Heat Pump Loop Flow Control	Loop flow and Heat Pump Control Valve	Fixed	Two position Valve with VFD on Pump. Loop flow at 3 gpm/ton	7, 8
Heat Pump Loop Temperature Control		Fixed	Set to maintain temperature between 50°F and 70°F	7
GLHP Well Field		Fixed	Bore depth = 250' Bore length 200'/ton for greater of cooling or heating load Bore spacing = 15' Bore diameter = 5" ¾" Polyethylene pipe Ground and grout conductivity = 4.8 Btu-in/h-ft2-0F	8

a. Part load fan power and pump power modified in accordance with Table C408.6.1.10.2(2)

TABLE C408.6.1.10.2(2) FAN AND PUMP Power CURVE COEFFICIENTS

Equation Term	Fan Power Coefficients	Pump Power Coefficients	
	VSD + SP reset	Ride Pump Curve	VSD + DP/valve reset
b	0.0408	0	0
x	0.088	3.2485	0.0205

x2	-0.0729	-4.7443	0.4101
x3	0.9437	2.5295	0.5753

C408.6.1.10.3 Demand Control Ventilation. Demand Controlled Ventilation (DCV) shall be modeled using a simplified approach that adjusts the design outdoor supply air flow rate based on the floor area of the building that is covered by DCV. The simplified method shall accommodate both variable DCV and on/off DCV, giving on/off DCV one third the effective floor control area of variable DCV. Outdoor air reduction coefficients shall be as stated in Table C408.6.1.10.3.

Exception: On/off DCV shall receive full effective area adjustment for R-1 and R-2 occupancies.

Table C408.6.1.10.3 DCV Outdoor Air Reduction Curve Coefficients

Equation Term	***DCV* OSA reduction (y) as a function of effective *DCV* control floor area (x)**			
	Office	**School**	**Hotel; Motel; Multi-Family; Dormitory**	**Retail**
b	0	0	0	0
x	0.4053	0.2676	0.5882	0.4623
x_2	-0.8489	0.7753	-1.0712	-0.848
x_3	1.0092	-1.5165	1.3565	1.1925
x_4	-0.4168	0.7136	-0.6379	-0.5895

C408.6.2 Simulation of the standard reference design. The standard reference design shall be configured and analyzed as specified in this section.

C408.6.2.1 Utility Rates. Same as proposed design.

C408.6.2.2 Blocks. Same as proposed design.

C408.6.2.3 Thermal zoning. Same as proposed design.

C408.6.2.4 Occupancy type, schedule, density, and heat gain. Same as proposed design.

C408.6.2.5 Envelope components. Same as proposed design.

C408.6.2.6 Lighting. Same as proposed design.

C408.6.2.7 Miscellaneous equipment. Same as proposed design.

C408.6.2.8 Elevators. Not modeled. Same as proposed design.

C408.6.2.9 Service water heating equipment. Not modeled. Same as proposed design.

C408.6.2.10 On-site renewable energy systems. Not modeled. Same as proposed design.

C408.6.2.11 HVAC equipment. The reference building design HVAC equipment consists of separate space conditioning systems as described in Table C408.6.2.11(1) through Table C408.6.2.11(3) for the appropriate building use types.

Table C408.6.2.11(1) Reference Building Design HVAC Complex Systems

Building Type Parameter	**Large Office**	**School**
System Type	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*
Fan control	VSD (No SP Reset)	VSD (No SP Reset)
Main fan power (W/CFM	1.165 (2.468)	1.165 (2.468)

(W·s/L) Proposed ≥ MERV13		
Main fan power (W/CFM (W·s/L) proposed < MERV13	1.066 (2.259)	1.066 (2.259)
Zonal fan power (W/CFM (W·s/L))	NA	NA
Minimum zone airflow fraction	1.5* Voz	1.2 * Voz
Heat/cool sizing factor	1.25/1.15	1.25/1.15
Outdoor air economizer	Yes except 4A	Yes except 4A
Occupied OSA (= proposed)	Sum(Voz)/0.75	Sum(Voz)/0.65
Energy recovery ventilator *efficiency* ERR (Enthalpy Recovery Ratio) ERV bypass SAT *set point*	NA	50% 60°F
DCV	No	No
Cooling Source	(2) Water- cooled Centrifugal Chillers	(2) Water- Cooled Screw Chillers
Cooling *COP* (net of fan)	Path B for profile	Path B for profile
Heating source (reheat)	Gas *Boiler*	Gas *Boiler*
Furnace or *boiler efficiency*	75% Et	80% Et
Condenser heat rejection	Cooling tower	Cooling tower
Cooling tower *efficiency* (gpm/fan-hp)	38.2	38.2
Tower turndown (> 300 ton (1060 *kW*))	50%	50%
Pump (constant flow/variable flow)	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range
Tower Approach	25.72 – (0.24 x WB), where WB is the 0.4% evaporation design wet-bulb temperature (°F)	
Cooling condenser *pump* power (W/gpm)	19	19
Cooling primary *pump* power (W/gpm)	9	9
Cooling secondary *pump* power (W/gpm)	13	13

Cooling coil chilled water delta- T, °F	12	12
Design chilled water supply temperature, °F	44	44
Chilled water supply temperature (CHWST) reset *set point* vs OAT, °F (°C)	CHWST/OAT :44-54/ 80-60 (6.7-12.2/26.7-15.6)	CHWST/OAT :44-54/ 80-60 (6.7-12.2/26.7-15.6)
CHW cooling loop pumping control	2-way Valves & pump VSD	2-way Valves & pump VSD
Heating pump power (W/gpm)	16.1	19
Heating oil HW dT. °F	50	50
Design Hot Water Supply Temperature (HWST). °F	180	180
HWST reset set point vs OAT, °F	HWST: 180-150/ OAT 20- 50 (82-65.6/ -6.7-10)	HWST: 180-150/ OAT 20- 50 (82-65.6/ -6.7-10)
Heat loop pumping control	2-way Valves & pump VSD	2-way Valves & pump VSD

Table C408.6.2.11(3) TSPR Reference Building Design HVAC Simple Systems

Building Type Parameter	**Hotel**	**Multifamily**
System type	*PTAC*	*PTAC*
Fan control	Constant Volume	Constant Volume
Main fan power (W/CFM (W·s/L))	0.300 (0.636)	0.300 (0.636)
Heat/cool sizing factor	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA
Outdoor air economizer	No	No
Occupied OSA source	Packaged unit, occupied damper	Packaged unit, occupied damper
Energy recovery ventilator	No	No
DCV	No	No
Cooling source	DX, 1 stage	DX, 1 stage

Cooling *COP* (net of fan)	3.20	3.20
Heating source	(2) Hydronic *Boiler*	(2) Hydronic *Boiler*
Heating *COP* (net of fan) / furnace or *boiler efficiency*	75% E_t	75% E_t
Heating *pump* power (W/gpm (W·s/L))	19 (300)	19 (300)
Heating coil heating water delta-T, °F (°C)	50 (27.8)	50 (27.8)
Design HWST, °F (°C)	180 (82.2)	180 (82.2)
HWST reset *set point* vs OAT, °F (°C)	HWST: 180-150/ OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150 / OAT 20- 50 (82-65.6/ -6.7-10)
Heat loop *pump*ing control	2-way Valves & ride *pump* curve	2-way Valves & ride *pump* curve

CHAPTER 5 [CE]
EXISTING BUILDINGS

SECTION C501
GENERAL

delete **C501.2 Existing buildings** *and replace with* **C501.1.1 Existing buildings.**

add **C501.2 Compliance.**
Additions, alterations, repairs, and changes of occupancy to, or relocation of, existing *buildings* and structures shall comply with Sections C502, C503, C504 and C505 of this code, as applicable, and with the provisions for *alterations, repairs, additions* and changes of occupancy or relocation, respectively, in the *International Building Code, International Existing Building Code, International Fire Code, International Fuel Gas Code, International Plumbing Code, International Property Maintenance Code, International Private Sewage Disposal Code*, ANSI/SMACNA 006 *HVAC Duct Construction Standards*, ASHRAE Standard 62.1, and NFPA 70. Changes where unconditioned space is changed to conditioned space shall comply with Section C502.

Exception: Additions, alterations, repairs or changes of occupancy complying with ANSI/ASHRAE/IESNA 90.1.
delete **C501.4 Compliance.**

renumber **C501.5 New and replacement materials** *as* **C501.4 New and replacement materials.**

renumber **C501.6 Historic buildings** *as* **C501.5 Historic buildings.**

SECTION C502
ADDITIONS

add **C502.2 Change in space conditioning.**
Any nonconditioned or low-energy space that is altered to become conditioned space shall be required to comply with Section C502.

Exceptions:

1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.

2. Where the total building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.

delete **C502.2 Prescriptive compliance** *and replace with* **C502.3 Compliance.**

delete **C502.2.1 Vertical fenestration** *and replace with* **C502.3.1 Vertical fenestration**
Additions shall comply with the following:

1. Where an addition has a new *vertical fenestration* area that results in a total building *fenestration* area less than or equal to that permitted by Section C402.3.1, the addition shall comply with Section C402.1.3 or C402.3.3.
2. *Where an addition* with *vertical fenestration* that results in a total building *fenestration* area greater than Section C402.3.1 or *additions* that exceed the fenestration area greater than that permitted by Section C402.3.1, the fenestration shall comply with Section C402.3.1.1 for the *addition* only.
3. Where an addition has vertical fenestration that results in a total building vertical fenestration area exceeding that permitted by Section C402.3.1.1, the addition shall comply with Section C402.1.3.

delete **C502.2.2 Skylight area** *and replace with* **C502.3.2 Skylight area**
Skylights shall comply with the following:
1. Where an addition has a new *skylight* area that results in a total building *fenestration* area less than or equal to that permitted by Section C402.3.1, the addition shall comply with shall comply with Section C402.1.3.
2. Where an addition has a new *skylight* area that results in a total building *skylight* area greater than C402.3.1 or additions have skylight area greater than that permitted by Section C402.3.1.2 for the *addition* only.
3. Where an addition has skylight area that results in a total building skylight area exceeding that permitted by Section C402.3.1.2, the addition shall comply with Section C402.1.3.

delete **C502.2.3 Building mechanical systems** *and replace with* **C502.3.3 Building mechanical systems**
New mechanical systems and equipment that are part of the *addition* and serve the building heating, cooling and ventilation needs shall comply with Section C403 and C407.

delete **C502.2.4 Service water-heating systems** *and replace with* **C502.3.4 Service water-heating systems.**

delete **C502.2.5 Pools and inground permanently installed spas** *and replace with* **C502.3.5 Pools and inground permanently installed spas**

delete **C502.3.6 Lighting power and systems** *and replace with* **C502.3.6 Lighting power and systems.**
New lighting systems that are installed as part of the addition shall comply with Section C405 and C407.

delete **C502.2.6.1 Interior lighting power** *and replace with* **C502.3.6.1 Interior lighting power.**

delete **C502.2.6.2 Exterior lighting power** *and replace with* **C502.3.6.2 Exterior lighting power.**

SECTION C503
ALTERATIONS

Delete and replace **C503.1 General.**
Alterations to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the *existing building* or structure was prior to the *alteration. Alterations* to an existing *building, building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Alterations complying with ANSI/ASHRAE/IESNA 90.1. need not comply with Sections C402, C403, C404 and C405.

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

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

Delete and replace **C503.3.1 Roof replacement.**
Roof replacements shall comply with Section C402.1.1, C402.1.2 or C402.1.3 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. In no case shall the R-value of the roof insulation be reduced or the U-

factor of the roof assembly be increased as part of the roof replacement.

add **C503.3.2.1 Application to replacement fenestration products.**
Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and SHGC in Table C402.4.

> **Exception:** An area-weighted average of the U-factor of replacement fenestration products being installed in the building for each fenestration product category listed in Table C402.4 shall be permitted to satisfy the U-factor requirements for each fenestration product category listed in Table C402.4. Individual fenestration products from different product categories listed in Table C402.4 shall not be combined in calculating the area-weighted average U-factor.

delete and replace **C503.4 Heating and cooling systems.**
New heating, cooling and duct systems that are part of the *alteration* shall comply with Sections C403 and C407.

delete and replace **C503.5 Service hot water systems.**
New service hot water systems that are part of the *alteration* shall comply with Section C404 and C407.

delete and replace **C503.6 Lighting systems.**
New lighting systems that are part of the *alteration* shall comply with Section C405 and C407.

> **Exception:** *Alterations* that replace less than 10 percent of the luminaires in a space, provided that such *alterations* do not increase the installed interior lighting power.

Delete and replace Chapter 6 in its entirety

CHAPTER 6 [CE]
REFERENCED STANDARDS

AAMA

American Architectural
Manufacturers Association
1827 Walden Office Square
Suite 550
Schaumburg, IL 60173-4268

AAMA/WDMA/CSA 101/I.S.2/A C440—17: North American Fenestration Standard/Specifications for Windows, Doors and Unit Skylights

Table C402.5.2

AHAM

Association of Home Appliance Manufacturers
1111 19th Street NW, Suite 402
Washington, DC 20036

ANSI/AHAM RAC-1—2015: Room Air Conditioners
Table C403.3.2(3)

AHAM HRF-1—2016: Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers
Table C403.10.1

AHRI

Air-Conditioning, Heating, & Refrigeration Institute
2111 Wilson Blvd, Suite 500
Arlington, VA 22201

ISO/AHRI/ASHRAE 13256-1 (2012): Water-to-Air and Brine-to-Air Heat Pumps—Testing and Rating for Performance
Table C403.3.2(2)

ISO/AHRI/ASHRAE 13256-2 (1998 RA2014): Water-to-Water and Brine-to-Water Heat Pumps —Testing and Rating for Performance
Table C403.3.2(2)

210/240—2017 and 2023: Performance Rating of Unitary Air-conditioning and Air-source Heat Pump Equipment
Table C403.3.2(1), Table C403.3.2(2)

310/380—2017 (CSA-C744-17): Standard for Packaged Terminal Air Conditioners and Heat Pumps
Table C403.3.2(3)

340/360—2019: Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment
Table C403.3.2(1), Table C403.3.2(2)

365(I-P)—2009: Commercial and Industrial Unitary Air-conditioning Condensing Units
Table C403.3.2(1), Table C403.3.2(6)

390 (I-P)—2003: Performance Rating of Single Package Vertical Air-conditioners and Heat Pumps
Table C403.3.2(3)

400 (I-P)—2015: Performance Rating of Liquid to Liquid Heat Exchangers
Table C403.3.2(10)

440—2008: Performance Rating of Room Fan Coils—with Addendum 1
C403.11.3

460—2005: Performance Rating of Remote Mechanical-draft Air-cooled Refrigerant Condensers
Table C403.3.2(8)

550/590 (I-P)—2018: Performance Rating of Water-chilling and Heat Pump Water-heating Packages

Using the Vapor Compression Cycle

C403.3.2.1, Table C403.3.2(7)

560—2018: Absorption Water Chilling and Water Heating Packages

Table C403.3.2(7)

910—2014: Performance Rating of Indoor Pool Dehumidifiers

Table C403.3.2(11)

920—2015: Performance Rating of DX-Dedicated Outdoor Air System Units

Table C403.3.2(12), Table C403.3.2(13)

1160 (I-P) —2014: Performance Rating of Heat Pump Pool Heaters (with Addendum 1)

Table C404.2

1200 (I-P)—2013: Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets

C403.10, Table C403.10.1(1), Table C403.10.1(2)

1230—2014: Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air Conditioning and Heat Pump Equipment (with Addendum 1)

Table C403.3.2(9)

1250 (I-P)—2014: Standard for Performance Rating in Walk-in Coolers and Freezers

Table C403.11.2.1(3)

1360—2017: Performance Rating of Computer and Data Processing Room Air Conditioners

Table C403.3.2(10), Table C403.3.2(16)

AMCA

Air Movement and Control Association International
30 West University Drive
Arlington Heights, IL 60004-1806

208—18: Calculation of the Fan Energy Index

C403.8.3

220—19: Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating

C402.5.6

500D—18: Laboratory Methods for Testing Dampers for Rating

C403.7.7

230—15: Laboratory Methods of Testing Air Circulating Fans for Rating and Certification

C403.9

ANSI

American National Standards Institute
25 West 43rd Street, 4th Floor
New York, NY 10036

**Z21.10.3/CSA 4.3—17: Gas Water Heaters, Volume III—Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour,
Circulating Tank and Instantaneous**
Table C404.2

Z21.47/CSA 2.3—16: Gas-fired Central Furnaces
Table C403.3.2(4)

Z83.8/CSA 2.6—16: Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-fired Duct Furnaces
Table C403.3.2(4)

APSP

The Association of Pool & Spa Professionals
2111 Eisenhower Avenue, Suite 580
Alexandria, VA 22314

14—2019: American National Standard for Portable Electric Spa Energy Efficiency
C404.10

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085

S640—2017: Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)
C405.4

ASHRAE

ASHRAE
1791 Tullie Circle NE
Atlanta, GA 30329

**ANSI/ASHRAE/ACCA Standard 183—2007 (RA2017): Peak Cooling and Heating Load Calculations in Buildings, Except Low-rise
Residential Buildings**
C403.1.1

ANSI/ASHRAE Standard 62.1—2016: Ventilation for Acceptable Indoor Air Quality
C201.3, C403.2.2, C403.6.1, C403.7.1, C403.7.4,
C403.7.7, C403.8.5.1, C406.6, C501.4

ASHRAE—2020: ASHRAE HVAC Systems and Equipment Handbook—2020
C403.1.1

ISO/AHRI/ASHRAE 13256-1 (1998 RA2014): Water-to-Air and Brine-to-Air Heat Pumps—Testing and

Rating for Performance

Table C403.3.2(2)

ISO/AHRI/ASHRAE 13256-2 (1998 RA2014): Water-to-Water and Brine-to-Water Heat Pumps—Testing and Rating for Performance

Table C403.3.2(2)

55—2017: Thermal Environmental Conditions for Human Occupancy

Table C407.5.1

90.1—2019: Energy Standard for Buildings Except Low-rise Residential Buildings

C401.2, Table C402.1.3, Table C402.1.4, C406.2,
Table C407.6.1, C502.1, C503.1, C504.1

90.4—2016: Energy Standard for Data Centers

C403.1.2, C405.2.4

140—2014: Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs

C407.6.1

146—2011: Testing and Rating Pool Heaters

Table C404.2

ASME

American Society of
Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990

ASME A17.1—2019/CSA B44—19: Safety Code for Elevators and Escalators

C405.8.2

ASTM

ASTM International
100 Barr Harbor Drive, P.O.
Box C700
West Conshohocken, PA
19428-2959

C90—2016A: Specification for Load-bearing Concrete Masonry Units

Table C401.3

C1363—11: Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

C303.1.4.1, Table C402.1.4, 402.2.7

C1371—15: Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

Table C402.3

C1549—2016: Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature

Using a Portable Solar Reflectometer

Table C402.3

D1003—13: Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics

C402.4.2.2

D8052/D8052M—2017: Standard Test Method for Quantification of Air Leakage in Low-Sloped Membrane Roof Assemblies

C402.5.1.4

E283—2004(2012): Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen

C402.5.1.2.2, Table C402.5.2, C402.5.7

E408—13: Test Methods for Total Normal Emittance of Surfaces Using Inspection-meter Techniques

Table C402.3

E779—10(2018): Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

C402.5

E903—2012: Standard Test Method Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)

Table C402.3

E1677—11: Specification for Air Barrier (AB) Material or Systems for Low-rise Framed Building Walls

C402.5.1.2.2

E1827—2011(2017): Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door

C402.5, C406.9, C606.4

E1918—06(2016): Standard Test Method for Measuring Solar Reflectance of Horizontal or Low-sloped Surfaces in the Field

Table C402.3

E1980—11: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces

Table C402.3, C402.3.2

E2178—13: Standard Test Method for Air Permanence of Building Materials

C402.5.1.2.1

E2357—2018: Standard Test Method for Determining Air Leakage of Air Barriers Assemblies

C402.5.1.2.2

E3158—2018: Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building

Section C402.5.3

F1281—2017: Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Pressure Pipe

Table C404.5.2.1

F1361—2017: Standard Test Method for Performance of Open Deep Fat Fryers

Table C406.12(1)

F1484—2018: Standard Test Method for Performance of Steam Cookers

Table C406.12(2)

F1495—2014a: Standard Specification for Combination Oven Electric or Gas Fired
Table C406.12(4)
F1496—2013: Standard Test Method for Performance of Convection Ovens
Table C406.12(4)
F1696—2018: Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines
Table C406.12(3)
F1920—2015: Standard Test Method for Performance of Rack Conveyor Commercial Dishwashing Machines
Table C406.12(3)
F2093—2018: Standard Test Method for Performance of Rack Ovens
Table C406.12(4)
F2144—2017: Standard Test Method for Performance of Large Open Vat Fryers
Table C406.12(1)
F2861—2017: Standard Test Method for Enhanced Performance of Combination Oven in Various Modes
Table C406.12(4)

CRRC

Cool Roof Rating Council
2435 North Lombard Street
Portland, OR 97217

ANSI/CRRC-S100—2020: Standard Test Methods for Determining Radiative Properties of Materials
Table C402.3, C402.3.1

CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights
Table C402.5.2

CSA B55.1—2015: Test Method for Measuring Efficiency and Pressure Loss of Drain Water Heat Recovery Units
C404.8

CSA B55.2—2015: Drain Water Heat Recovery Units
C404.8

CTI

Cooling Technology Institute
P. O. Box 681807
Houston, TX 77268

ATC 105—2019: Acceptance Test Code for Water Cooling Tower
Table C403.3.2(8)

ATC 105DS—2018 : Acceptance Test Code for Dry Fluid Coolers
Table C403.3.2(7)
ATC 105S—11: Acceptance Test Code for Closed Circuit Cooling Towers
Table C403.3.2(8)

ATC 106—11: Acceptance Test for Mechanical Draft Evaporative Vapor Condensers

Table C403.3.2(8)

STD 201—11: Standard for Certification of Water Cooling Towers Thermal Performances
Table C403.3.2(8)

CTI STD 201 RS(17): Performance Rating of Evaporative Heat Rejection Equipment
Table C403.3.2(8)

DASMA

Door & Access Systems
Manufacturers Association,
International
1300 Sumner Avenue
Cleveland, OH 44115-2851

105—2017: Test Method for Thermal Transmittance and Air Infiltration of Garage Doors and Rolling Doors
C303.1.3, Table C402.5.2

DOE

U.S. Department of Energy
c/o Superintendent of
Documents
1000 Independence Avenue
SW
Washington, DC 20585

**10 CFR, Part 430—2015: Energy Conservation Program for Consumer Products: Test Procedures and Certification and Enforcement
Requirement for Plumbing Products; and Certification and Enforcement Requirements for Residential Appliances; Final Rule**
Table C403.3.2(4), Table C403.3.2(5), Table C404.2

**10 CFR, Part 430, Subpart B, Appendix N—(2015): Uniform Test Method for Measuring the Energy Consumption of Furnaces and
Boilers**
C202

**10 CFR, Part 431—2015: Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and
Efficiency Standards; Final Rules**
Table C403.3.2(5), C405.6, Table C405.6, C405.7

10 CFR 431 Subpart B App B: Uniform Test Method for Measuring Nominal Full Load Efficiency of Electric Motors
C403.8.4, Table C405.7(1), Table C405.7(2), Table C405.7(3), C405.7(4)

NAECA 87—(88): National Appliance Energy Conservation Act 1987 [Public Law 100-12 (with Amendments of 1988-P.L. 100-357)]
Table C403.3.2(1), Table C403.3.2(2), Table C403.3.2(4)

HVI

Home Ventilating Institute
1740 Dell Range Blvd Ste
H, PMB 45
Cheyenne, WY 82009

916-18 : Airflow Test Procedure
C403.8.5

ICC

International Code Council, Inc.
500 New Jersey Avenue NW
6th Floor
Washington, DC 20001

ANSI/RESNET/ICC—19: Standard for Testing Airtightness of Building, Dwelling Unit and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems
C402.5.2, C402.5.3

IBC—21: International Building Code®
C201.3, C303.2, C402.5.3, C501.4

ICC 500—2020: Standard for the Design and Construction of Storm Shelters
C402.4.2

IFC—21: International Fire Code®
C201.3, C501.4

IFGC—21: International Fuel Gas Code®
C201.3, C501.4

IPC—21: International Plumbing Code®
C201.3, C501.4

IPMC—21: International Property Maintenance Code®
C501.4

IPSDC—21: International Private Sewage Disposal Code®
C501.4

IEEE

Institute of Electrical and Electronic Engineers
3 Park Avenue, 17th Floor
New York, NY 10016

IEEE 515.1—2012: IEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications
C404.6.2

IES

Illuminating Engineering Society
120 Wall Street, 17th Floor
New York, NY 10005-4001

ANSI/ASHRAE/IESNA 90.1—2019: Energy Standard for Buildings, Except Low-rise Residential Buildings
C401.2, Table C402.1.3, Table C402.1.4, C406.2, C502.1, C503.1, C504.1

ISO

International Organization for Standardization
Chemin de Blandonnet 8, CP 401, 1214 Vernier
Geneva, Switzerland

ISO/AHRI/ASHRAE 13256-1(2017): Water-to-Air and Brine-to-Air Heat Pumps -Testing and Rating for Performance
Table C403.3.2(2)

ISO/AHRI/ASHRAE 13256-2(2017): Water-to-Water and Brine-to-Water Heat Pumps -Testing and Rating for Performance
C403.3.2(2)

NEMA

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, VA 22209

MG1—2016: Motors and Generators
C202

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

70—20: National Electrical Code
C501.4

NFRC

National Fenestration Rating Council, Inc.
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770

100—2020: Procedure for Determining Fenestration Products *U-factors*
C303.1.3, C402.2.1.1

200—2020: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence

C303.1.3, C402.4.1.1

203—2017: Procedure for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence

C303.1.3

400—2020: Procedure for Determining Fenestration Product Air Leakage

Table C402.5.2

SMACNA

Sheet Metal and Air Conditioning Contractors' National Association, Inc.
4021 Lafayette Center Drive
Chantilly, VA 20151-1219

SMACNA—2012: HVAC Air Duct Leakage Test Manual Second Edition

C403.2.11.2.3

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

710—12: Exhaust Hoods for Commercial Cooking Equipment—with Revisions through November 2013

C403.7.5

727—18: Oil-fired Central Furnaces

Table C403.3.2(4)

731—18: Oil-fired Unit Heaters

Table C403.3.2(4)

1784—15: Air Leakage Tests of Door Assemblies—with Revisions through February 2015

C402.5.3

2202—2009: ***Electric Vehicle (EV) Charging System- with revisions through February 2018***

C405.13

2594—2016: Standard for Electric Vehicle Supply Equipment

C405.13

US-FTC

United States-Federal Trade Commission
600 Pennsylvania Avenue NW
Washington, DC 20580

CFR Title 16 (2015): *R*-value Rule

C303.1.4

WDMA

Window and Door
Manufacturers Association
2025 M Street NW, Suite 800
Washington, DC 20036-3309

AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights
Table C402.5.2

delete **APPENDIX CA**

add **APPENDIX CC**

APPENDIX CC ZERO ENERGY COMMERCIAL BUILDING PROVISIONS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.
User note:
About this chapter: Appendix CC provides a model for applying new renewable energy generation when new buildings add electric load to the grid. This renewable energy will avoid the additional emissions that would otherwise occur from conventional power generation.

SECTION CC101 GENERAL

CC101.1 Purpose.
The purpose of this appendix is to supplement the International Energy Conservation Code and require renewable energy systems of adequate capacity to achieve net zero carbon.

CC101.2 Scope.
This appendix applies to new buildings that are addressed by the International Energy Conservation Code.

Exceptions:
1. Detached one- and two-family dwellings and townhouses as well as Group R2 buildings three stories or less in height above grade plane, manufactured homes (mobile dwellings), and manufactured houses (modular dwellings).
2. Buildings that use neither electricity nor fossil fuel.

SECTION CC102 DEFINITIONS

CC102.1 Definitions.
The definitions contained in this section supplement or modify the definitions in the International Energy Conservation Code.

ADJUSTED OFF-SITE RENEWABLE ENERGY. The amount of energy production from offsite renewable energy systems that may be used to offset building energy.

BUILDING ENERGY. All energy consumed at the building site as measured at the site boundary. Contributions from on-site or off-site renewable energy systems shall not be considered when determining the building energy.

ENERGY UTILIZATION INTENSITY (EUI). The site energy for either the baseline building or the proposed building divided by the gross conditioned floor area plus any semiheated floor area of the building. For the baseline building, the EUI can be divided between regulated energy use and unregulated energy use.

OFF-SITE RENEWABLE ENERGY SYSTEM. Renewable energy system not located on the building project.

ON-SITE RENEWABLE ENERGY SYSTEM. Renewable energy systems on the building project.

RENEWABLE ENERGY SYSTEM. Photovoltaic, solar thermal, geothermal energy and wind systems used to generate energy.

SEMIHEATED SPACE. An enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h × ft2 of floor area but is not a conditioned space.

ZERO ENERGY PERFORMANCE INDEX (ZEPIPB,EE). The ratio of the proposed building EUI without renewables to the baseline building EUI, expressed as a percentage.

SECTION CC103
MINIMUM RENEWABLE ENERGY

CC103.1 Renewable energy. On-site renewable energy systems shall be installed, or off-site renewable energy shall be procured to offset the building energy as calculated in Equation CC-1.

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

where:
RE_{onsite} = Annual site energy production from on-site renewable energy systems (see Section CC103.2).
$RE_{offsite}$ = Adjusted annual site energy production from off-site renewable energy systems that may be credited against building energy use (see Section CC103.3).
$E_{building}$ = Building energy use without consideration of renewable energy systems.

When Section C401.2.1(1) is used for compliance with the International Energy Conservation Code, building energy shall be determined by multiplying the gross conditioned floor area plus the gross semiheated floor area of the proposed building by an EUI selected from Table CC103.1. Use a weighted average for mixed-use buildings.

When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the International Energy Conservation Code, building energy shall be determined from energy simulations.

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

Building Area Type	**kBtu/ft² – yr**
Healthcare/hospital (I-2)	126
Hotel/motel (R-1)	77
Multiple-family (R-2)	53
Office (B)	33
Restaurant (A-2)	589
Retail (M)	60
School (E)	44
Warehouse (S)	32
All others	63

CC103.2 Calculation of on-site renewable energy.
The annual energy production from onsite renewable energy systems shall be determined using the PVWatts software or other software approved by the code official.

CC103.3 Off-site renewable energy.
Off-site energy shall comply with Sections CC103.3.1 and CC103.3.2.

CC103.3.1 Qualifying off-site procurement methods.
The following are considered qualifying off-site renewable energy procurement methods:

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

CC103.3.2 Requirements for all procurement methods.
The following requirements shall apply to all off-site renewable energy procurement methods:

1. The building owner shall sign a legally binding contract to procure qualifying offsite renewable energy.

2. The procurement contract shall have duration of not less than 15 years and shall be structured to survive a partial or full transfer of ownership of the property.
3. RECs and other environmental attributes associated with the procured off-site renewable energy shall be assigned to the building project for the duration of the contract.
4. The renewable energy generating source shall include one or more of the following: photovoltaic systems, solar thermal power plants, geothermal power plants and wind turbines.
5. The generation source shall be located where the energy can be delivered to the building site by the same utility or distribution entity, the same independent system operator (ISO) or regional transmission organization (RTO), or within integrated ISOs (electric coordination council).
6. The off-site renewable energy producer shall maintain transparent accounting that clearly assigns production to the building. Records on power sent to or purchased by the building shall be retained by the building owner and made available for inspection by the code official upon request.

CC103.3.3 Adjusted off-site renewable energy.
The process for calculating the adjusted off-site renewable energy is shown in Equation 2.

$$RE_{offsite} = \sum_{i=1}^{n} PF_i \times RE_i = PF_1 \times RE_1 + PF_2 \times RE_2 + ... + PF_n \times RE_n$$

(Equation CC-2)

where:
$RE_{offsite}$ = Adjusted off-site renewable energy.
PF_i = Procurement factor for the i^{th} renewable energy procurement method or class taken from Table CC103.3.3.
RE_i = Annual energy production for the i^{th} renewable energy procurement method or class.
n = The number of renewable energy procurement options or classes considered.

TABLE CC103.3.3
DEFAULT OFF-SITE RENEWABLE ENERGY PROCUREMENT METHODS, CLASSES AND COEFFICIENTS

CLASS	PROCUREMENT FACTOR (PF)	PROCUREMENT OPTIONS	ADDITIONAL REQUIREMENTS (see also Section CC103.3.2)
1	0.75	Community Solar	-
		REIFs	Entity must be managed to prevent fraud or misuse of funds.
		Virtual PPA	-
		Self-owned off-site	Provisions shall prevent the generation from being sold separately from the building.
2	0.55	Green retail tariffs	The offering shall not include the purchase of unbundled RECs.
		Direct access	The offering shall not include the purchase of unbundled RECs.
3	0.20	Unbundled RECs	The vintage of the RECs shall align with building energy use.

~~2020~~2023 Vermont Commercial Building Energy Standard AMENDMENTS

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Montpelier, VT 05620

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https://publicservice.vermont.gov/

These rules are adopted under 30 V.S.A. § 53. This document shall be known and cited as the *2023 Vermont Commercial Building Energy Standard Amendments*. The *2020 Vermont Commercial Building Energy* ~~*Standard Amendments. The 2018 International Energy Conservation Code (IECC)*~~*Standards* (First Printing: ~~August 2017) and *ANSI/ASHRAE/IES Standard 90.1-2016 Energy Standard for Buildings Except Low-Rise Residential Buildings*~~July 2020) published by International Code Council (ICC), Inc., as amended herein, are incorporated by reference and are available on the ICC website at: www.iccsafe.org ~~. The IECC is amended herein as follows.~~

PREFACE

delete and replace Preface as follows:

Introduction

The 2023 *Vermont Commercial Building Energy Standards* (CBES) is based on the 2020 *Vermont Commercial Building Energy Standards* (CBES~~) is~~), which are based ~~on~~upon the *International Energy Conservation Code*® (IECC~~)~~®) 2018 edition ~~and~~. The 2023 CBES also includes elements of the 2021 IECC energy efficiency requirements as well as select language updates and additional, more stringent Vermont energy efficiency requirements. The 2023 CBES also incorporates elements of ANSI/ASHRAE/IES Standard 90.1-~~*2016*~~ 2019 *Energy Standard for Buildings Except Low-Rise Residential Buildings.*

This comprehensive energy conservation code establishes minimum regulations for energy efficient buildings using prescriptive and performance-related provisions. It is founded on broad-based principles that make possible the use of new materials and new energy efficient designs.

The *International Energy Conservation Code* provisions provide many benefits, among which is the model code development process that offers an international forum for energy professionals to discuss performance and prescriptive code requirements. This model code also encourages international consistency in the application of provisions.

Development

This ~~2020~~2023 CBES is founded on principles intended to establish provisions consistent with the scope of an energy conservation code that adequately conserves energy; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

Background

The Vermont Commercial Building Energy Standards (CBES) was adopted by statute (30 V.S.A. § 53) in 2006. This code applies to all commercial buildings and residential ~~building 4~~buildings four stories or greater above grade in Vermont and took effect January 1, 2007.

Update Process

The Commercial Building Energy Standards statute requires that revisions to the CBES are made promptly after the issuance of updated standards under the International Energy Conservation Code (IECC). The Department of Public Service (PSD) is required to convene stakeholders that include mortgage lenders, builders, building designers, utility representatives, and other persons with experience and expertise prior to the adoption of a revised CBES to provide recommendations~~.~~

The ~~2020~~2023 CBES is based on the language in the *International Energy Conservation Code®* (IECC) 2018 ~~edition~~and 2021 editions and incorporates elements of ANSI/ASHRAE/IES Standard 90.1-~~*2016*~~2019 *Energy Standard for Buildings Except Low-Rise Residential Buildings*. The ~~2020~~2023 CBES includes a new “Additional Efficiency~~ Package options~~, Renewable, and Load Management Requirements” section based ~~upon~~on a points approach to code compliance~~ based upon building usage.~~. The addition of “points” provides builders and designers greater flexibility in complying with the CBES. The Vermont PSD held a series of code collaborative meetings in 2021 and a series of stakeholder and advisory committee meetings in ~~2018 and 2019~~2022 to gather feedback on proposed changes to the CBES. The revisions presented in this document were modified based on input received from these meetings.

EFFECTIVE USE OF THE ~~2020~~2023 VERMONT COMMERCIAL BUILDING ENERGY STANDARDS

The ~~2020~~2023 *Vermont Commercial Building Energy Standards* (CBES) is a code that regulates minimum energy conservation requirements for new buildings as well as additions, alterations, renovations, and repairs to existing buildings. The ~~2020~~2023 CBES addresses energy conservation requirements for all aspects of energy uses in commercial construction, including heating and ventilating, lighting, water heating, and power usage for appliances and building systems.

The ~~2020~~2023 CBES is a design document. For example, before constructing a building, the designer must determine the minimum insulation *R*-values and fenestration *U*-factors for the building exterior envelope. The CBES sets forth minimum requirements for exterior envelope insulation, window and door *U*-factors and SHGC ratings, duct insulation, lighting and power efficiency, mechanical ventilation, and water distribution insulation.

Arrangement and Format of the ~~2020~~2023 CBES

The ~~2020~~2023 CBES, like other codes published by ICC, is arranged and organized to follow sequential steps that generally occur during a plan review or inspection. The ~~2020~~2023 CBES is divided into six different parts:

Chapters	Subjects
1~~-~~–2	Scope, Administration and Definitions
3	General Requirements
4	Commercial Energy Efficiency
5	Existing Buildings

6	Referenced standards

Italicized Terms

Selected terms set forth in Chapter 2: Definitions, are italicized where they appear in code text. Such terms are not italicized where the definition set forth in Chapter 2 does not impart the intended meaning in the use of the term. The terms selected have definitions that the user should read carefully to facilitate better understanding of the code.

The following is a chapter-by-chapter synopsis of the scope and intent of the provisions of the ~~2020~~2023 *Vermont Commercial Building Energy Standards*:

Chapter 1~~:~~ Scope and Administration. This chapter contains provisions for the application, enforcement and administration of subsequent requirements of the code. In addition to establishing the scope of the code, Chapter 1 identifies which buildings and structures come under its purview. Chapter 1 is largely concerned with maintaining "due process of law" in enforcing the energy conservation criteria contained in the body of this code. Only through careful observation of the administrative provisions can the code official or other authority having jurisdiction, where one exists, reasonably expect to demonstrate that "equal protection under the law" has been provided.

Chapter 2 Definitions. Chapter 2 is the repository of the definitions of terms used in the body of the code. Codes are technical documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results. The code often uses terms that have a unique meaning in the code and the code meaning can differ substantially from the ordinarily understood meaning of the term as used outside of the code.

The terms defined in Chapter 2 are deemed to be of prime importance in establishing the meaning and intent of the code text. The user of the code should be familiar with and consult this chapter because the definitions are essential to the correct interpretation of the code and the user may not be aware that a term is defined.

Where understanding of a term's definition is especially key to or necessary for understanding of a particular code provision, the term is shown in *italics* wherever it appears in the code. This is true only for those terms that have a meaning that is unique to the code. In other words, the generally understood meaning of a term or phrase might not be sufficient or consistent with the meaning prescribed by the code; therefore, it is essential that the code-defined meaning be known.

Guidance regarding tense, gender and plurality of defined terms as well as guidance regarding terms not defined in this code is provided.

Chapter 3 General Requirements. Chapter 3 provides interior design conditions that are used as a basis for assumptions in heating and cooling load calculations and provides basic material requirements for insulation materials and fenestration materials and provides standards for commercial mechanical ventilation and combustion safety.

Chapter 4 Commercial Energy Efficiency. Chapter 4 contains the energy-efficiency-related requirements for the design and construction of most types of commercial buildings, and residential buildings greater than three stories in height above grade. This chapter defines requirements for the portions of the building and building systems that impact energy use in new commercial construction and new residential construction greater than three stories in height and promotes the effective use of energy. The provisions within the chapter promote energy efficiency in the building envelope, the heating and cooling system, and the service water heating system of the building.

Chapter 5 Existing Buildings. Chapter 5 of each set of provisions contains the technical energy efficiency requirements for existing buildings. Chapter 5 provisions address the maintenance of buildings in compliance with the code as well as how additions, alterations, repairs and changes of occupancy need to be addressed from the standpoint of energy efficiency. Specific provisions are provided for historic buildings.

Chapter 6 Referenced Standards. The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 6 contains a comprehensive list of all standards that are referenced in the code. The standards are part of the code to the extent of the reference to the standard. Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the code official, or other authority having jurisdiction, where one exists, contractor, designer and owner.

Chapter 6 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency's standards are then listed in either alphabetical or numeric order based ~~upon~~on the standard identification. The list also contains the title of the standard; the edition (date) of the standard referenced; any addenda included as part of the ICC adoption; and the section or sections of this code that reference the standard.

Marginal Markings

Solid vertical lines in the margins within the body of the code indicate ~~a technical change~~ Vermont specific additions and changes from the requirements of the IECC ~~2015 and 2018~~2021 edition. ~~Vermont specific additions and changes are designated through dotted lines in the margin.~~ Deletion indicators in the form of an arrow (➡~~)~~➡) are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a table has been deleted.

Abbreviations and Notations

The following is a list of common abbreviations and units of measurement used in this code. Some of the abbreviations are for terms defined in Chapter 2. Others are terms used in various tables and text of the code.

AFUE	Annual fuel utilization efficiency
bhp	Brake horsepower (fans)
Btu	British thermal unit
Btu/h-ft^2	Btu per hour per square foot
C-factor	See Chapter 2—Definitions
CDD	Cooling degree days
cfm	Cubic feet per minute

cfm/ft^2	Cubic feet per minute per square foot
ci	Continuous insulation
COP	Coefficient of performance
DCV	Demand control ventilation
°C	Degrees Celsius
°F	Degrees Fahrenheit
DWHR	Drain water heat recovery
DX	Direct expansion
E_c	Combustion efficiency
E_v	Ventilation efficiency
E_t	Thermal efficiency
EER	Energy efficiency ratio
EF	Energy factor
ERI	Energy rating index
F-factor	See Chapter 2—Definitions
FDD	Fault detection and diagnostics
FEG	Fan efficiency grade
FL	Full load
ft^2	Square foot
gpm	Gallons per minute
HDD	Heating degree days
HERS	Home Energy Rating System
~~hp~~	~~Horsepower~~
hp	Horsepower
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilating and air conditioning
IEER	Integrated energy efficiency ratio
IPLV	Integrated Part Load Value
Kg/m^2	Kilograms per square meter
kW	Kilowatt
LPD	Light power density (lighting power allowance)
L/s	Liters per second
Ls	Liner system
m^2	Square meters
MERV	Minimum efficiency reporting value
NAECA	National Appliance Energy Conservation Act
NPLV	Nonstandard Part Load Value
Pa	Pascal
PF	Projection factor
pcf	Pounds per cubic foot
PSD	Department of Public Service (Vermont)
psf	Pounds per square foot
PTAC	Packaged terminal air conditioner
PTHP	Packaged terminal heat pump
R-value	See Chapter 2—Definitions
SCOP	Sensible coefficient of performance
SEER	Seasonal energy efficiency ratio

SHGC	Solar Heat Gain Coefficient
SPVAC	Single packaged vertical air conditioner
SPVHP	Single packaged vertical heat pump
SRI	Solar reflectance index
SWHF	Service water heat recovery factor
U-factor	See Chapter 2—Definitions
VAV	Variable air volume
VRF	Variable refrigerant flow
VT	Visible transmittance
W	Watts
w.c.	Water column
w.g.	Water gauge

~~Add, amend, delete and replace as follows:~~

CHAPTER 1

~~SCOPE AND~~ ADMINISTRATION

~~- *delete and replace* -~~PART 1—SCOPE AND APPLICATION

SECTION C101
SCOPE AND GENERAL REQUIREMENTS

delete and replace **C101.1 Title~~:~~**

.

This code shall be known as the ~~2019~~20202023 Commercial Building Energy Standards (CBES) of Vermont and shall be cited as such. It is referred to herein as "this code."

~~-~~*delete and replace* ~~-~~**C101.2 Scope~~:~~**

.

This code applies to *commercial buildings* and the buildings' sites and provides the minimum energy-efficient, renewable energy, and energy storage requirements for the design and construction, and a plan for operation and maintenance of the following:

1. ~~1.~~ New buildings and their systems~~,~~.
2. ~~2.~~ New portions of buildings and their systems~~,~~.
3. ~~3.~~ New systems and equipment in existing buildings~~, and~~.
4. ~~4.~~ New stand-alone equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes.

~~**Exception:**~~**Exceptions:**

1. **Farm Structures.** This code shall not apply to farm structures as defined in 24 Vermont Statutes Annotated (V.S.A~~.~~.) § 4413.

~~- *delete and replace* - **C101.3 Intent:**~~

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

~~This code has been designed to minimize any conflict or difference between other adopted codes and standards. Where there is conflict between the codes or codes and standards, the Life~~

~~Safety Code (NFPA 101), Fire Code (NFPA 1), and the IBC shall apply. Where one code or standard has a requirement and another code or standard does not have a requirement, the code or standard with a requirement shall apply.~~

~~- *delete and replace* - **C101.4.1 Mixed occupancy.**~~
~~Where a building includes both *residential* and *commercial* occupancies, the following shall apply:~~

1. ~~With respect to a structure that is three stories or less in height,~~

    i. ~~The term "residential building" shall include the living spaces in the structure and the nonliving spaces in the structure that serve only the residential users such as common hallways, laundry facilities, residential management offices, community rooms, storage rooms, and foyers.~~

    ii. ~~The term "commercial building" shall include all commercial uses within the structure and all common areas and facilities that serve both residential and commercial uses.~~

2. ~~With respect to a structure that is four stories or more in height, the term "commercial building" shall include all uses and areas within the structure.~~

~~- *add* - **C101.4.2 Application to existing buildings.**~~
~~Existing buildings shall follow the provisions of Chapter 5 of this code.~~

2. ~~- *delete and replace* -~~ **Process applications.** This code shall not apply to manufacturing or industrial processes equipment that are not identified in this standard or are integral to equipment that is not identified in the standard.

delete and replace **C101.5 Compliance.**
Residential buildings shall meet the provisions of the ~~2020~~2023 *Vermont Residential Building Energy Standards* (RBES), and *Commercial buildings* shall meet the provisions of the ~~2020~~2023 *Vermont* *Commercial Building Energy Standards* (CBES).

~~- *delete and replace* - **C101.5.1 Compliance materials.**~~
~~The *code official or other authority having jurisdiction* shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code.~~

~~At the time of application for a construction permit, where required, the designer shall include a statement on the submitted stamped drawings that the design complies with the requirements of the CBES.~~

~~- *add* - **C101.5.2 Exempt buildings.**~~
~~The following buildings, or portions thereof separated from the remainder of the building by *building thermal envelope* assemblies complying with Section C402 shall be exempt from the *building thermal envelope* provisions of Section C402.~~

1. ~~**Low energy buildings.** Those with a peak design rate of energy usage less than 3.4 Btu/h · ft^2 (10.7 W/m^2) or 1.0 watt per square foot (10.7 W/m^2) of floor area for space conditioning purposes.~~

2. ~~**Unconditioned buildings.** Those that do not contain *conditioned space*.~~

3. ~~***Greenhouses*.**~~

4. ~~**Inflatable buildings.** Temporary air-supported structures shall be exempt only from the thermal envelope provisions of this code.~~

5. ~~**Yurt buildings.** A yurt or tent that is not mechanically cooled and is only heated through biomass or other on-site renewable energy.~~

6. ~~**Equipment buildings.** Buildings that comply with all the following shall be exempt from the *building thermal envelope* provisions of this code:~~

   A. ~~Buildings that are separate buildings with floor area not more than 500 square feet (50 m^2).~~

   B. ~~Buildings that are intended to house electronic equipment with installed equipment power totaling not less than 7 watts per square foot (75 W/m^2) and not intended for human occupancy.~~

   C. ~~Buildings that have a heating system capacity not greater than 17,000 Btu/hr (5 kW) and a heating thermostat set point that is restricted to not more than 50°F (10°C).~~

   D. ~~Buildings that have an average wall and roof *U*-factor less than 0.120.~~

~~*- delete and replace -*~~SECTION C102 ALTERNATIVE MATERIALS, DESIGN AND METHODS OF CONSTRUCTION AND EQUIPMENT

delete and replace **C102.1 General.**
The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. The Public Service Department shall have the authority to approve an alternative material, design or method of construction ~~shall be *approved* where~~upon the written application of the owner or the owner's authorized agent. The code *official* ~~or other authority having jurisdiction finds~~shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability and safety. ~~Where the alternative material, design or method of construction is not *approved*,~~ The *code official or* ~~other~~ *authority having jurisdiction* shall respond to the applicant, in writing, stating the reasons why the alternative was approved or was not *approved*.

~~- delete and replace -~~

delete and replace **C102.1.1 Above code programs.**

The *code official or authority having jurisdiction* shall be permitted to deem a national, state or local energy efficiency program an exceeding the energy efficiency required by this code. Buildings *approved* in writing by such an energy efficiency program shall be considered to be in compliance with this code. The requirements identified as "mandatory" in Chapter 4 shall be met.

PART 2—ADMINISTRATION AND ENFORCEMENT

SECTION C103 CONSTRUCTION DOCUMENTS

delete and replace **C103.1 General.**

Where required construction documents and other supporting data shall be submitted in one or more sets, or in a digital format where allowed by the reviewing official, with each application for a permit. The construction documents shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed. Where special conditions exist, the *code official or ~~other~~ authority having jurisdiction* is authorized to require necessary construction documents to be prepared by a registered design professional.

> **Exception:** The *code official or ~~other~~ authority having jurisdiction* is authorized to waive the requirements for construction documents or other supporting data if the *code official or ~~other~~ authority having jurisdiction* determines they are not necessary to confirm compliance with this code.

~~-~~*delete and replace*~~ -~~ **C103.2 Information on construction documents.**

Where required construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where approved by the *code official or ~~other~~ authority having jurisdiction*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. ~~1.~~ Energy compliance path.
2. ~~1.~~ Insulation materials and their *R*-values.
3. ~~2.~~ ~~2.~~ Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. ~~3.~~ ~~3.~~ Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. ~~4.~~ ~~4.~~ Design ambient temperatures.
6. ~~5.~~ ~~5.~~ Interior temperatures for heating and cooling modes.
7. ~~6.~~ ~~6.~~ Relative humidity setpoints.

~~7.~~8. ~~7.~~ Ventilation rates.

~~8.~~9. ~~8.~~ Mechanical system design criteria.

~~9.~~10. ~~9.~~ Mechanical and service water heating systems and equipment types, sizes and efficiencies.

~~10.~~11. ~~10.~~ Economizer description.

~~11.~~12. ~~11.~~ Equipment and system controls.

~~12.~~13. ~~12.~~ Fan motor horsepower (hp) and controls.

~~13.~~14. ~~13.~~ Duct sealing, duct and pipe insulation and location.

~~14.~~15. ~~14.~~ Lighting fixture schedule with wattage and control narrative.

~~15.~~16. ~~15.~~ Location of *daylight* zones on floor plans.

~~16.~~17. ~~16.~~ Air barrier and air sealing details, including the location of the air barrier, a diagram showing the building's pressure boundary in plan(s) and section(s), and a calculation of the area of the pressure boundary as specified in Section C402.4.1.3.

Mechanical equipment schedules shall be included in the submitted construction documents and shall include, but are not limited to, the following information:

1. ~~1.~~ Equipment efficiencies.
2. ~~2.~~ Fan and pump nameplate motor and brake horsepower.
3. ~~3.~~ Fan efficiency grade (FEG), where applicable.
4. ~~4.~~ Hydronic system (if applicable) supply and return water design temperatures for boilers and all terminal devices (e.g., baseboards, unit ventilators, etc.).
5. ~~5.~~ Steam system (if applicable) design pressure for boilers and all terminal devices.

~~- *delete and replace* - **C103.3 Examination of documents.**~~
~~The *code official or other authority having jurisdiction* shall examine or cause to be examined the accompanying construction documents and shall ascertain whether the construction indicated and described is in accordance with the requirements of this code and other pertinent laws or ordinances. The *code official or other authority having jurisdiction* is authorized to utilize a registered design professional, or other *approved* entity not affiliated with the building design or construction, in conducting the review of the plans and specifications for compliance with the code.~~

~~- *delete and replace* - **C103.3.1 Approval of construction documents.**~~
~~When the *code official or other authority having jurisdiction* issues a permit where construction documents are required, the construction documents shall be endorsed in writing and stamped "Reviewed for Code Compliance." Such *approved* construction documents shall not be changed, modified or altered without authorization from the *code official or other authority*~~

~~*having jurisdiction*. Work shall be done in accordance with the *approved* construction documents.~~

~~One set of construction documents so reviewed shall be retained by the *code official*. The other set shall be returned to the applicant, kept at the site of work and shall be open to inspection by the *code official or other authority having jurisdiction* or a duly authorized representative.~~

~~- *delete* - **C103.3.2 Previous approvals.**~~
~~This code shall not require changes in the construction documents, construction or designated occupancy of a structure for which a lawful permit has been heretofore issued or otherwise lawfully authorized, and the construction of which has been pursued in good faith within 180 days after the effective date of this code and has not been abandoned.~~

~~- delete and replace -~~ ~~**C103.3.3 Phased approval.**~~
~~The *code official or other authority having jurisdiction* shall have the authority to issue a permit for the construction of part of an energy conservation system before the construction documents for the entire system have been submitted or *approved*, provided that adequate information and detailed statements have been filed complying with all pertinent requirements of this code. The holders of such permit shall proceed at their own risk without assurance that the permit for the entire energy conservation system will be granted.~~

~~- *delete and replace* -~~ *Add* **C103.2.2 Electrification system.** The construction documents shall provide details for additional electric infrastructure, including branch circuits, conduit, or pre-wiring, panel capacity, and electrical service capacity in compliance with the provisions of this code.

delete and replace **C103.5 Retention of construction documents.**
One set of *approved* construction documents shall be retained by the *code official* *where one exists* *or* ~~*other*~~ *authority having jurisdiction* *where one exists* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.

~~- *delete and replace* - **C103.6 Building documentation.**~~
~~The construction documents shall specify that the documents described in this section be provided to the building owner or owner's authorized agent within 90 days of the date of receipt of the certificate of occupancy.~~

~~- *delete and replace* -~~ *delete and replace* **C103.6.2 Compliance documentation.**
Energy code compliance documentation and supporting calculations shall be delivered in one document to the building owner as part of the project record documents or manuals, or as a standalone document. This document shall include the specific energy code edition utilized for compliance determination for each system, documentation demonstrating compliance with Section C303.1.3 for each fenestration product installed, and the interior lighting power compliance path, building area or space-by-space, used to calculate the lighting power allowance.

For projects complying with Item 1 of Section C401.2, the documentation shall include:

1. ~~1.~~ The envelope insulation compliance path.

2. ~~2.~~ All compliance calculations including those required by Sections C402.1.3, C403.8.1, C405.3 and C405.~~4~~5.

~~- *delete* – **SECTION C104 FEES** (C104.1 through C104.5) in its entirety~~

~~- *delete and replace* - **C105.1 General.**~~
~~Where required, construction or work for which a permit is required shall be subject to inspection by the *code official or other authority having jurisdiction*, his or her designated agent or an approved agency, and such construction or work shall remain visible and able to be accessed for inspection purposes until *approved*. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel the provisions of this code or of other ordinances of the jurisdiction shall not be valid. It shall be the duty of the permit applicant to cause the work to remain visible and able to be accessed for inspection purposes. Neither the *code official or other authority having jurisdiction,* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material, product, system or building component required to allow inspection to validate compliance with this code.~~

~~- *delete* - **C105.2 Required Inspections** and its subsections (**C105.2.1** through **C105.2.6**) and replace with the following-~~

~~**C10.2 Required approvals.**~~
~~Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *code official or other authority having jurisdiction*. The *code official or other authority having jurisdiction*, upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or notify the permit holder or his or her agent wherein the same fails to comply with this code. Any portions that do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the *code official or other authority having jurisdiction*.~~

~~**C105.2.1 Final inspection.**~~
~~Where applicable, the building shall have a final inspection and shall not be occupied until *approved*. The final inspection shall include verification of the installation and proper operation of all required building controls, and documentation verifying activities associated with required *building commissioning* have been conducted and findings of noncompliance corrected.~~

~~- *delete and replace* - **C105.3 Reinspection.**~~
~~A building shall be reinspected where determined necessary by the *code official or other authority having jurisdiction*.~~

~~- *delete and replace* - **C105.4 Approved inspection agencies.**~~
~~The *code official or other authority having jurisdiction* is authorized to accept reports of third-party inspection agencies not affiliated with the building design or construction, provided that such agencies are *approved* as to qualifications and reliability relevant to the building components and systems that they are inspecting.~~

~~- *delete and replace* - **C105.5 Inspection requests.**~~
~~It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official or other authority having jurisdiction* when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.~~

~~- *delete and replace* - **C105.6 Reinspection and testing.**~~
~~Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made to achieve compliance with this code. The work or installation shall then be resubmitted to the *code official or other authority having jurisdiction* for inspection and testing.~~

~~- *delete and replace* - **C105.7 Approval.**~~
~~After the prescribed tests and inspections indicate that the work complies in all respects with this code, a notice of approval shall be issued by the *code official or other authority having jurisdiction*.~~

~~- *delete and replace* - **C105.7.1 Revocation.**~~
~~The *code official or other authority having jurisdiction* is authorized to suspend or revoke, in writing, a notice of approval issued under the provisions of this code wherever the certificate is issued in error, or on the basis of incorrect information supplied, or where it is determined that the *building* or structure, premise, or portion thereof is in violation of any ordinance or regulation or any of the provisions of this code.~~

~~- *delete* – **SECTION C108 STOP WORK ORDER** (C108.1 through C108.4) in its entirety~~

~~- *delete* – **SECTION C109 BOARD OF APPEALS** (C109.1 through C109.3) in its entirety~~

CHAPTER 2
DEFINITIONS

~~SECTION C201~~
~~GENERAL~~

~~- *delete and replace* - **C201.3 Terms defined in other codes and standards.**~~
~~Terms that are not defined in this code but are defined in the *International Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, International Plumbing Code, or* ASHRAE Standard 62.1 or by *ANSI/SMACNA* shall have the meanings ascribed to them in those codes and standards.~~

SECTION C202
GENERAL DEFINITIONS

~~- *delete and replace* - **AIR CURTAIN.** A device, installed at the building entrance, that generates and discharges a laminar air stream intended to prevent or reduce the infiltration of external, unconditioned air into the conditioned spaces, or the loss of interior, conditioned air to the outside.~~

~~- *delete and replace* - **APPROVED.** Approval by the *code official or other authority having jurisdiction* as a result of investigation and tests conducted by him or her, or by reason of accepted principles or tests by nationally recognized organizations.~~

~~- *delete and replace* - **APPROVED AGENCY.** An established and recognized agency that is regularly engaged in conducting tests or furnishing inspection services, or furnishing product certification research reports, where such agency has been approved by the *code official or other authority having jurisdiction*.~~

~~- *add* - **BIODIESEL.** Mono alkyl esters derived from plant or animal matter that meet the registration requirements for fuels and fuel additives established by the Environmental Protection Agency under section 211 of the Clean Air Act (42 U.S.C. § 7545), and the requirements of ASTM D6751.~~

~~- *add* - **BIOMASS.** The vegetation removed from the forest, usually logging slash, small-diameter trees, tops, limbs, or trees. This includes wood logs, wood pellets and wood chips.~~

~~- *add* - **CIRCADIAN RHYTHM SYSTEMS.** Lighting systems meant to mimic natural daylight by having different color correlated temperature (CCT) settings at different times of day. This may be accomplished by a single light source that can change CCT electronically or by using multiple light sources, each with a different CCT.~~

~~- *add* - **CLERESTORY.** An outside wall of a room or building that rises above an adjoining roof and contains fenestration.~~

~~- *delete and replace* - **CODE OFFICIAL.**~~ *add* **ALL-ELECTRIC BUILDING.** A building that contains no combustion equipment, or plumbing for combustion equipment, installed within the building or building site.

add **ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE).** Boiler and furnace efficiency measurement as the percentage of heating fuel that is effectively turned into usable energy (heat).

add **APPLIANCE.** A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

delete and replace **AUTHORITY HAVING JURISDICTION.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. ~~The Vermont Public Service Department is not the *code official* and shall not be required to conduct inspections of construction or construction documents~~For purposes of this code, neither the Vermont Public Service Department nor the Division of Fire Safety should be considered the authority having jurisdiction. Where there is conflict between rules adopted by the Division of Fire Safety and this code those adopted by the Division of Fire Safety have preemption over this code.

~~*add* **COLD-CLIMATE HEAT PUMP.** An air source heat pump with an inverter-driven, variable capacity compressor that is designed to provide full heating heat pump capacity and having a minimum COP of 1.75 or greater at maximum operating capacity at an outside air temperature of 5°F. The indoor and outdoor units must be part of an AHRI matched system.~~

~~*add*~~ *add* **AUTOMOBILE PARKING SPACE.** A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

add **BIOGAS.** A mixture of hydrocarbons that is a gas at 60°F (15.5°C) and 1 atmosphere of pressure that is produced through the anaerobic digestion of organic matter.

add **CARBON DIOXIDE EQUIVALENT (CO_2e).** A measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO_2e approximates the warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO_2).

delete and replace **CLIMATE ZONE.** A geographical region based on climatic criteria as specified in this code. Vermont is *Climate Zone* 6.

delete and replace ***CODE OFFICIAL***. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. For purposes of this code, neither the Vermont Public Service Department nor the Division of Fire Safety should be considered the authority having jurisdiction. Where there is conflict between rules adopted by the Division of Fire Safety and this code those adopted by the Division of Fire Safety have preemption over this code.

add **Combined Energy Efficiency Ratio (CEER).** Window or room air conditioner efficiency measurement which combines the efficiency of the unit both in standby mode and in cooling mode.

add **COMBUSTION EQUIPMENT.** Any *equipment* or *appliance* used for space heating, *service water heating*, cooking, clothes drying and/or lighting that uses *fuel gas* or *fuel oil*.

delete and replace **COMMERCIAL BUILDING ENERGY STANDARDS (CBES).** The Vermont ~~non-residential~~nonresidential Energy Code, based on the ~~2018~~ 2021 *International Energy Conservation Code* (IECC~~,~~), but modified substantially.

~~- *delete and replace* - **CONDITIONED SPACE.** An area, room or space that is enclosed within the building thermal envelope and is directly or indirectly heated by a heating system whose output capacity is greater than 14 Btu/h·ft² of floor area or directly or indirectly cooled by a cooling system whose sensible output capacity is greater than or equal to 3.4 Btu/h·ft² of floor area. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.~~

~~- *add* - **DC Fast Charge,** DC Fast Charge uses a 480V, direct-current (DC) plug, sometimes knows as Level 3.~~

~~- *add* - **DESIGN PROFESSIONAL/AGENCY.** An individual or group of individuals who are registered, licensed or experienced to practice their respective design profession as defined by the laws of the state or jurisdiction in which the project is to be constructed.~~

~~- *add* - **DUCT FURNACE.** A furnace normally installed in distribution ducts of air-conditioning systems to supply warm air for heating and which depends on a blower not furnished as part of the duct furnace for air circulation.~~

~~- *add* - **FULLY SHIELDED FIXTURE.** A fixture constructed and installed in such a manner that all light emitted by it, either directly from the lamp (bulb) or a diffusing element, or indirectly by reflection or refraction from any part of the fixture, is projected below the horizontal.~~

~~- *add* - **FURNACE, WARM AIR.** A self-contained, indirect-fired or electrically heated furnace that supplies heated air through ducts to spaces that require it.~~

~~- *add* -~~*add* **COMMERCIAL COOKING APPLIANCES.** Appliances used in a commercial food service establishment for heating or cooking food, and which produce grease vapors, steam, fumes, smoke, or odors that are required to be removed through a local exhaust ventilation system. Such appliances include deep fat fryers, upright broilers, griddles, broilers, steam-jacketed kettles, hot-top ranges, under-fired broilers (charbroilers), ovens, barbecues, rotisseries, and similar appliances. For the purpose of this definition, a food service establishment shall include any building or a portion thereof used for the preparation and serving of food.

delete and replace **COMPUTER ROOM.** A room whose primary function is to house equipment for the processing and storage of electronic data which has a design total information technology equipment (ITE) equipment power density less than or equal to 20 watts per square foot (20 watts per 0.092 m^2) of conditioned area or a design total ITE equipment load less than or equal to 10 kW.

add **DATA CENTER.** A room or series of rooms that share data center systems, whose primary function is to house equipment for the processing and storage of electronic data and that has a design total ITE equipment power density exceeding 20 watts per square foot (20 watts per 0.092 m^2) of conditioned area and a total design ITE equipment load greater than 10 kW.

add **DATA CENTER SYSTEMS.** HVAC systems and equipment, or portions thereof, used to provide cooling or ventilation in a data center.

delete and replace **DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system where one or more pumps prime the service hot water piping with heated water upon a demand for hot water.

add **DIRECT DIGITAL CONTROL (DDC).** A type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control physical devices.

add **ELECTRIC VEHICLE (EV).** An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

add **ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE).** A designated *automobile parking space* that is provided with all the requisite infrastructure in place within five feet to allow installation of electrical wiring and connection to power for EVSE

add **ELECTRIC VEHICLE FAST CHARGER (EV FAST CHARGER).** Also referred to as a Level 3 charger. An *EV fast charger* is an *EVSE* equipped with a direct-current (DC) plug for electric vehicle charging with either a CHAdeMO or SAE combined charging system (CCS) format connector. Other DC fast charging plug standards may be accepted as they are developed.

add **ELECTRIC VEHICLE READY SPACE (EV READY SPACE).** An *automobile parking space* that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed *EVSE*.

add **ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).** Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle*.

add **ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space).** An *automobile parking space* that is provided with a dedicated *EVSE* connection.

add **ENERGY EFFICIENCY RATIO (EER).** Air handling unit measure of efficiency defined as the system output in Btu/h per watt of electrical energy input.

add **ENTHALPY RECOVERY RATIO.** Change in the enthalpy of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air enthalpy, expressed as a percentage.

add **ENVIRONMENTAL PRODUCT DECLARATION (EPD), TYPE III PRODUCT-SPECIFIC.** An EPD is a document that describes the results of a life cycle assessment (LCA) for a material or product. While there are industry-specific EPDs, which average results across multiple product manufacturers, product-specific EPDs are the most thorough type of EPD. Type III, product-specific EPDs cover a single product from a manufacturer and are reviewed by a third-party entity. They conform to ISO 14025 and either EN 15804 or ISO 21930. Like all product specific EPDs, the scope must cover the product's life-cycle from cradle to gate.

add **EQUIPMENT.** Piping, ducts, vents, control devices and other components of systems other than appliances that are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

add **FAN, EMBEDDED.** A fan that is part of a manufactured assembly where the assembly includes functions other than air movement.

add **FAN ARRAY.** Multiple fans in parallel between two plenum sections in an air distribution system.

delete **FAN EFFICIENCY GRADE (FEG).** A numerical rating identifying the fan's aerodynamic ability to convert shaft power, or impeller power in the case of a direct-driven fan, to air power.

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

add **FAN NAMEPLATE ELECTRICAL INPUT POWER.** The nominal electrical input power rating stamped on a fan assembly nameplate.

add **FAN SYSTEM ELECTRICAL INPUT POWER.** The sum of the fan electrical power of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors.

add **FAULT DETECTION AND DIAGNOSTICS (FDD) SYSTEM.** A software platform that utilizes building analytic algorithms to convert data provided by sensors and devices to automatically identify faults in building systems and provide a prioritized list of actionable resolutions to those faults based on cost or energy avoidance, comfort and maintenance impact.

delete and replace **FENESTRATION.** Products classified as either skylights or vertical fenestration.

> **Skylights.** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal, including unit skylights, tubular daylighting devices and glazing materials in solariums, sunrooms, roofs, greenhouses and sloped walls.
>
> **Vertical fenestration.** Windows that are fixed or operable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees (1.05 rad) from horizontal.

add **FUEL GAS.** A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.

add **FUEL OIL.** Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

add **GARAGE DOOR.** A large door that allows a vehicle to access the building or allows a shipping truck to load or unload.

delete and replace **GENERAL LIGHTING.** Interior lighting that provides a substantially uniform level of illumination throughout a space.

add **GLOBAL WARMING POTENTIAL (GWP).** GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO2. The following GWP values are used based on a 100-year time horizon: 1 for CO_2, < 10 for pentane (e.g., C_5H_{12}), and 1430 for R-134a (CH_2FCF_3).

add **GLOBAL WARMING POTENTIAL (GWP) INTENSITY.** For the purposes of this document, GWP intensity refers to the GWP impact from materials (kg CO2e) divided by the project's total conditioned floor area in square feet (ft2).

delete and replace **GREENHOUSE.** A structure or a thermally isolated area of a building that maintains a specialized sunlit environment exclusively used for, and essential to, the cultivation, protection or maintenance of plants. *Greenhouses* are those that are erected for a period of 180 days or more.

delete and replace **GROSS AREA OF EXTERIOR WALLS.** The normal projection of all exterior walls, including the edge area of above grade floors, the edge area of roof insulation, and the area of all windows and doors installed therein (see "Exterior wall").

~~-~~ *add* ~~-~~ **HEATING SEASONAL PERFORMANCE FACTOR (HSPF).** Heat pump heating efficiency rating measured as the ratio of heat output over the heating season (in Btu) to electricity used (in watt-hours).

delete and replace **HIGH-EFFICACY** ~~**LAMPS/LIGHTING.** Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter~~ **LIGHT SOURCES.** Non-linear ~~fluorescent lamps, or other~~medium screw- and pin-base lamps with an efficacy of not less than 65 lumens per watt; or light fixtures of not less than ~~55~~65 lumens per watt. In determining the number or percent of lamps, each replaceable lamp (or light string) connected to a permanently installed lighting fixture shall count as one lamp.

~~- *delete and replace* - **HIGH SPEED DOOR.** A door used primarily to facilitate vehicular access or material transportation, with a minimum opening rate of 32 inches (813 mm) per second, a minimum closing rate of 24 inches (610 mm) per second and that includes an automatic-closing device.~~

~~- *add* - **LEVEL 1 ELECTRIC VEHICLE CHARGING.** Level 1 charging uses a standard alternating current 120V outlet.~~

~~- *add* - **LEVEL 2 ELECTRIC VEHICLE CHARGING.** Level 2 uses a 240V alternating current outlet. , also known as DC Fast Charge.~~

~~- *add* - **LEVEL 3 ELECTRIC VEHICLE CHARGING.** Level 3 uses a 480V, direct-current (DC) plug.~~

~~- *delete and replace* - **LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the *code official or other authority having jurisdiction*~~

~~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.~~

~~- *add* -~~*delete* **HUMIDISTAT.** A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

add **INFORMATION TECHNOLOGY EQUIPMENT (ITE).** Items including computers, data storage devices, servers and network and communication equipment.

add **INTEGRATED ENERGY EFFICIENCY RATIO (IEER).** Integrated efficiency value of a mechanical system operating at 100%, 75%, 50%, and 25% of full load capacity designed to reflect the efficiency at different load levels.

add **INTERNAL CURTAIN SYSTEM.** A system consisting of movable panels of fabric or plastic film used to cover and uncover the space enclosed in a greenhouse on a daily basis.

add **LARGE-DIAMETER CEILING FAN.** A ceiling fan that is greater than 7 feet (2134 mm) in diameter. These fans are sometimes referred to as High-Volume, Low-Speed (HVLS) fans.

delete and replace **METAL BUILDING.** A complete integrated set of mutually dependent components and assemblies that form a building, which consists of a steel-framed superstructure and metal ~~skin~~exterior cladding.

~~-~~*add* ~~-~~ **~~METAL~~MIXED-FUEL BUILDING ~~ROOF~~.** A ~~roof~~*building* that:
contains *combustion equipment* or includes piping for such *equipment.*

~~a. is constructed with a metal, structural, weathering surface;~~

~~b. has no ventilated cavity; and~~

~~c. has the insulation entirely below deck (i.e., does not include composite concrete and metal deck construction nor a roof framing system that is separated from the superstructure by a wood substrate) and whose structure consists of one or more of the following configurations:~~

~~1. metal roofing in direct contact with the steel framing members;~~

~~2. metal roofing separated from the steel framing members by insulation; or~~

~~3. insulated metal roofing panels installed as described in sub items (a) or (b).~~

~~- *add* - **METAL BUILDING WALL.** A wall whose structure consists of metal spanning members supported by steel structural members (i.e., does not include spandrel glass or metal panels in curtain wall systems).~~

~~- *add* - **MULTIFAMILY DWELLING.** A building containing three or more dwelling units where the occupants are primarily permanent in nature and which are adjacent vertically or horizontally. If built side-by-side, at least one of the following is true: (1) they do not have a wall that extends~~

~~from ground to roof, (2) they share a heating system, or (3) they have interstructural public utilities such as water supply/sewage disposal.~~

~~- *add* -~~*delete and replace* **NETWORKED GUESTROOM CONTROL SYSTEM.** A control system, with access from the front desk or other central location associated with a *Group R*-1 building, that is capable of identifying the rented and unrented status of each guestroom according to a timed schedule, and is capable of controlling HVAC in each hotel and motel guestroom separately.

delete and replace **OCCUPANCY CLASSIFICATIONS.** Building occupancies shall be defined by the ~~2018~~2021 *International Building Code*, which is summarized here. Discrepancies in the summary or further clarifications shall defer to the ~~2018~~ *International Building Code*.

Assembly Group A is the occupancy group used for buildings that are for the gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption or awaiting transportation.

The first occupancy group is A-1. The group is for the production and viewing of the performing arts, motion pictures, or television and radio studios admitting an audience.

The next occupancy group is A-2. The group includes assembly uses intended for food and/or drink consumption, such as: banquet halls, casino gambling areas, ~~nightclubs~~night-clubs, restaurants, cafeterias, taverns, and bars.

Group A-3 includes assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A such as: community halls, courtrooms, gymnasiums, and waiting areas in transportation terminals.

Group A-4 includes assembly uses intended for viewing of indoor sporting events and activities with spectator seating.

Group A-5 includes assembly uses intended for participation in or viewing outdoor activities.

Business Group B is the occupancy group used for office, professional or service-type transactions, including storage or records and accounts.

Educational Group E is the occupancy group used by six or more persons at any one time for educational purposes through the 12th grade.

Factory Industrial Group F is the occupancy group used for disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operation that are not classified as Group H or Group S.

High-hazard Group H is the occupancy group used for manufacturing, processing, generation or storage of materials that constitute a physical or health hazard.

Institutional Group I is the occupancy group used for more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised environment and receive custodial care.

Mercantile Group M is the occupancy group used for the display and sale of merchandise, and involves stocks of goods, wares or merchandise.

Residential Group R is the occupancy group used for buildings that include sleeping rooms and are not institutional. There are four different occupancy groups within R.

The first occupancy group is R-1. This group is for transient uses like hotels, motels and boarding houses.

Group R-2 is occupancies containing sleeping units or more than two dwelling units where the occupants are primarily permanent. This includes apartments, dormitories, fraternities and sororities. It also includes vacation timeshares (with more than two units) and convents and monasteries. Boarding houses or congregate living facilities with 16 or fewer occupants go into Group R-3.

Group R-3 is for permanent occupancies that are not R-1, R-2, or R-4.

Group R-4 is for occupancies for more than five but not more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised residential environment and receive custodial care.

Storage Group S is the occupancy group used for storage that is not classified as a hazardous occupancy.

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

~~- *add* -~~ *delete and replace* **RENEWABLE ENERGY RESOURCES.** Energy produced using a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate including, but not limited to, solar hot water, solar hot air, solar photovoltaics, wind, and hydro.

1. ~~A.~~ Methane gas and other flammable gases produced by the decay of sewage treatment plant wastes or landfill wastes and anaerobic digestion of agricultural products, byproducts, or wastes shall be considered renewable energy resources, but no form of solid waste, other than agricultural or silvicultural waste, shall be considered renewable.

2. ~~B.~~ The only portion of electricity produced by a system of generating resources that shall be considered renewable is that portion generated by a technology that qualifies as renewable.

3. ~~C.~~ The following fuels shall not be considered renewable energy supplies: coal, oil, propane, and natural gas.

4. ~~D.~~ Biomass is considered renewable.

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

~~- *add* -~~ **RESIDENTIAL BUILDING ENERGY STANDARDS (RBES).** The *Vermont Residential Energy Code* based on the ~~2019 IECC~~2015 *International Energy Conservation Code with 2018, 2020, and 2023 additions*.

~~- *add* -~~ *add* **SEASONAL ENERGY EFFICIENCY RATIO (SEER).** Air conditioner efficiency rating, measured as the ratio of cooling output over a typical cooling season (in Btuh), divided by the provided electrical energy (in watt-hours).

delete and replace **SEMI-CONDITIONED SPACE.** An enclosed space within a building that is not a conditioned space, but is directly or indirectly mechanically heated ~~by a heating system whose output capacity is less than or equal to 14 Btu/h·ft² of floor area; or if the space is directly or indirectly~~ or cooled ~~and the cooling system's sensible output capacity is less than 3.4 Btu/h·ft²~~.

add **SOLAR-READY ZONE.** A section of ~~floor area.~~sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.

~~CHAPTER 3~~
~~GENERAL REQUIREMENTS~~

~~SECTION C301~~
~~CLIMATE ZONES~~

~~- *delete* – **Section C301 CLIMATE ZONES (C301.1** through **C301.4)** in its entirety.~~

~~- *add* – **C301.1 General**~~
~~The State of Vermont, in its entirety, is classified as climate zone 6A~~

~~SECTION C302~~
~~DESIGN CONDITIONS~~

~~- *add* - **C302.2 Climatic data**[1]**.**~~

- ~~Heating Design Temperature, 99.6%: -9°F (ASHRAE Standard 169)~~
- ~~Cooling Design Temperature Dry-Bulb, 1.0%: 84°F (ASHRAE Standard 169)~~
- ~~Cooling Design Temperature Wet-Bulb, 1.0%: 69°F (ASHRAE Standard 169)~~
- ~~Heating Degree Days, 65° Base: 7,626 (ASHRAE Standard 169)~~
- ~~Cooling Degree Days, 50° Base: 2,183 (ASHRAE Standard 169)~~

~~Adjustments may be made only in the following cases:~~

1. ~~Winter heating design temperatures for projects either:~~
   - ~~i. Located at an elevation of 1,500 feet or higher, or~~
   - ~~ii. Located in Caledonia, Essex or Orleans counties.~~
   - ~~iii. Adjustments shall be made as listed in the National Climate Data Center for the specific weather station: http://www.ncdc.noaa.gov/cdo-web/.~~
2. ~~As approved by the *code official or other authority having jurisdiction.*~~

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

add **THERMAL DISTRIBUTION EFFICIENCY (TDE).** The resistance to changes in air heat as air is conveyed through a distance of air duct. TDE is a heat loss calculation evaluating the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.

add **TYPE III PRODUCT-SPECIFIC ENVIRONMENTAL PRODUCT DECLARATION (EPD).** See ENVIRONMENTAL PRODUCT DECLARATION, TYPE III PRODUCT-SPECIFIC.

add **VEGETATIVE ROOF.** An assembly of interacting components designed to waterproof a building's top surface that includes, by design, vegetation and related landscape elements.

add **VISIBLE TRANSMITTANCE, ANNUAL [VT_{annual}].** The ratio of visible light entering the space through the fenestration product assembly to the incident visible light during the course of a year, which includes the effects of glazing material, frame, and light well or tubular conduit, and is expressed as a number between 0 and 1.

delete and replace **WALL, ABOVE-GRADE.** A wall associated with the *building thermal envelope* that is more than 15 percent above grade and is on the exterior of the building or any wall that is associated with the *building thermal envelope* that is not on the exterior of the building. This includes, but is not limited to, between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

CHAPTER 3 [CE]
GENERAL REQUIREMENTS

SECTION C303
MATERIALS, SYSTEMS AND EQUIPMENT

~~*delete and replace* – **TABLE C303.1.3(1)**~~
delete and replace **C303.1.2 Insulation mark installation.**
Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection. For insulation materials that are installed without an observable manufacturer's R-value mark, such as blown or draped products, an insulation certificate complying with Section C303.1.1 shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed R-value of the insulation material.

delete and replace **TABLE C303.1.3(2)**

TABLE C303.1.3(~~1~~2)
DEFAULT ~~GLAZED WINDOW, GLASS~~OPAQUE DOOR ~~AND SKYLIGHT~~ *U*-FACTORS

~~FRAME~~DOOR TYPE		**~~WINDOW AND GLASS DOOR~~OPAQUE *U*-FACTOR**		**~~SKYLIGHT~~**	
Uninsulated Metal[1]		**~~Single~~**1.20	**~~Double~~**	**~~Single~~**	**~~Double~~**
Insulated Metal (Rolling)	~~1.20~~	0.~~80~~90	~~2.00~~	~~1.30~~	
Insulated Metal ~~with Thermal Break~~(Other)	~~1.10~~	0.~~65~~60	~~1.90~~	~~1.10~~	
~~Nonmetal or Metal Clad~~Wood		0.~~95~~50	~~0.55~~	~~1.75~~	~~1.05~~
~~Glazed Block~~Insulated, nonmetal edge, max 45% glazing, any glazing double pane		0.~~60~~35			

~~Metal Thermal Break.= A metal thermal break framed window shall incorporate the following minimum design characteristics:~~
~~a) The thermal conductivity~~

1. Uninsulated opaque doors are prohibited when part of the thermal ~~break material shall be not more than 3.6 Btu-in/h/ft2/°F;~~envelope.

~~b) The thermal break material must produce a gap in the frame material of not less than 0.210 inches; and~~
~~c) All metal framing members of the products exposed to interior and exterior air shall incorporate a thermal break meeting the criteria in a) and b) above.~~

CHAPTER 4 [CE]
COMMERCIAL ENERGY EFFICIENCY

SECTION C401
GENERAL

~~–~~*delete and replace* ~~–~~**C401.2 Application.**
Commercial buildings shall comply with ~~one of the following:~~

Section C401.2.1~~.~~ or C401.2.2.

delete and replace **C401.2.1 CBES Prescriptive Compliance.** The ~~requirements of~~ Prescriptive Compliance option requires compliance with Sections C402 through ~~C405 and~~ C407. ~~In addition, commercial~~Dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance, provided that they comply with Section ~~C406~~R406 of *RBES*.

delete *and* ~~tenant spaces~~*replace* **C401.2.2 ASHRAE 90.1.** Commercial buildings shall comply with ~~Section C406.1.1.~~

~~2.~~ the requirements of ANSI/ASHRAE/IESNA 90.1-~~2016~~2019. New buildings using ANSI/ASHRAE/IESNA 90.1-~~2016~~2019 compliance paths (a) or (b) (see ANSI/ASHRAE/IESNA 90.1-~~2016~~2019 section 4.2.1.1 *New Buildings*) shall comply with Section C406 in the ~~2019~~ ~~2019 CBES and tenant spaces shall comply with Section C406.1.1 in the 2019~~2023 CBES. Commercial building projects utilizing the alternative compliance path of ANSI/ASHRAE/IESNA 90.1-~~2016~~2019 must follow all applicable provisions listed in Section ~~401~~C401.2.2.1.

~~– *delete and replace* –~~*add* **C401.2.2.1 Applicable provisions to Standard 90.1-~~2016~~2019.**

1. All instances of the term building official in ASHRAE/IESNA 90.1-~~2016~~2019 shall be replaced with the terms *code official or* ~~*other*~~ *authority having jurisdiction*.

2. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 4.2.1.1 New Buildings*. Delete the equation for Performance Cost Index Target (PCI_t) and replace with:

   PCI_t = [BPF ~~x~~× (BBUEC + BBREC~~)] /~~)]/BBP.

   Delete Table 4.2.1.1 *Building* Performance Factor (BPF) and replace with:

TABLE 4.2.1
~~.1~~ **BUILDING PERFORMANCE FACTOR (BPF)**

BUILDING AREA TYPE[a]	VERMONT BPF
Multifamily	~~.62~~0.55
Healthcare/hospital	0.46
Hotel/motel	~~.48~~0.43
Office	0.43
Restaurant	0.50
Retail	~~.44~~0.37
School	~~.39~~0.34
Warehouse	0.53
All Others	0.45

a. ~~a.~~ In cases where both a general *building* area type and a specific *building* area type are listed, the specific *building* area type shall apply.

3. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 5.1.4.1 United States Locations*. Delete the exception clause and replace with the following:

   a. Adjustments may be made only in the following cases:

      a. Winter heating design temperatures for projects either:

         i. Located at an elevation of 1,500 feet or higher~~, or~~.

         ii. Located in Caledonia, Essex or Orleans counties.

         iii. Adjustments shall be made as listed in the National Climate Data Center for the specific weather station: http://www.ncdc.noaa.gov/cdo-web/.

      b. As approved by the *code official or* ~~other~~ *authority having jurisdiction*.

4. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 5 Building Envelope*. All envelope requirements shall comply with the following tables in the ~~2019~~2023 *Vermont Commercial Building Energy Standards*(CBES):

   i. *Table C402.1(2) and Table C402.1(3), Building Envelope Requirements—Opaque Assemblies and Elements*. Any spaces that qualify as Semiheated in ASHRAE/IESNA 90.1-~~2016~~2019 need only comply with the *Semiconditioned* requirement in Table C402.1(2) and Table C402.1~~),~~(3).

   ii. *Table C402.1(~~2~~4), Building Envelope Requirements—Metal Building Assembly Descriptions*~~, and~~.

   iii. *Table C402.3, Building Envelope Fenestration Maximum U-Factor and SHGC Requirements*.

5. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 5.4.3 Air Leakage*. Delete section in its entirety and replace *with Section C402.4 Air leakage—thermal envelope of the ~~2019~~2023 Vermont CBES*.

6. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 5.5.3.1 Roof Insulation*. Delete section in its entirety and replace with *Section C402.2.1 Roof assembly of the ~~2019~~2023 Vermont CBES*.

7. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 5.5.3.3 Below-Grade Wall Insulation*. Delete section in its entirety and replace with *Section C402.2.3 Below-grade walls of the ~~2019~~2023 Vermont CBES*.

8. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 5.5.3.5 Slab-on-Grade Floor Insulation*. Add to the end of this section the requirements of section *C402.2.6 Slabs-on-grade perimeter insulation of the ~~2019~~2023 Vermont CBES*.

9. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.2 Compliance Path(s)*. Add new section as follows:

   a. *Section 6.2.3 Electric Resistance Space Heating*. Building heating with electrical resistance units, including baseboard radiation, heat pump reheat coils, duct coils, boilers, domestic hot water heaters, and coils in terminal units and air systems is prohibited.

      Exceptions to ~~Section~~ 6.2.3:

      a. Areas, such as stairways, that are not permitted to be penetrated with piping or duct and no other method of heating is possible.

      b. Replacement of existing electrical resistance unit.

      c. Special conditions of occupancy or use that require electrical resistance heat to maintain health, safety or environmental conditions.

      d. Limited areas where a practical application of resistance electrical heat is demonstrated (e.g., small interior space, such as a rest room, which is distant from the distribution system, hazardous material storerooms, stairwell or other means of emergency egress).

      e. Domestic hot water heaters less than or equal to 7.5 kW in total unit input capacity.

      f. Multifamily buildings with heating loads ~~≤~~less than or equal to 6.0 Btu/hour/square foot at design temperature~~.*~~.*

      g. *Cold-Climate Heat Pump* where~~:*~~:*

         a. the full heating demand can be met with the heat pump at an outside air temperature of 5°F~~; and~~ (-15°C).

b. the building *thermal envelope* shall be tested in accordance with ASTM ~~E 779~~E779 at a pressure differential of 0.3 inch water gauge (75 Pa) and deemed to comply with the provisions of Section C402.4.1 when the tested air leakage rate of the building thermal envelope is not greater than 0.~~20~~15 cfm/ft^2 (including the areas of the slab and below grade walls).

~~~~Buildings served by the City of Burlington Electric (BED) must also receive approval from BED before installing electric resistance heating equipment.

10. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.3.2(e) Criteria*. Delete “an electric resistance heater.”

11. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.4.3.5 Heat Pump Auxiliary Heat Control*. Delete section in its entirety and replace with *Section C403.4.1.1 Heat pump supplementary heat of the ~~2019~~2023 Vermont CBES*.

12. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.4.3.8 Ventilation Controls for High-Occupancy Areas*. Add *exception (6)*: Ventilation needs for process loads.

13. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.4.3.9 Heated or Cooled Vestibules*. Delete section in its entirety and replace with *Section C403.4.1.4 Duct and plenum insulation and sealing of the ~~2019~~2023 Vermont CBES*.

14. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.4.4.1.2 Duct and Plenum Insulation*. Delete section in its entirety and replace with *Section C403.11.1 Duct and plenum insulation and sealing of the ~~2019~~2023 Vermont* CBES.

15. Add new Section 6.4.7 to ASHRAE/IESNA 90.1-~~2016~~2019, titled *Economizer Fault Detection and Diagnostics (FDD)*. Insert *Section C403.5.5 Economizer fault detection and diagnostics (FDD) of the ~~2019~~2023 Vermont CBES*.

16. ASHRAE/IESNA 90.1-~~2016~~2019 Section 6.5.1 *Economizers*. Delete section in its entirety and replace with *Section C403.5 Economizers of the ~~2019~~2023 Vermont CBES*.

17. ASHRAE/IESNA 90.1-~~2016 Table~~2019 Tables 6.5.6.1-1 and 6.5.6.1-2 *Exhaust Air Energy Recovery Requirements for Ventilation Systems*. Both tables shall be greater than or equal to ~~3000~~3,000 hours per year rather than ~~8000~~8,000 hours.

18. ASHRAE/IESNA 90.1-~~2016 Table~~2019 Tables 6.5.6.1-1 and Table 6.5.6.1-2 *Exhaust Air Energy Recovery Requirements*, delete requirement for systems with ~~≥~~≥ 10% and < 20% outdoor air (second column of tables).

19. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.5.6.2 Heat Recovery for Service Water Heating~~, 6.5.6.2.2~~*. Add exception (3): If compliance with Section 6.5.6.2 will be detrimental to chiller operating efficiency due to conflicts with optimized chiller head pressure control.

20. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 6.7.2.4 System Commissioning*. Delete section in its entirety and replace with *Section* ~~C407System~~*C407 System Commissioning of the* ~~*2019*~~*2023 Vermont CBES*.

21. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 7.1 General*. Add new section as follows:

    a. *Section 7.1.1.4 Electrical Water Heating Limitation*. Individual electric service water heating units shall be limited to a maximum of 7.5 kW total power input.

       Exception: Instantaneous electric water heaters used to serve emergency showers and emergency eye wash stations.

22. ASHRAE/IESNA 90.1-~~2016~~2019 *Table 7.8 Performance Requirements for Water Heating Equipment*.

    a. Change first row (Electric tabletop water heaters) size category to < 7.5 kW~~, and ~~.

    b. Change second row (Electric water heaters) size category to < 7.5 kW~~, and~~.

    c. Delete entire third row for electric water heaters > 12 kW.

23. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 9 Lighting*. All lighting power density (LPD) requirements shall comply with the following tables in the ~~2019~~2023 *Vermont Commercial Building Energy Standards* (CBES):

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

    ii. *Table C405.3.2(2), Interior Lighting Power Allowances: Space-by-Space Method*~~*, and*~~.

    iii. *Table C405.4.2(2), Individual Lighting Power Allowances for Building Exteriors*. Note that Vermont does not have any exterior lighting zone 4 areas.

       Exception: *Exterior lighting zone 0 shall follow LPD requirements given by* ASHRAE/IESNA 90.1-~~2016~~2019 Table 9.4.4-2.

24. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 9.4.1.3 Special Applications*. At the end of the section add the following wording:

    d. Luminaires providing means of egress illumination where the means of egress shall be illuminated at all times the room or space is occupied shall be controlled by occupancy sensors, or a signal from another building control system, that automatically reduces the lighting power by at least 50% when unoccupied for a period longer than 15 minutes.

       Exceptions:

       1. Means of egress illumination that does not exceed 0.02 watts per square foot of building area is exempt from this requirement.

2. Emergency lighting designated to meet Section 1008.3 of the *International Building Code*.

25. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 9.4.1.4 Exterior Lighting Control*. Add the following requirement:

    e. Exterior lighting shall be *full cut off* fixtures, limiting the light output to less than 10% at and below 10 degrees below the horizontal. Fixtures shall be independently certified by manufacturer as full cut off or meet the definition of a *fully shielded* light fixture.

26. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 9.4.4 Dwelling Units*. Delete section in its entirety and replace with: Not less than 90% of the *permanently installed* lighting fixtures shall use lamps with an *efficacy* of at least 65 lm/W or have a total *luminaire efficacy* of at least 55 lm/W.

27. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 9.6.2 Additional Interior Lighting Power.* Amend the exception in part (a) to read that the power shall not exceed 0.6 W/ft^2 of such *spaces* instead of 0.75 W/ft^2. In part (b~~)~~), delete the equation for Additional Interior Lighting Power Allowance and replace with:

~~Additional interior lighting power allowance = 250 W + (Retail Area 1 × 0.20 W/ft^2) + (Retail Area 2 × 0.20 W/ft^2) + (Retail Area 3 × 0.50 W/ft^2) + (Retail Area 4 × 0.90 W/ft^2)~~

Additional interior lighting power allowance = 250 W + (Retail Area 1 × 0.20 W/ft^2) + (Retail Area 2 × 0.20 W/ft^2) + (Retail Area 3 × 0.50 W/ft^2) + (Retail Area 4 × 0.90 W/ft^2)

28. ASHRAE/IESNA 90.1-~~2016~~2019 *Section 10.4 Mandatory Provisions*. Add the following sections:

    i. *10.4.6, Renewable energy systems*, which will meet the requirements of *Section C405.10 Renewable energy systems* in the ~~2019~~2023 Vermont CBES.

    ii. *10.4.7 Electric Vehicle Charging Stations*, which will meet the requirements of *Section C405.11 Electric Vehicle Charging Stations* in the ~~2019~~2023 Vermont CBES.

~~- *add* – **C401.2.2 Application to replacement fenestration products.**~~
~~Where some or all of an existing *fenestration* unit is replaced with a new *fenestration* product, including sash and glazing, the replacement *fenestration* unit shall meet the applicable requirements for *U*-factor and *SHGC* in Table C402.3.~~

~~**Exception:** An area-weighted average of the *U*-factor of replacement fenestration products being installed in the building for each fenestration product category listed in Table C402.3~~

~~shall be permitted to satisfy the *U*-factor requirements for each fenestration product category listed in Table C402.3. Individual fenestration products from different product categories listed in Table C402.3 shall not be combined in calculating the area-weighted average *U*-factor.~~

~~- *add* - **C401.3 Certificate of compliance**~~*delete and replace* **C401.3 CBES Certificate and Affidavits**.

30 V.S.A. §53 requires certification that both the design and the construction of a commercial building is in compliance with the CBES. Copies of the CBES Certificate and Affidavits are available on the Department of Public Service website at https://publicservice.vermont.gov/energy_efficiency/cbes.

Certification shall be issued by an approved party completing and signing a certificate ~~permanently~~ and affixing it ~~to~~ permanently on a wall in the ~~outside of~~space where the ~~heating or cooling~~space conditioning equipment~~, to~~ is located, in the interior space where the electrical service panel ~~and~~is located ~~inside the building~~, or in a visible location in the immediate vicinity of one of these ~~three~~ areas. If located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. Copies of the signed certification documents shall be included in the construction files for the project, shall be sent to the local town clerk ~~and~~for recording in the land records, and shall be sent to the Vermont Public Service Department. The certificate shall include the following:

1. Compliance method
2. Thermal envelope details including:
   a. R-values of insulation installed in or on ceilings, roofs, walls, foundations and slabs, 101229848 basement walls, crawl space walls and floors and ducts outside conditioned spaces.
   b. U-factors and solar heat gain coefficients (SHGC) of fenestrations.
3. Results from any building envelope air leakage testing performed on the building.
4. An indication of the solar-ready zone and other requirements of Section C402.5.

Where there is more than one value for any component of the building envelope, the certificate shall indicate the area-weighted average value where available. If the area-weighted average is not available, the certificate shall list each value that applies to 10 percent or more of the total component area.

SECTION C402
BUILDING ENVELOPE REQUIREMENTS

~~–~~*delete and replace* ~~—~~**C402.1 General** ~~**(Prescriptive).**~~**.**

In addition to the envelope requirements of Section C402, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, envelope enhancements may be needed ~~to meet the requirements of Section C406, Additional Efficiency Package Options.~~.

The requirements of C402 that may be affected and the corresponding C406 references are summarized in Table C402.1(1). For a full list of potential measures See ~~Section~~Table C406.2.1 and Table C406.3.1.

Table C402.1(1): C406 MEASURES AFFECTING BUILDING ENVELOPE

ID	C406 Energy Credit Title	C402 Reference	C406 Section
E01	Envelope Performance	n/a	C406.2.1.1
E02	UA Reduction	C402.1.3	C406.2.1.2
E03	Envelope Leak Reduction	C403.3.2	C406.2.1.3
E04	Add Roof Insulation	C402.1.1	C406.2.1.4
E05	Add Wall Insulation	C402.1.1	C406.2.1.5
E06	Improve Fenestration	Table C402.3	C406.2.1.6
G03	Automated Shading	n/a	C406.3.4
G07	Building Thermal Mass	n/a	C406.3.8
C01	Insulation Embodied Carbon	n/a	C406.3.9

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2, shall comply with the following:

1. The opaque portions of the building thermal envelope shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.1; the *U*-, *C*- and *F*-factor-based method of Section C402.1.2; the component performance alternative of Section C402.1.3; or the building above-grade performance alternative of Section C402.1.4. Building assemblies between conditioned and semi-conditioned spaces shall comply with the semi-conditioned requirements.

2. Fenestration in building envelope assemblies shall comply with Section C402.3.

   Exception: Semi-conditioned spaces do not have fenestration requirements.

3. Air leakage of building envelope assemblies shall comply with Section C402.4. Buildings with both conditioned and semi-conditioned spaces shall independently comply with the requirements of Section C402.4.

4. Solar readiness of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.3, the building and building thermal envelope shall comply with Section C401.2, Item 2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.10.1.

~~–~~*delete* ~~–~~**TABLE C402.1~~.~~(1 ~~Low-energy buildings.~~**

~~– *delete* –~~*) and replace* **TABLE C402.1~~.~~(2 ~~Equipment buildings.~~)**

TABLE C402.1(2)
CONDITIONED SPACE BUILDING ENVELOPE REQUIREMENTS—OPAQUE ASSEMBLIES AND ELEMENTS[a,b]

COMPONENT	MAXIMUM OVERALL *U*-FACTOR		EXAMPLE ASSEMBLIES MEETING U-FACTOR REQUIREMENT	
	All Other *Occupancy Classifications*	R-2 *Occupancy Classifications*	All Other *Occupancy Classifications*	R-2 *Occupancy Classifications*
Roofs				
Insulation entirely above deck	U-0.022	Same as All Other ←	R-45ci	Same as All Other ←
Metal buildings	U-0.023	Same as All Other ←	R-10 + R-10 + R-32ci	Same as All Other ←
Attic and Other[i]	U-0.017	U-0.020	R-60	R-49
Walls, Above grade				
Mass[f]	U-0.037	Same as All Other ←	R-25ci	Same as All Other ←
Metal Building	U-0.039	Same as All Other ←	R-13 + R-19.5ci or R-25ci	Same as All Other ←
Metal-framed	U-0.037	Same as All Other ←	R-13 + R-18.8ci or R-25ci	Same as All Other ←
Wood-framed and other	U-0.036	U-0.042	R-13 + R-16ci or R-19 + R-12ci or R-25ci	R-13 + R-12ci or R-19 + R-8ci or R-20ci
Walls, Below Grade[c]				
Below-grade wall	C-0.048	Same as All Other ←	R-20ci	Same as All Other ←
Floors				
Mass[d]	U-0.038	Same as All Other ←	R-23ci	Same as All Other ←
Joist/Framing—Metal	U-0.027	Same as All Other ←	R-38 + R-6ci	Same as All Other ←
Joist/Framing—Wood and Other	U-0.027	Same as All Other ←	R-38	Same as All Other ←
Slab-on-Grade Floors				
Unheated slabs	F-0.434	Same as All Other ←	R-20 for 48" below	Same as All Other ←
Heated slabs[e]	F-0.433	Same as All Other ←	R-20 for 48" below + R-15 full slab	Same as All Other ←

Opaque Doors				
Swinging[g]	U-0.37		N/A	
Non-Swinging	N/A		R-4.75	
Garage door <14% glazing[h]	N/A		R-10	

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.
ci = Continuous insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors, and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1-2019 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/IESNA 90.1-2019 Appendix A. Alternatively, Table C402.1(4) for metal building assembly descriptions, Table C402.1(5) for metal building roof assembly *U*-factors, Table C402.1(6) for attic roofs with wood joists *U*-factors, Table C402.1(7) for metal building wall assembly *U*-factors, Table C402.1(8) for metal-framed wall assembly U-factors, and Table C402.1(9) for wood-framed wall assembly U-factors may be used in lieu of ANSI/ASHRAE/IESNA 90.1-2019 Appendix A.
b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The R-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.
c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.
d. "Mass floors" shall be in accordance with **Section C402.2.3** and shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.
e. Evidence of compliance with the *F*-factors indicated in the table for heated slabs shall be demonstrated by the application of the unheated slab *F*-factors and *R*-values derived from ASHRAE 90.1-2019 Appendix A.
f. "Mass walls" shall be in accordance with **Section C402.2.2**
g. Swinging door U-factors shall be determined in accordance with NFRC-100.
h. Garage doors having a single row of fenestration shall have an assembly U-factor less than or equal to 0.31, provided that fenestration area is not less than 14 percent and not more than 25 percent of the total door area.
i. For Group R buildings, R-49 (U-0.023) for insulation in the ceiling slope

add -**TABLE C402.1(3)**

TABLE C402.1(3)
***SEMI-CONDITIONED SPACE* BUILDING ENVELOPE REQUIREMENTS—OPAQUE ASSEMBLIES AND ELEMENTS[a,b]**

COMPONENT	**MAXIMUM OVERALL *U*-FACTOR**	**EXAMPLE ASSEMBLIES MEETING U-FACTOR REQUIREMENT**
	All *Occupancy Classifications*	**All *Occupancy Classifications***
Roofs		
Insulation entirely above deck	U-0.039	R-25ci
Metal buildings	U-0.037	R-19 + R-11 LS or R-25 + R-8 LS
Attic and Other[i]	U-0.027	R-38

Walls, Above grade		
Mass[f]	U-0.104	R-9.5ci
Metal Building	U-0.060	R-15.8ci
Metal-framed	U-0.064	R-13 + R-7.5ci
Wood-framed and other	U-0.051	R-13 + R-7.5ci
Walls, Below Grade[c]		
Below-grade wall	C-0.119	R-7.5ci
Floors		
Mass[d]	U-0.064	R-12.5ci
Joist/Framing—Metal	U-0.052	R-19
Joist/Framing—Wood and Other	U-0.033	R-30
Slab-on-Grade Floors		
Unheated slabs	F-0.540	R-10 for 24 in. below
Heated slabs[e]	F-0.860	R-15 for 24 in below
Opaque Doors		
Swinging[g]	U-0.37	N/A
Non-Swinging	N/A	R-4.75
Garage door <14% glazing[h]	N/A	R-10

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.
ci = Continuous insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors, and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1-2019 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/IESNA 90.1-2019 Appendix A. Alternatively, Table C402.1(4) for metal building assembly descriptions, Table C402.1(5) for metal building roof assembly *U*-factors, Table C402.1(6) for attic roofs with wood joists *U*-factors, Table C402.1(7) for metal building wall assembly *U*-factors, Table C402.1(8) for metal-framed wall assembly U-factors, and Table C402.1(9) for wood-framed wall assembly U-factors may be used in lieu of ANSI/ASHRAE/IESNA 90.1-2019 Appendix A.

b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The R-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.

c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.

d. "Mass floors" shall be in accordance with **Section C402.2.3** and shall include floors weighing not less than:
   1. 35 pounds per square foot of floor surface area; or
   2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

e. Evidence of compliance with the *F*-factors indicated in the table for heated slabs shall be demonstrated by the application of the unheated slab *F*-factors and *R*-values derived from ASHRAE 90.1-2019 Appendix A.

f. "Mass walls" shall be in accordance with **Section C402.2.2**

g. Swinging door U-factors shall be determined in accordance with NFRC-100.

h. Garage doors having a single row of fenestration shall have an assembly U-factor less than or equal to 0.36, provided that fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

delete **TABLE C402.1(2)** *and replace* **TABLE C402.1(4)**

TABLE C402.1(4)
BUILDING ENVELOPE REQUIREMENTS—METAL BUILDING ASSEMBLY DESCRIPTIONS

BUILDING ENVELOPE REQUIREMENTS—METAL BUILDING ASSEMBLY DESCRIPTIONS	**DESCRIPTION**	**REFERENCE**
	ROOFS	
Since Layer	The rated R-value of insulation is for insulation installed perpendicular to and draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly U-factor.	ANSI/ASHRAE/IESNA 90.1-2019
Double Layer	The first rated R-value of insulation is for insulation installed perpendicular to and draped over purlins. The second rated R-value of insulation is for unfaced insulation installed above the first layer and parallel to the purlins and then compressed when the metal roof panels are attached. A minimum R-3 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly U-factor.	ANSI/ASHRAE/IESNA 90.1-2019
Continuous Insulation	For assemblies with continuous insulation the continuous insulation is installed above or below the purlins, uncompressed and uninterrupted by framing members.	ANSI/ASHRAE/IESNA 90.1-2019
Liner system	A continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. For multilayer installations, the last rated *R*-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached. A minimum R-5 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly *U*-factor.	ANSI/ASHRAE/IESNA 90.1-2019
Filled Cavity (Fc)	The first *rated R-value of insulation* represents faced or unfaced insulation installed between the purlins. The second *rated R-value of insulation* represents unfaced insulation installed above the first layer, perpendicular to the purlins and compressed when the metal *roof* panels are attached. A supporting structure retains the bottom of the first layer at the prescribed depth required for the full thickness of insulation. A minimum R-5 thermal spacer block between the purlins and the metal *roof* panels is required unless compliance is shown by the overall assembly *U-factor*.	ANSI/ASHRAE/IESNA 90.1-2019
	WALLS	
Single-Layer Compressed	The first rated *R*-value of insulation is for insulation compressed between metal building wall panels and the steel structure.	ANSI/ASHRAE/IESNA 90.1-2019
Continuous Insulation	For assemblies with continuous insulation, the continuous	ANSI/ASHRAE/IESNA

	insulation is installed on the outside or inside of the girts, uncompressed and uninterrupted by the framing members.	90.1-2019
Single-Layer in Cavity	The insulation is installed in the cavity between the girts, not compressed by the framing. A membrane or facing, installed separately or adhered to the insulation, is installed inside of the girts to form a continuous layer. A thermal spacer block or thermal break strip between the girts and metal wall panels is required when specified in Table A3.2.3.	ANSI/ASHRAE/IESNA 90.1-2019
Double-Layer	The first rated R-value of insulation is for insulation installed in the cavity between the girts, not compressed by the framing. The second rated R-value of insulation is for insulation compressed between metal wall panels and the steel structure. A membrane or facing, installed separately or adhered to the insulation, is installed inside of the girts to form a continuous layer. A thermal spacer block or thermal break strip between the girts and metal wall panels is required when specified in Table A3.2.3.	ANSI/ASHRAE/IESNA 90.1-2019

delete **TABLE C402.1(3)** *and replace* **TABLE C402.1(5)**

TABLE C402.1(5)
ASSEMBLY *U*-FACTORS FOR METAL BUILDING ROOFS

INSULATION SYSTEM	RATED *R*-VALUE OF INSULATION	OVERALL *U*-FACTOR FOR ENTIRE BASE ROOF ASSEMBLY	OVERALL U-FACTOR FOR ASSEMBLY OF BASE ROOF PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)					
			Rated *R*-Value of Continuous Insulation					
Standing Seam Roofs with Thermal Spacer Blocks[a]			R-15.8	R-19	R-22.1	R-25	R-32	R-38
Single layer[b]	None	1.280					00.031	0.026
	R-10	0.115		0.036	0.032	0.030	0.025	0.021
	R-11	0.107		0.035	0.032	0.029	0.024	0.021
	R-13	0.101		0.035	0.031	0.029	0.024	0.021
	R-16	0.096		0.034	0.031	0.028	0.024	0.021
	R-19	0.082	0.036	0.032	0.029	0.027	0.023	0.020
Double layer[b]	R-10 + R-10	0.088	0.037	0.033	0.030	0.028	0.023	0.020
	R-10 + R-11	0.086	0.036	0.033	0.030	0.027	0.023	0.020
	R-11 + R-11	0.085	0.036	0.033	0.030	0.027	0.023	0.020
	R-10 + R-13	0.084	0.036	0.032	0.029	0.027	0.023	0.020
	R-11 + R-13	0.082	0.036	0.032	0.029	0.027	0.023	0.020
	R-13 + R-13	0.075	0.034	0.031	0.028	0.026	0.022	0.019
	R-10 + R-19	0.074	0.034	0.031	0.028	0.026	0.022	0.019
	R-11 + R-19	0.072	0.034	0.030	0.028	0.026	0.022	0.019
	R-13 + R-19	0.068	0.033	0.030	0.027	0.025	0.021	0.019
	R-16 + R-19	0.065	0.032	0.029	0.027	0.025	0.021	0.019
	R-19 + R-19	0.060	0.031	0.028	0.026	0.024	0.021	0.018
Liner	R-19 + R-11	0.037						

system[c]	R-25 + R-8	0.037						
	R-25 + R-11	0.031						
	R-30 + R11	0.029						
	R-25 + R-11 + R-11 LS	0.026						
Filled cavity[c]	R-10 + R-19 Fc	0.041	0.025	0.023	0.022	0.020	0.018	0.016
Thru-fastened Roofs without Thermal Spacer Blocks								
	R-10	0.184			0.036	0.033	0.027	0.023
	R-11	0.182			0.036	0.033	0.027	0.023
	R-13	0.174			0.036	0.033	0.026	0.023
	R-16	0.157			0.035	0.032	0.026	0.023
	R-19	0.151			0.035	0.032	0.026	0.022

Note: (Multiple *R*-values are listed in order from inside to outside)
Shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.
a. A standing seam roof clip that provides a minimum 1.5 inch distance between the top of the purlins and the underside of the metal building roof panels is required.
b. A minimum R-3 thermal spacer block is required.
c. A minimum R-5 thermal spacer block is required.

delete **TABLE C402.1(4)** *and replace* **TABLE C402.1(6)**

TABLE C402.1(6)
ASSEMBLY *U*-FACTORS FOR ATTIC ROOFS WITH WOOD JOISTS

RATED *R*-VALUE OF INSULATION ALONE	OVERALL *U*-FACTOR FOR ENTIRE ROOF ASSEMBLY[a]
Wood-framed Attic, Standard Framing	
R-38	U-0.027
R-49	U-0.021
R-60	U-0.017
R-71	U-0.015
R-82	U-0.013
R-93	U-0.011
R-104	U-0.010
R-115	U-0.009
R-126	U-0.008
Wood-framed Attic, Advanced Framing	

R-38	U-0.026
R-49	U-0.020
R-60	U-0.016
R-71	U-0.014
R-82	U-0.012
R-93	U-0.011
R-104	U-0.010
R-115	U-0.009
R-126	U-0.008
Wood Joists, Single-Rafter Roof[b]	
R-38 + R-15ci	U-0.020

a. Lightly shaded areas comply with conditioned R-2 spaces, but not other conditioned building occupancies. Darkly shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.

b. The first *R*-value is the cavity insulation, while the second value is the continuous insulation uninterrupted by framing.

renumber **TABLE C402.1(5)** *to* **TABLE C402.1(7)**

renumber **TABLE C402.1(6)** *to* **TABLE C402.1(8)**

delete **TABLE C402.1(7)** *and replace* **TABLE C402.1(9)**

TABLE C402.1(9)
ASSEMBLY *U*-FACTORS FOR WOOD-FRAMED WALLS

RATED *R*-VALUE OF CAVITY INSULATION (EFFECTIVE INSTALLED)	OVERALL *U*-FACTOR FOR ASSEMBLY	OVERALL *U*-FACTOR FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)								
		R-6	**R-9**	**R-12**	**R-15**	**R-20**	**R-25**	**R-30**	**R-35**	**R-40**
Wood Studs at 16 in. on Center and 3.5 in. Depth										
R-0 (0.0)	0.292					0.042	0.035	0.030	0.026	0.023
R-11 (11.0)	0.096		0.050	0.044	0.038	0.032	0.028	0.024	0.022	0.020
R-13 (13.0)	0.089		0.047	0.041	0.037	0.031	0.027	0.024	0.021	0.019
R-15 (15.0)	0.083		0.045	0.039	0.035	0.030	0.026	0.023	0.020	0.019
Wood Studs at 16 in. on Center and 5.5 in. Depth										
R-19 (18.0)	0.067	0.046	0.040	0.036	0.032	0.027	0.024	0.021	0.019	0.018
R-21 (21.0)	0.063	0.043	0.038	0.034	0.030	0.026	0.023	0.021	0.019	0.017
Wood Studs at 16 in. on Center and R-10 Headers										
R-19 (18.0)	0.063	0.045	0.039	0.035	0.031	0.027	0.024	0.021	0.019	0.017
R-21 (21.0)	0.059	0.042	0.037	0.033	0.030	0.026	0.023	0.020	0.018	0.017

Wood Studs at 24 in. on Center and 3.5 in. Depth										
R-0 (0.0)	0.298					0.042	0.035	0.030	0.026	0.023
R-11 (11.0)	0.094		0.050	0.043	0.038	0.032	0.027	0.024	0.022	0.019
R-13 (13.0)	0.086		0.047	0.041	0.036	0.031	0.026	0.023	0.021	0.019
R-15 (15.0)	0.080		0.044	0.039	0.035	0.029	0.026	0.023	0.020	0.018
Wood Studs at 24 in. on Center and 5.5 in. Depth										
R-19 (18.0)	0.065	0.045	0.039	0.035	0.032	0.027	0.024	0.021	0.019	0.018
R-21 (21.0)	0.060	0.042	0.037	0.033	0.030	0.026	0.023	0.020	0.018	0.017
Wood Studs at 24 in. on Center and R-10 Headers										
R-19 (18.0)	0.062	0.044	0.039	0.034	0.031	0.027	0.024	0.021	0.019	0.017
R-21 (21.0)	0.057	0.041	0.036	0.032	0.029	0.025	0.023	0.020	0.018	0.017

Note: Lightly shaded areas comply with building occupancies other than conditioned R-2 spaces. Darkly shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces .

delete and replace **C402.1.1 Insulation component *R*-value-based method.**
Building thermal envelope opaque assemblies shall comply with the requirements of Sections C402.2 and C402.3. For opaque portions of the *building thermal envelope* intended to comply on an insulation component *R-value* basis, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in the "Minimum R-values" columns of Table C402.1(2) and Table C402.1(3). Where cavity insulation is installed in multiple layers, the cavity insulation R-values shall be summed to determine compliance with the cavity insulation R-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation R-values shall be summed to determine compliance with the continuous insulation R-value requirements. Cavity insulation R-values shall not be used to determine compliance with the continuous insulation R-value requirements in Table C402.1(2) and Table C402.1(3). Commercial buildings or portions of commercial buildings enclosing *conditioned spaces* shall use the *R*-values from the "Conditioned Space" ~~column of~~ Table C402.1(~~1~~2). Commercial buildings or portions of commercial buildings enclosing semi-conditioned spaces shall use the *R*-values from the "Semi-conditioned Space" ~~column of~~ Table C402.1(~~1~~3). Walls between conditioned and semi-conditioned spaces shall use the *R*-values from the "Semi-conditioned Space" ~~column of~~ Table C402.1(~~1~~3).

~~- add -~~
delete and replace **C402.1.2 Assembly *U*-factor, *C*-factor or *F*-factor-based method.**
Building thermal envelope opaque assemblies shall meet the requirements of Sections C402.2 and C402.3. Building thermal envelope opaque assemblies intended to comply on an assembly *U*-, *C*- or *F*-factor basis shall have a *U*-, *C*- or *F*-factor not greater than that specified in the "Maximum Overall *U*-factor" columns of Table C402.1(2) and Table C402.1(3). Commercial buildings or portions of commercial buildings enclosing *conditioned spaces* shall use the *U*-, *C*- or *F*-factor from the "*Conditioned Space*" ~~column of~~ Table C402.1(~~1~~2). Commercial buildings or portions of commercial buildings enclosing semi-conditioned spaces shall use the *U*-, *C*- or *F*-factor from the "Semi-conditioned Space" ~~column of~~ Table C402.1(~~1~~3). Walls between conditioned and semi-conditioned spaces shall use the *R*-values from the "Semi-conditioned

Space" ~~column of~~ Table C402.1(~~1).~~3).

~~- *delete* – **TABLE**~~ add **C402.1.**~~**3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD**~~

~~- delete - **TABLE C402.1.4 OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD**~~

~~- *add* – **Table C402.1 (1) BUILDING ENVELOPE REQUIREMENTS—OPAQUE ASSEMBLIES AND ELEMENTS**~~

~~**TABLE C402.1(1)**~~

~~**BUILDING ENVELOPE REQUIREMENTS—OPAQUE ASSEMBLIES AND ELEMENTS[a,b]**~~

~~**COMPONENT**~~	~~**MAXIMUM OVERALL *U*-FACTOR[a]**~~		~~**MINIMUM *R*-VALUES**~~	
	~~**Conditioned Space**~~	~~**Semi-conditioned Space**~~	~~**Conditioned Space**~~	~~**Semi-conditioned Space**~~
~~**Roofs**~~				
~~Insulation entirely above deck~~	~~U-0.025~~	~~U-0.039~~	~~R-40ci~~	~~R-25ci~~
~~Metal buildings[a]~~	~~U-0.026~~	~~U-0.037~~	~~R-25+R-11+R-11 LS~~	~~R-19 + R-11 LS or R-25 + R-8 LS~~
~~Attic and Other~~	~~U-0.021~~	~~U-0.034~~	~~R-49~~	~~R-30~~
~~**Walls, Above grade**~~				
~~Mass~~	~~U-0.048~~	~~U-0.104~~	~~R-19ci~~	~~R-9.5ci~~
~~Metal building[a]~~	~~U-0.044~~	~~U-0.060~~	~~R-13 + R-17ci or R-22.1ci~~	~~R-15.8ci~~
~~Metal-framed~~	~~U-0.044~~	~~U-0.064~~	~~R-13 + R-15ci or R-20ci~~	~~R-13 + R-7.5ci~~
~~Wood-framed and other~~	~~U-0.042~~	~~U-0.064~~	~~R-13 + R-12ci or R-19 + R-8ci or R-20ci~~	~~R-13 + R-3.8ci~~
~~**Walls, Below Grade[c]**~~				
~~Below-grade wall~~	~~C-0.063~~	~~C-0.119~~	~~R-15ci~~	~~R-7.5ci~~
~~**Floors**~~				
~~Mass[d]~~	~~U-0.051~~	~~U-0.087~~	~~R-16.7ci~~	~~R-8.3ci~~
~~Joist/Framing—Metal~~	~~U-0.032~~	~~U-0.052~~	~~R-38~~	~~R-19~~
~~Joist/Framing—Wood and Other~~	~~U-0.033~~	~~U-0.051~~	~~R-30~~	~~R-19~~
~~**Slab-on-Grade Floors**~~				
~~Unheated slabs~~	~~F-0.36~~	~~F-0.54~~	~~R-10 for entire slab and around perimeter~~	~~R-10 for 24 in.~~
~~Heated slabs[e]~~	~~F-0.373~~	~~F-0.55~~	~~R-20 for entire slab and around perimeter~~	~~R-10 for entire slab and around perimeter~~
~~**Opaque Doors**~~				
~~Swinging~~	~~U-0.37~~		~~N/A~~	

~~Non-Swinging~~	~~N/A~~	~~R-4.75~~
~~Upward-acting, Sectional~~	~~N/A~~	~~R-10~~
~~Garage door <14% glazing~~	~~U-0.31~~	~~N/A~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.~~
~~ci = Continuous insulation, NR = No Requirement, LS = Liner System.~~

~~a. For all envelope categories the use of opaque~~**2.1 Roof/ceiling** **assembly** ~~U-factors, C-factors, and F-factors from ANSI/ ASHRAE/IESNA 90.1-2016 Appendix A shall be permitted, provided the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/IESNA 90.1-2016 Appendix A. Alternatively,~~**.**

The maximum, roof/ceiling assembly U-factor shall not exceed that specified in Table C402.1(2) and Table C402.1(~~2) for metal building assembly descriptions, Table C402.1(3) for metal building roof assembly U-factors, Table 402.1(4) for attic roofs with wood joists U-factors, Table 402.1(5) for metal building wall assembly U-factors, Table 402.1(6) for metal-framed wall assembly U-factors, and Table 402.1(7) for wood-framed wall assembly U-factors may be used in lieu of ANSI/ASHRAE/IESNA 90.1-2016 Appendix A.~~

~~b. Opaque assembly *U*-factors~~3) based on ~~designs tested in accordance with ASTM C1363 shall be permitted. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design~~construction materials used in the roof/ceiling assembly.

~~c. Where heated slabs are below grade, below-grade walls shall comply with the *F*-factor requirements for heated slabs.~~

~~d. "Mass floors" shall include floors weighing not less than:~~

~~1. 35 pounds per square foot of floor surface area; or~~

~~2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.~~

~~e. Evidence of compliance with the F-factors indicated in the table for heated slabs shall be demonstrated by the application of the unheated slab *F*-factors and *R*-values derived from ASHRAE 90.1-2016 Appendix A.~~

~~- *add* - **TABLE C402.1(2) BUILDING ENVELOPE REQUIREMENTS—METAL BUILDING ASSEMBLY DESCRIPTIONS**~~

~~TABLE C402.1(2)~~
~~BUILDING ENVELOPE REQUIREMENTS—METAL BUILDING ASSEMBLY DESCRIPTIONS~~

~~**BUILDING ENVELOPE REQUIREMENTS—METAL BUILDING ASSEMBLY DESCRIPTIONS**~~	~~**DESCRIPTION**~~	~~**REFERENCE**~~
	~~**ROOFS**~~	
~~Liner system~~	~~A continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. For multilayer installations, the last rated R-Value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached. A minimum R-5 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly U-factor.~~	~~ANSI/ASHRAE/IESNA 90.1-2016~~
~~Filled Cavity (Fc)~~	~~The first *rated R-value of insulation* represents faced or unfaced insulation installed between the purlins. The second *rated R-value of insulation* represents unfaced insulation installed above the first layer, perpendicular to the purlins and compressed when the metal *roof* panels are attached. A supporting structure retains the bottom of the first layer at the prescribed depth required for the full thickness of insulation. A minimum R-5 thermal spacer block between the purlins and the metal *roof* panels is required unless compliance is shown by the overall assembly *U-factor*.~~	~~ANSI/ASHRAE/IESNA 90.1-2016~~
	~~**WALLS**~~	
~~R-13 + R-17ci~~	~~The first rated *R*-value of insulation is for insulation compressed between metal building wall panels and the steel structure.~~ ~~The second rated *R*-value is for continuous insulation (e.g., insulation boards). It is assumed that the insulation boards are installed on the inside of the girts and uninterrupted by the framing members.~~ ~~Insulation exposed to the conditioned space or semi-heated space shall have a facing, and all insulation seams shall be continuously sealed to pro- vide a continuous air barrier.~~	~~ANSI/ASHRAE/IESNA 90.1-2016~~
~~R-22.1ci~~	~~The rated *R*-value is for continuous insulation (e.g., insulation boards). It is assumed that the insulation boards are installed on the inside of the girts and uninterrupted by the framing members.~~ ~~Insulation exposed to the conditioned space or semi-heated space shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.~~	~~ANSI/ASHRAE/IESNA 90.1-2016~~

~~- *add* - TABLE C402.1(3) ASSEMBLY U-FACTORS FOR METAL BUILDING ROOFS~~

~~TABLE C402.1(3)~~
~~ASSEMBLY *U*-FACTORS FOR METAL BUILDING ROOFS~~

~~INSULATION SYSTEM~~	~~RATED *R*-VALUE OF INSULATION~~	~~OVERALL *U*-FACTOR FOR ENTIRE BASE ROOF ASSEMBLY~~	~~OVERALL *U*-FACTOR FOR ASSEMBLY OF BASE ROOF PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)~~					
			~~Rated *R*-Value of Continuous Insulation~~					
~~Standing Seam Roofs with Thermal Spacer Blocks[a]~~			~~R-15.8~~	~~R-19~~	~~R-22.1~~	~~R-25~~	~~R-32~~	~~R-38~~
~~Single layer[b]~~	~~None~~	~~1.280~~					~~0.031~~	~~0.026~~
	~~R-10~~	~~0.115~~		~~0.036~~	~~0.032~~	~~0.030~~	~~0.025~~	~~0.021~~
	~~R-11~~	~~0.107~~		~~0.035~~	~~0.032~~	~~0.029~~	~~0.024~~	~~0.021~~
	~~R-13~~	~~0.101~~		~~0.035~~	~~0.031~~	~~0.029~~	~~0.024~~	~~0.021~~
	~~R-16~~	~~0.096~~		~~0.034~~	~~0.031~~	~~0.028~~	~~0.024~~	~~0.021~~
	~~R-19~~	~~0.082~~	~~0.036~~	~~0.032~~	~~0.029~~	~~0.027~~	~~0.023~~	~~0.020~~
~~Double layer[b]~~	~~R-10 + R-10~~	~~0.088~~	~~0.037~~	~~0.033~~	~~0.030~~	~~0.028~~	~~0.023~~	~~0.020~~
	~~R-10 + R-11~~	~~0.086~~	~~0.036~~	~~0.033~~	~~0.030~~	~~0.027~~	~~0.023~~	~~0.020~~
	~~R-11 + R-11~~	~~0.085~~	~~0.036~~	~~0.033~~	~~0.030~~	~~0.027~~	~~0.023~~	~~0.020~~
	~~R-10 + R-13~~	~~0.084~~	~~0.036~~	~~0.032~~	~~0.029~~	~~0.027~~	~~0.023~~	~~0.020~~
	~~R-11 + R-13~~	~~0.082~~	~~0.036~~	~~0.032~~	~~0.029~~	~~0.027~~	~~0.023~~	~~0.020~~
	~~R-13 + R-13~~	~~0.075~~	~~0.034~~	~~0.031~~	~~0.028~~	~~0.026~~	~~0.022~~	~~0.019~~
	~~R-10 + R-19~~	~~0.074~~	~~0.034~~	~~0.031~~	~~0.028~~	~~0.026~~	~~0.022~~	~~0.019~~
	~~R-11 + R-19~~	~~0.072~~	~~0.034~~	~~0.030~~	~~0.028~~	~~0.026~~	~~0.022~~	~~0.019~~
	~~R-13 + R-19~~	~~0.068~~	~~0.033~~	~~0.030~~	~~0.027~~	~~0.025~~	~~0.021~~	~~0.019~~
	~~R-16 + R-19~~	~~0.065~~	~~0.032~~	~~0.029~~	~~0.027~~	~~0.025~~	~~0.021~~	~~0.019~~
	~~R-19 + R-19~~	~~0.060~~	~~0.031~~	~~0.028~~	~~0.026~~	~~0.024~~	~~0.021~~	~~0.018~~
~~Liner system[c]~~	~~R-25+R-11+R-11 LS~~	~~0.026~~						
~~Filled cavity[c]~~	~~R-10 + R-19 Fc~~	~~0.041~~	~~0.025~~	~~0.023~~	~~0.022~~	~~0.020~~	~~0.018~~	~~0.016~~
~~Thru-fastened Roofs without Thermal Spacer Blocks~~								
	~~R-10~~	~~0.184~~			~~0.036~~	~~0.033~~	~~0.027~~	~~0.023~~
	~~R-11~~	~~0.182~~			~~0.036~~	~~0.033~~	~~0.027~~	~~0.023~~
	~~R-13~~	~~0.174~~			~~0.036~~	~~0.033~~	~~0.026~~	~~0.023~~
	~~R-16~~	~~0.157~~			~~0.035~~	~~0.032~~	~~0.026~~	~~0.023~~
	~~R-19~~	~~0.151~~			~~0.035~~	~~0.032~~	~~0.026~~	~~0.022~~
~~(Multiple *R*-values are listed in order from inside to outside)~~ ~~Shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.~~								

a. ~~A standing seam roof clip that provides a minimum 1.5 inch distance between the top of the purlins and the underside of the metal building roof panels is required.~~
b. ~~A minimum R-3 thermal spacer block is required.~~
c. ~~A minimum R-5 thermal spacer block is required.~~

~~*- add -* TABLE C402.1(4) ASSEMBLY U-FACTORS FOR ATTIC ROOFS WITH WOOD JOISTS~~

~~TABLE C402.1(4)~~
~~ASSEMBLY *U*-FACTORS FOR ATTIC ROOFS WITH WOOD JOISTS~~

~~RATED R-VALUE OF INSULATION ALONE~~	~~OVERALL U-FACTOR FOR ENTIRE ROOF ASSEMBLY[a]~~
~~**Wood-Framed Attic, Standard Framing**~~	
~~R-30~~	~~U-0.034~~
~~R-38~~	~~U-0.027~~
~~R-49~~	~~U-0.021~~
~~R-60~~	~~U-0.017~~
~~R-71~~	~~U-0.015~~
~~R-82~~	~~U-0.013~~
~~R-93~~	~~U-0.011~~
~~R-104~~	~~U-0.010~~
~~R-115~~	~~U-0.009~~
~~R-126~~	~~U-0.008~~
~~**Wood-Framed Attic, Advanced Framing**~~	
~~R-30~~	~~U-0.032~~
~~R-38~~	~~U-0.026~~
~~R-49~~	~~U-0.020~~
~~R-60~~	~~U-0.016~~
~~R-71~~	~~U-0.014~~
~~R-82~~	~~U-0.012~~
~~R-93~~	~~U-0.011~~
~~R-104~~	~~U-0.010~~
~~R-115~~	~~U-0.009~~
~~R-126~~	~~U-0.008~~
~~**Wood Joists, Single-Rafter Roof[b]**~~	
~~R-30~~	~~U-0.036~~
~~R-38~~	~~U-0.029~~
~~R-38 + R-15ci~~	~~U-0.020~~

~~a. Shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.~~

~~b. The first R-value is the cavity insulation, while the second value is the continuous insulation uninterrupted by framing.~~

~~*- add -* **TABLE C402.1(5) ASSEMBLY U-FACTORS FOR METAL BUILDING WALLS**~~

~~TABLE C402.1(5)~~
~~ASSEMBLY *U*-FACTORS FOR METAL BUILDING WALLS~~

~~**RATED *R*-VALUE OF INSULATION**~~	~~**OVERALL U-FACTOR FOR BASE WALL ASSEMBLY**~~	~~**OVERALL *U*-FACTORS FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)**~~								
		~~**R-6.5**~~	~~**R-9.8**~~	~~**R-13**~~	~~**R-15.8**~~	~~**R-19**~~	~~**R-22.1**~~	~~**R-25**~~	~~**R-32**~~	~~**R-38**~~
~~**Continuous Insulation Only**~~										
~~R-0~~	~~1.180~~				~~0.060~~	~~0.050~~	~~0.044~~	~~0.039~~	~~0.030~~	~~0.026~~
~~**Single Compressed Layer**~~										
~~R-10~~	~~0.186~~			~~0.054~~	~~0.047~~	~~0.041~~	~~0.036~~	~~0.033~~	~~0.027~~	~~0.023~~
~~R-11~~	~~0.185~~			~~0.054~~	~~0.047~~	~~0.041~~	~~0.036~~	~~0.033~~	~~0.027~~	~~0.023~~
~~R-13~~	~~0.162~~			~~0.052~~	~~0.046~~	~~0.040~~	~~0.035~~	~~0.032~~	~~0.026~~	~~0.023~~
~~R-16~~	~~0.155~~			~~0.051~~	~~0.045~~	~~0.039~~	~~0.035~~	~~0.032~~	~~0.026~~	~~0.022~~
~~R-19~~	~~0.147~~		~~0.060~~	~~0.050~~	~~0.044~~	~~0.039~~	~~0.035~~	~~0.031~~	~~0.026~~	~~0.022~~
~~**Single Layer in Cavity**~~										
~~R-25[a]~~	~~0.059~~	~~0.044~~	~~0.039~~	~~0.035~~	~~0.032~~	~~0.029~~	~~0.027~~	~~0.025~~	~~0.021~~	~~0.019~~
~~R-30[b]~~	~~0.052~~	~~0.042~~	~~0.037~~	~~0.033~~	~~0.031~~	~~0.028~~	~~0.026~~	~~0.024~~	~~0.021~~	~~0.019~~
~~**Double Layer**~~										
~~R-25 + R-10~~	~~0.047~~									
~~R-25 + R-16~~	~~0.042~~									
~~R-25 + R-10[c]~~	~~0.039~~									
~~R-30 + R-16~~	~~0.039~~									
~~Shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.~~										

~~a. A minimum R-0.375 thermal spacer block or thermal break strip is required when installed without continuous insulation.~~

~~b. A minimum R-0.75 thermal spacer block or thermal break strip is required when installed without continuous insulation.~~

~~c. A minimum R-3 thermal spacer block is required.~~

~~- *add* - **TABLE C402.1(6) ASSEMBLY U-FACTORS FOR METAL-FRAMED WALLS**~~

~~TABLE C402.1(6)
ASSEMBLY *U*-FACTORS FOR METAL-FRAMED WALLS~~

RATED *R*-VALUE OF CAVITY INSULATION (EFFECTIVE INSTALLED)	OVERALL U-FACTOR FOR BASE WALL ASSEMBLY	OVERALL *U*-FACTORS FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)								
		R-12	R-13	R-14	R-15	R-20	R-25	R-30	R-35	R-40
Steel Framing at 16 in. on Center and 3.5 in. Depth										
R-0 (0.0)	0.352		0.063	0.059	0.056	0.044	0.036	0.030	0.026	0.023
R-11 (5.5)	0.132	0.051	0.049	0.046	0.044	0.036	0.031	0.027	0.024	0.021
R-13 (6.0)	0.124	0.050	0.048	0.045	0.043	0.036	0.030	0.026	0.023	0.021
R-15 (6.4)	0.118	0.049	0.047	0.045	0.043	0.035	0.030	0.026	0.023	0.021
Steel Framing at 16 in. on Center and 6.0 in. Depth										
R-19 (7.1)	0.109	0.047	0.045	0.043	0.041	0.034	0.029	0.026	0.023	0.020
R-21 (7.4)	0.106	0.047	0.045	0.043	0.041	0.034	0.029	0.025	0.022	0.020
Steel Framing at 24 in. on Center and 3.5 in. Depth										
R-0 (0.0)	0.338		0.063	0.059	0.056	0.044	0.036	0.030	0.026	0.023
R-11 (6.6)	0.116	0.048	0.046	0.044	0.042	0.035	0.030	0.026	0.023	0.021
R-13 (7.2)	0.108	0.047	0.045	0.043	0.041	0.034	0.029	0.025	0.023	0.020
R-15 (7.8)	0.102	0.046	0.044	0.042	0.040	0.034	0.029	0.025	0.022	0.020
Steel Framing at 24 in. on Center and 6.0 in. Depth										
R-19 (8.6)	0.094	0.044	0.042	0.041	0.039	0.033	0.028	0.025	0.022	0.020
R-21 (9.0)	0.090	0.043	0.042	0.040	0.038	0.032	0.028	0.024	0.022	0.020
Shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.										

~~*- add -* **TABLE C402.1(7) ASSEMBLY U-FACTORS FOR WOOD-FRAMED WALLS**~~

~~TABLE C402.1(7)~~
~~ASSEMBLY *U*-FACTORS FOR WOOD-FRAMED WALLS~~

~~RATED *R*-VALUE OF CAVITY INSULATION (EFFECTIVE INSTALLED)~~	~~OVERALL U-FACTOR FOR BASE WALL ASSEMBLY~~	~~OVERALL *U*-FACTORS FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)~~								
		~~R-6~~	~~R-9~~	~~R-12~~	~~R-15~~	~~R-20~~	~~R-25~~	~~R-30~~	~~R-35~~	~~R-40~~
~~**Wood Studs at 16 in. on Center and 3.5 in. Depth**~~										
~~R-0 (0.0)~~	~~0.292~~			~~0.064~~	~~0.053~~	~~0.042~~	~~0.035~~	~~0.030~~	~~0.026~~	~~0.023~~
~~R-11 (11.0)~~	~~0.096~~	~~0.059~~	~~0.050~~	~~0.044~~	~~0.038~~	~~0.032~~	~~0.028~~	~~0.024~~	~~0.022~~	~~0.020~~
~~R-13 (13.0)~~	~~0.089~~	~~0.056~~	~~0.047~~	~~0.041~~	~~0.037~~	~~0.031~~	~~0.027~~	~~0.024~~	~~0.021~~	~~0.019~~
~~R-15 (15.0)~~	~~0.083~~	~~0.053~~	~~0.045~~	~~0.039~~	~~0.035~~	~~0.030~~	~~0.026~~	~~0.023~~	~~0.020~~	~~0.019~~
~~**Wood Studs at 16 in. on Center and 5.5 in. Depth**~~										
~~R-19 (18.0)~~	~~0.067~~	~~0.046~~	~~0.040~~	~~0.036~~	~~0.032~~	~~0.027~~	~~0.024~~	~~0.021~~	~~0.019~~	~~0.018~~
~~R-21 (21.0)~~	~~0.063~~	~~0.043~~	~~0.038~~	~~0.034~~	~~0.030~~	~~0.026~~	~~0.023~~	~~0.021~~	~~0.019~~	~~0.017~~
~~**Wood Studs at 16 in. on Center and R-10 Headers**~~										
~~R-19 (18.0)~~	~~0.063~~	~~0.045~~	~~0.039~~	~~0.035~~	~~0.031~~	~~0.027~~	~~0.024~~	~~0.021~~	~~0.019~~	~~0.017~~
~~R-21 (21.0)~~	~~0.059~~	~~0.042~~	~~0.037~~	~~0.033~~	~~0.030~~	~~0.026~~	~~0.023~~	~~0.020~~	~~0.018~~	~~0.017~~
~~**Wood Studs at 24 in. on Center and 3.5 in. Depth**~~										
~~R-0 (0.0)~~	~~0.298~~			~~0.064~~	~~0.054~~	~~0.042~~	~~0.035~~	~~0.030~~	~~0.026~~	~~0.023~~
~~R-11 (11.0)~~	~~0.094~~	~~0.059~~	~~0.050~~	~~0.043~~	~~0.038~~	~~0.032~~	~~0.027~~	~~0.024~~	~~0.022~~	~~0.019~~
~~R-13 (13.0)~~	~~0.086~~	~~0.055~~	~~0.047~~	~~0.041~~	~~0.036~~	~~0.031~~	~~0.026~~	~~0.023~~	~~0.021~~	~~0.019~~
~~R-15 (15.0)~~	~~0.080~~	~~0.052~~	~~0.044~~	~~0.039~~	~~0.035~~	~~0.029~~	~~0.026~~	~~0.023~~	~~0.020~~	~~0.018~~
~~**Wood Studs at 24 in. on Center and 5.5 in. Depth**~~										
~~R-19 (18.0)~~	~~0.065~~	~~0.045~~	~~0.039~~	~~0.035~~	~~0.032~~	~~0.027~~	~~0.024~~	~~0.021~~	~~0.019~~	~~0.018~~
~~R-21 (21.0)~~	~~0.060~~	~~0.042~~	~~0.037~~	~~0.033~~	~~0.030~~	~~0.026~~	~~0.023~~	~~0.020~~	~~0.018~~	~~0.017~~
~~**Wood Studs at 24 in. on Center and R-10 Headers**~~										
~~R-19 (18.0)~~	~~0.062~~	~~0.044~~	~~0.039~~	~~0.034~~	~~0.031~~	~~0.027~~	~~0.024~~	~~0.021~~	~~0.019~~	~~0.017~~
~~R-21 (21.0)~~	~~0.057~~	~~0.041~~	~~0.036~~	~~0.032~~	~~0.029~~	~~0.025~~	~~0.023~~	~~0.020~~	~~0.018~~	~~0.017~~
~~Shaded areas comply with minimum requirements for semi-conditioned spaces but not conditioned spaces.~~										

~~*- delete -* **C402.1.4.1 Thermal resistance of cold-formed steel walls.**~~

~~*- delete -* **TABLE C402.1.4.1 EFFECTIVE R-VALUES FOR STEEL STUD WALL ASSEMBLIES**~~

~~*- delete -* **C402.1.5 Component performance alternative.**~~

~~*- add -*~~

add **C402.1.2.1.1 Tapered, above-deck insulation based on thickness.**
Where used as a component of a maximum roof/ceiling assembly U-factor calculation, the sloped roof insulation R-value contribution to that calculation shall use the average thickness in inches (mm) along with the material R-value-per-inch (per-mm) solely for U-factor compliance as prescribed in Section C402.1.1.

add **C402.1.2.1.2 Suspended ceilings.**
Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly U-factor of the roof/ceiling construction.

add **C402.1.2.1.3 Joints staggered.**
Continuous insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

delete and replace **C402.1.3 Component performance alternative.**
Building envelope values and fenestration areas determined in accordance with Equation 4-1 shall be an alternative to compliance with the *U-, F-* and *C*-factors in Tables C402.1(~~1~~2) and Table C402.1(3) and C402.3 and the maximum allowable fenestration areas in Section C402.3.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.3.3.

A + B + C + D + E ~~≤~~≤ Zero **(Equation 4-1)**

where:

A	=	Sum of the (UA Dif) values for each distinct assembly type of the building thermal envelope, other than slabs on grade and below-grade walls.
UA Dif	=	UA Proposed - UA Table.
UA Proposed	=	Proposed *U*-value × Area.
UA Table	=	(*U*-factor from Table C402.1(2) and Table C402.1(3) or C402.3) × Area.
B	=	Sum of the (FL Dif) values for each distinct slab on-grade perimeter condition of the building thermal envelope.
FL Dif	=	FL Proposed - FL Table.
FL Proposed	=	Proposed *F*-value × Perimeter length.
FL Table	=	~~(~~[*F*-factor specified in Table C402.1(2) and Table C402.1~~))~~(3)] × Perimeter length.
C	=	Sum of the (CA Dif) values for each distinct below-grade wall assembly type of the building thermal envelope.
CA Dif	=	CA Proposed - CA Table.
CA Proposed	=	Proposed *C*-value × Area.
CA Table	=	~~(~~[Maximum allowable *C*-factor specified in Table C402.1(2) and Table C402.1~~))~~(3)] × Area.

Where the proposed vertical glazing area is less than or equal to the maximum vertical glazing area allowed by Section C402.3.1, the value of D (Excess Vertical Glazing Value) shall be zero. Otherwise:

D	=	(DA × UV) - (DA × U Wall), but not less than zero.
DA	=	(Proposed Vertical Glazing Area) - (Vertical Glazing Area allowed by Section C402.3.1).
UA Wall	=	Sum of the (UA Proposed) values for each opaque assembly of the exterior wall.
U Wall	=	Area-weighted average *U*-value of all above-grade wall assemblies.
UAV	=	Sum of the (UA Proposed) values for each vertical glazing assembly.
UV	=	UAV/total vertical glazing area.

Where the proposed skylight area is less than or equal to the skylight area allowed by Section C402.3.1, the value of E (Excess Skylight Value) shall be zero. Otherwise:

E	=	(EA × US) - (EA × U Roof), but not less than zero.
EA	=	(Proposed Skylight Area) - (Allowable Skylight Area as specified in Section C402.3.1).
U Roof	=	Area-weighted average *U*-value of all roof assemblies.
UAS	=	Sum of the (UA Proposed) values for each skylight assembly.
US	=	UAS/total skylight area.

~~*add*~~ *delete and replace* **C402.1.4 Building above-grade performance alternative.** Above-grade building envelope values determined in accordance with Equation 4-2 shall be an alternative to compliance with the *U*-factors in Tables C402.1(~~1~~2) and Table C402.1(3) and C402.3 and the maximum allowable fenestration areas in Section C402.3.1. Below-grade walls, floors, and slabs shall meet the applicable requirements of Section C402.1.1 or C402.1.2. *Fenestration* shall meet the applicable SHGC requirements of Section C402.3.3.

UA-Total ~~/~~ /Area ~~≤~~ ≤ 0.~~035~~032 **(Equation 4-2)**

where:

UA-Total	=	Sum of the (UA) values for each distinct above-grade assembly type of the building thermal envelope including above-grade walls, roofs, doors, vertical fenestration, and skylights.
UA	=	Proposed *U*-value × Area.
Area	=	Surface area in square feet of the above-grade thermal barrier (above-grade wall area plus roof area).

delete and replace **C402.2 Specific building thermal envelope insulation requirements ~~(Prescriptive).~~.**
Insulation in building thermal envelope opaque assemblies shall comply with Sections C402.2.1 through C402.2.8 and Table C402.1(~~1).~~2) and Table C402.1(3).

delete and replace **C402.2.1 Roof assembly.**
The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1(2) and Table C402.1(3), based on construction materials used in the roof assembly. ~~Insulation installed on a suspended ceiling having removable ceiling tiles shall not be considered as part of the minimum thermal resistance of the roof insulation. Continuous insulation board shall be installed in not less than 2 layers and the edge joints between each layer of insulation shall be staggered. Mechanical curbs shall be insulated to R-12.~~

~~**Exceptions:**~~

~~1. Continuously insulated roof assemblies where the R-value is at least R-12 over the entire roof assembly and where the average, area-weighted R-value is equivalent to the *R*-value specified in Table C402.1(1).~~

~~2. A~~*add* **C402.2.1.1 Tapered, above-deck insulation based on thickness.** Where used as a component of a roof/ceiling assembly R-value calculation, the sloped roof insulation R-value contribution to that calculation shall use the average thickness in inches (mm) along with the material R-value-per-inch (per-mm) solely for R-value compliance as prescribed in Section 402.1.3.

add **C402.2.1.2 Minimum insulation, lowest point.** The minimum insulation of ~~60%~~abovedeck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than R-12.

add **C402.2.1.3 Suspended ceilings.** Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the ~~required R-~~minimum thermal resistance (R-value~~ from Table C402.1(1) must be maintained~~) of roof insulation in ~~area~~roof/ceiling construction.

add **C402.2.1.4 Joints staggered.** Continuous insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where ~~the roof~~ insulation tapers~~, such as~~ to the roof deck at a gutter edge, roof ~~drains~~drain or scupper.

~~*- delete and replace -* **C402.2.1.1**~~*add* **C402.2.1.5 Mechanical curbs.** The minimum insulation of abovedeck roof insulation at the location of a mechanical curb, shall be not less than R-12.

add **C402.2.1.6 Skylight curbs.**
Skylight curbs shall be insulated to the level of roofs with insulation entirely above the deck or R-10, whichever is less.

> **Exception:** Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

~~-~~*delete and replace*~~-~~ **C402.2.2 Above-grade walls.**
The minimum thermal resistance (*R*-value) of materials installed in the wall cavity between framing members and continuously on the walls shall be as specified in Table C402.1(2) and Table C402.1(3), based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1(~~1~~2) and Table C402.1(3) except as otherwise noted in the table. In determining compliance with Table C402.1(2) and Table C402.1(3), the use of the U-factor of concrete masonry units with integral insulation shall be permitted. "Mass walls" where used as a component in the thermal envelope of a building shall comply with one of the following:

1. Weigh not less than 35 pounds per square foot (171 kg/m^2) of wall surface area.

2. Weigh not less than 25 pounds per square foot (122 kg/m^2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m^3).

3. Have a heat capacity exceeding 7 Btu/ft^2 • °F (144 kJ/m^2 • K).

4. Have a heat capacity exceeding 5 Btu/ft^2 • °F (103 kJ/m^2 • K), where the material weight is not more than 120 pcf (1900 kg/m^3).

~~-~~*delete* -*and replace* **C402.2.3 Floors**~~. *- add -* **C402.2.3 Floors**~~**.**
The thermal properties (component *R*-values or assembly *U*-, *C*- or *F*-factors) of floor assemblies over outdoor air or unconditioned space~~.~~
~~The minimum thermal resistance (R-value) of the insulating material installed either between the floor framing, continuously above the floor assembly, or continuously below the floor assembly~~ shall be as specified in Table C402.1(~~1~~2) and Table C402.1(3), based on construction materials used in the floor assembly.

~~- *delete and replace* - **C402.2.4 Slabs-on-grade perimeter**~~ Floor framing *cavity insulation*~~.~~
~~Where the~~ or structural slab ~~on grade is in contact with the ground and~~ insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs.

"Mass floors" where used as a component of the thermal envelope of a building shall provide one of the following weights:

1. 35 pounds per square foot (171 kg/m^2) of floor surface area.

2. 25 pounds per square foot (122 kg/m^2) of floor surface area where the material weight is not ~~required for the entire~~more than 120 pounds per cubic foot. (1923 kg/m^3)

Exceptions:

1. The floor framing *cavity insulation* or structural slab~~,~~ insulation shall be permitted to be in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies where combined with insulation that meets or

exceeds the minimum *U*-value in Table C402.1(2) and Table C402.1(3) for "Metal framed" or "Wood framed and other" values for "Walls, Above Grade" and extends from the bottom to the top of all perimeter floor framing or floor assembly members.

2. Insulation applied to the underside of concrete floor slabs shall be permitted an airspace of not more than 1 inch (25 mm) where it turns up and is in contact with the underside of the floor under walls associated with the *building thermal envelope.*

delete and replace **C402.2.4 Slabs-on-grade.**
The minimum thermal resistance (*R*-value) of the insulation ~~around the perimeter of~~for unheated or heated slab-on-grade floors designed in accordance with the *R*-value method of Section C402.1.1 shall be as specified in Table C402.1(~~1).~~2) and Table C402.1(3).

add **C402.2.4.1 Insulation installation.** Where installed, the perimeter insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The perimeter insulation shall extend downward from the top of the slab for the minimum distance shown in the table~~.~~ or to the top of the footing, whichever is less, or downward to not less than the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. Insulation extending away from the building shall be protected by pavement or by not less than of 10 inches (254 mm) of soil. Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

Exception: Where the slab-on-grade floor is greater than ~~48~~24 inches (~~1224~~61 mm) below the finished exterior grade, perimeter insulation is not required.

~~-~~*delete and replace* ~~-~~**C402.2.5 Below-grade walls.**
The *C*-factor for the below-grade exterior walls shall be in accordance with Table C402.1(2) and Table C402.1(3). The *R*-value of the insulating material installed continuously within or on the below-grade exterior walls of the building envelope shall be in accordance with Table C402.1(2) and Table C402.1(3). The *C*-factor or *R*-value required shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground level, or to the level of the lowest floor of the conditioned space enclosed by the below-grade wall, whichever is less.

~~-~~*delete and replace*~~-~~ **C402.2.6 Insulation of radiant heating systems.**
Radiant heating system panels, and their associated components that are installed in interior or exterior assemblies shall be insulated to an *R*-value of not less than R-3.5 on all surfaces not facing the space being heated. *Radiant heating system* panels that are installed in the *building thermal envelope* shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the *R*-value of insulation installed in the opaque assembly in which they are installed or the assembly shall comply with Section C402.1.2.

Exception: Heated slabs on grade insulated in accordance with the "Heated slabs" row of Table ~~402~~C402.1(2) and Table C402.1~~).~~(3).

~~- *delete* - **C402.3 Roof solar reflectance and thermal emittance.**~~

~~-~~*delete and replace* **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 an unventilated cavity constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.

> **Exception:** The thermal resistance of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.

delete ~~- **TABLE C402.3 MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS**~~

~~- *delete* - **C402.4**~~ *and replace* **C402.3 Fenestration** ~~**(Prescriptive).**~~

~~- *add* - **C402.3 Fenestration (Prescriptive).**~~**.**
Fenestration shall comply with Sections C402.3.1 through C402.3.5 and Table C402.3. Daylight responsive controls shall comply with this section and Section C405.2.3.1.

~~- *add* -~~*delete and replace* **TABLE C402.3** ~~**BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS**~~

TABLE C402.3
BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

VERTICAL FENESTRATION		
***U*-factor**		
Fixed fenestration other than *storefront*	0.29	
Storefront fenestration	0.33	
Operable fenestration, R-2 *occupancy classifications*	0.~~37~~30	
Operable fenestration, *occupancy classifications* other than R-2	0.36	
Entrance doors	0.~~68~~63	
SHGC		
~~Orientation[a]~~PF	~~SEW~~Fixed	~~N~~Operable
PF < 0.2	0.~~40~~38	0.~~53~~34
0.2 ~~≤~~≤ PF < 0.5	0.~~48~~46	0.~~58~~41
PF~~≥~~ ≥ 0.5	0.~~64~~61	0.~~64~~54
SKYLIGHTS		

U-factor	0.~~48~~41
SHGC	0.38

NR = No requirement, PF = Projection factor.

~~a. "N" indicates vertical fenestration oriented within 45 degrees of true north. "SEW" indicates orientations other than "N."~~

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

~~*- modify -* **C402.4.1 Maximum area** to **C402.3.1 Maximum area**~~

~~*- delete -* **C402.4.1.1 Increased vertical fenestration area with daylight responsive controls.**~~

~~*- add -* **C402.34**~~*and replace* **C402.3.1.1 Increased vertical fenestration area with daylight responsive controls (see Section C405.2.3).**
Not more than 40 percent of the gross above-grade wall area shall be vertical fenestration, provided that all of the following requirements are met:

1. In buildings not greater than two stories above grade, not less than 50 percent of the net floor area is within a *daylight zone*.
2. In buildings three or more stories above grade, not less than 25 percent of the net floor area is within a *daylight zone*.
3. *Daylight responsive controls* ~~complying with Section C405.2.3.1~~ are installed in *daylight zones*.
4. Visible transmittance (VT) of vertical fenestration is not less than 1.1 times solar heat gain coefficient (SHGC).

   Exception: Fenestration that is outside the scope of NFRC 200 is not required to comply with Item 4.

~~***- modify -*** C402.4.1.2 Increased skylight area with daylight responsive controls **to**~~*delete and replace* **C402.3.1.2 Increased skylight area with daylight responsive controls.**

~~***- delete -*** C402.4.2 Minimum~~The skylight ~~fenestration~~area shall be not more than 6 percent of the roof area~~.~~ provided that *daylight responsive controls* are installed in *toplit daylight zones.*

~~*- add -*~~*delete and replace* **C402.3.2 Minimum skylight fenestration area.**
~~In an~~Skylights shall be provided in enclosed ~~space~~spaces greater than 2,500 square feet (232 m^2) in floor area, directly under a roof with not less than 75 percent of the ceiling area with a ceiling height greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse,

corridor, storage space, gymnasium/exercise center, convention center, automotive service area, space where manufacturing occurs, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation depot or workshop~~,~~. The total *toplit daylight zone* shall be not less than half the floor area and shall ~~provide~~comply with one of the following:

1. A minimum skylight area to *toplit daylight zone* of not less than 3 percent where all skylights have a VT of not less than 0.40, or VT_{annual} of not less than 0.26, as determined in accordance with Section C303.1.3.

2. A minimum skylight effective aperture of not less than 1 percent, determined in accordance with Equation 4-3~~.~~, of:
   2.1 Not less than 1 percent, using a skylight's VT rating; or
   2.2 Not less than 0.66 percent using a Tubular Daylighting Device's VT_{annual} rating.

$$\text{Skylight Effective Aperture} = \frac{0.85 \times \text{Skylight Area} \times \text{Skylight VT} \times \text{WF}}{\text{Toplit Zone}} \quad \textbf{(Equation 4-3)}$$

~~Skylight Effective Aperture =~~

where:

Skylight area	=	Total fenestration area of skylights.
Skylight VT	=	Area weighted average visible transmittance of skylights.
WF	=	Area weighted average well factor, where well factor is 0.9 if light well depth is less than 2 feet (610 mm), or 0.7 if light well depth is 2 feet (610 mm) or greater~~.~~, or 1.0 for Tubular Daylighting Devices with VT_{annual} ratings.
Light well depth	=	Measure vertically from the underside of the lowest point of the skylight glazing to the ceiling plane under the skylight.

Exception: Skylights above *daylight zones* of enclosed spaces are not required in:

1. Spaces where the designed *general lighting* power densities are less than 0.5 W/ft^2 (5.4 W/m^2).

2. Areas where it is documented that existing structures or natural objects block direct beam sunlight on not less than half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

3. Spaces where the *daylight zone* under rooftop monitors is greater than 50 percent of the enclosed space floor area.

- ~~4.~~ Spaces where the total area minus the area of ~~sidelight~~sidelit *daylight zones* is less than 2,500 square feet (232 m^2), and where the lighting is controlled in accordance with Section C405.2.3.

- ~~*- modify -* **C402.4.2.1 Lighting controls in toplit daylight zones** to~~Spaces designed as storm shelters complying with ICC 500.

delete and replace **C402.3.2.1 Lighting controls in toplit daylight zones.**
Daylight responsive controls shall be provided in toplit daylight *zones*.

~~*- modify -* **C402.4.2.2 Haze factor to**~~*delete and replace* **C402.3.2.2 Haze factor**

~~*- delete –* **C402.4.3 Maximum U-factor and SHGC.**~~

~~*- add -* **C402.3.3 Maximum U-factor and SHGC.**~~
~~The maximum *U*-factor~~**.**
Skylights in office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store and ~~solar heat gain coefficient (SHGC) for fenestration shall be as specified in Table C402.3.~~

~~The window projection factor~~distribution/sorting area spaces shall ~~be determined~~have a glazing material or diffuser with a haze factor greater than 90 percent when tested in accordance with ~~Equation 4-4~~ASTM D1003.

~~*PF = A/B*~~ ~~**(Equation 4-4)**~~

~~where:~~

~~*PF*~~	=	~~Projection factor (decimal).~~
~~*A*~~	=	~~Distance measured horizontally from the farthest continuous extremity of any overhang, eave or permanently attached shading device to the vertical surface of the glazing.~~
~~*B*~~	=	~~Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave or permanently attached shading device.~~

~~Where different windows or glass doors have different *PF* values, they shall each be evaluated separately.~~

~~*- delete –* **C402.4.3.1 Increased skylight SHGC.**~~

~~*- add -* **C402.3.3.1 Increased skylight SHGC.**~~
~~Skylights shall be permitted a maximum SHGC of 0.57 where located above *daylight zones* provided with *daylight responsive controls*.~~

~~-~~**Exception:** Skylights and tubular daylighting devices designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated

<ins>baffles or the geometry of skylight and light well or the use of optical diffuser components.</ins>

delete ~~– **C402.4.3.2 Increased skylight U-factor.**~~

~~*- add -* **C402.3.3.2 Increased skylight U-factor.**~~
~~Where skylights are installed above *daylight zones* provided with *daylight responsive controls*, a maximum U-factor of 0.72 shall be permitted.~~

~~*- delete –* **C402.4.3.3 Dynamic glazing.**~~

~~*- add -* **C402.3.3.3 Dynamic glazing.**~~
~~Where dynamic glazing is intended to satisfy the SHGC and VT requirements of Table C402.3, the ratio of the higher to lower labeled SHGC shall be greater than or equal to 2.4, and the *dynamic glazing* shall be automatically controlled to modulate the amount of solar gain into the space in multiple steps. Dynamic glazing shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall not be permitted.~~

> ~~**Exception:** Dynamic glazing is not required to comply with this section where both the lower~~ *and* ~~higher labeled SHGC already comply with the requirements of Table C402.3.~~

~~*- delete –* **C402.4.3.4 Area-weighted U-factor.**~~

~~*- add -* **C402.3.3.4 Area-weighted U-factor.**~~
~~An area-weighted average shall be permitted to satisfy the *U*-factor requirements for each fenestration product category listed in Table C402.3. Individual fenestration products from different fenestration product categories listed in Table C402.3 shall not be combined in calculating area-weighted average *U*-factor.~~

~~*- delete –* **C402.4.4 Daylight zones.**~~

~~*- add -* **C402.3.4 Daylight zones.**~~
~~Daylight zones referenced in Sections C402.3.1.1 through C402.3.3.2 shall comply with Sections C405.2.3.2 and C405.2.3.3, as applicable. Daylight zones shall include *toplit zones* and sidelit zones.~~

~~*- delete –* **C402.4.5 Doors.**~~

~~*- add -*~~<ins>*replace*</ins> **C402.3.5 Doors.**
Opaque swinging doors shall comply with Table C402.1(<ins>2) and Table C402.</ins>1(<ins>3</ins>). Opaque nonswinging doors shall comply with Table C402.1(~~1~~<ins>2) and Table C402.1(3</ins>). Opaque doors shall be considered as part of the gross area of above-grade walls that are part of the building *thermal envelope*. <ins>Opaque doors shall comply with Section C402.3.5.1 or C402.3.5.2.</ins> Other doors shall comply with the provisions of Section C402.3.3 for vertical fenestration.

> ~~–~~<ins>*add* **C402.3.5.1 Opaque swinging doors.** Opaque swinging doors shall comply with Table C402.1(2) and Table C402.1(3).</ins>

add **C402.3.5.2 Nonswinging doors.** Opaque nonswinging doors that are horizontally hinged sectional doors with a single row of fenestration shall have an assembly U-factor less than or equal to 0.360, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

Exception: Other doors shall comply with the provisions of Section C402.4.3 for vertical fenestration.

delete ~~–~~*and replace* **C402.~~5~~4 Air leakage—thermal envelope ~~(Mandatory).~~**

~~- *add* - **C402.4 Air leakage—thermal envelope (Mandatory).**~~**.**
The *building* *thermal envelope* ~~of buildings~~ shall comply with Sections C402.4.1 through C402.4.~~5.~~6.

~~-~~*delete* ~~– **C402.5.1 Air barriers.**~~

~~- *add* -~~*and replace* **C402.4.1 Air barriers.**
A continuous air barrier shall be provided throughout the building thermal envelope. The continuous air barriers shall be ~~permitted to be~~ located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Section C402.4.1.1.

Exceptions:

1. For buildings larger than 250,000 ft² (25,000 m²), that do not include Group R or Group I occupancies, the air barrier shall either comply with section C402.4.1.1 or Sections C402.4.1.2 through C402.4.1.8.

2. ~~- *add* -~~Where air barrier performance testing is determined unfeasible by the Vermont Department of Public Service, the air barrier shall comply with sections C402.4.1.2 through C402.4.1.8.

delete and replace **C402.4.1.1 Air barrier performance testing.**
The building *thermal envelope* shall be tested in accordance with ASTM ~~E 779 at a pressure differential of 0.3 inch water gauge (75 Pa)~~E779, ANSI/RESNET/ICC 380, ASTME3158 OR ASTM E1827 or an equivalent method approved by the ~~code official or authority having jurisdiction and deemed to comply with the provisions~~Vermont Department of ~~this section when the tested~~Public Service. The measured air leakage ~~rate~~shall not exceed 0.25 cfm/ft² of the *building thermal envelope* ~~is not greater than 0.30 cfm/ft² (including the areas of the slab and below grade walls).~~

~~**Exceptions:**~~

~~1. For buildings having over 50,000 ft2 of gross conditioned floor~~ area~~, air leakage testing shall be permitted to be conducted on less than the whole building, provided the following~~ at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building ~~are~~shall be tested and ~~their~~the measured air ~~leakage is~~ leakages shall be area - weighted by the surface areas of the building envelope~~:~~ in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. ~~a.~~ The entire ~~floor~~envelope area of all stories that have any spaces directly under a roof.

2. ~~b.~~ The entire ~~floor~~envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.

3. ~~c.~~ Representative above-grade ~~wall~~ sections of the building totaling at least 25~~%~~ percent of the wall area enclosing the remaining conditioned space~~; floor area tested per (a) and (b) shall not be included in the 25%.~~.

~~2. Where the measured air leakage rate exceeds 0.30 cfm/ft2 but does not exceed 0.40 cfm/ft2, a diagnostic evaluation, such as a smoke tracer or infrared imaging shall be conducted while the building is pressurized, and any leaks noted shall be sealed if such sealing can be made without destruction of existing building components. In addition, a visual inspection of the air barrier shall be conducted, and any leaks noted shall be sealed if such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner and shall be deemed to satisfy the requirements of this section.~~

~~*- add -* **C402.4.1.2 Continuous Air Barrier Commissioning**~~

~~Prior to the final inspection, a design professional/Agency shall provide evidence of commissioning of the continuous air barrier by an approved agency. A final commissioning report shall be delivered to the building owner or the owner's representative, and shall include at a minimum:~~

~~1. A field inspection checklist showing the requirements necessary for proper installation of the continuous air barrier.~~

~~2. Reports from field inspections during project construction showing compliance with continuous air barrier requirements including but not limited to proper material handling and storage, use of approved materials and approved substitutes, proper material and surface preparation, air barrier continuity at building thermal envelope penetrations.~~

~~*- add -* **C402.4.1.2.1 Building Envelope Commissioning Guideline**~~

~~In addition to complying with C402.4.1.2, projects shall follow all applicable items in Table C402.4.1.2.1.~~

~~*- add -* **TABLE C402.4.1.2.1 BUILDING ENVELOPE COMMISIONING CHECKLIST**~~

~~TABLE C402.4.1.2.1~~
~~BUILDING ENVELOPE COMMISIONING CHECKLIST~~

~~RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS~~	~~TASKS/COMMENTS~~
~~Foundations subsoil drainage system~~	~~Verify compliance with approved plans, specifications and construction documents.~~
~~Foundation damp-proofing and waterproofing~~	
~~Flashing at: exterior doors, skylights, wall flashing and drainage systems~~	
~~Exterior wall coverings~~	
~~Moisture envelopes~~	~~Where applicable meet owner's project requirements (OPR), Basis of Design (BOD), Cx Specifications.~~
~~Exterior below-grade walls~~	~~Check for proper drainage system at exterior wall perimeter to keep water from entering building.~~
~~External floor and soffits, slab-on grade~~	~~Check for thermal resistance or insulation when required.~~ ~~Slabs: Check drainage for moisture penetration.~~
~~Exterior walls~~	~~Check drawings for wall assembly requirements.~~
~~Exterior glazed window fenestration: windows, glazed doors and skylights~~	~~Drawing reviews and contractor submittal reviews:~~ ~~• Check that fenestration products are labeled with a U-factor (see NFRC 100) and a solar heat gain coefficient (SHGC) (see NFRC 200), and certification for the air infiltration requirement.~~ ~~• Check for proper flashing and caulking at walls and roof assemblies.~~ ~~Glazed doors:~~ ~~• Check for proper flashing, and seals and gaskets; and proper pull force, if provided with a closer.~~ ~~• Check for proper door swing.~~
~~Site-built fenestration: curtain walls and store-front systems, and atrium roof systems~~	~~Check for a label certificate issued by the National Fenestration Rating Council (NFRC) or a label certificate issued by the glazing fabricator that meets the default U-factor and SHGC; or an NFRC component modeling approach (CMA) label certificate or another approved standard.~~ ~~• Check for proper door swing.~~

~~Field-fabricated fenestrations: fenestration made at the site, not preformed or cut~~	~~Check for compliance with the default U-factor and the default SHGC.~~
~~Exterior doors~~	~~Check for proper flashing installation at header, walls and floor.~~ ~~• Check for U-factor requirements for swinging and nonswinging doors.~~ ~~• Check for appropriate manufacturer's referenced standard [American Architectural Manufacturer's Association (AAMA); Canadian Standards Association (CSA); and Window and Door Manufacturer's Association (WDMA) or other approved standard] product data sheets.~~
~~Sealants, control joints and flashing (stationary and moveable)~~	~~Check for proper installation in accordance with the manufacturer's written instructions~~
~~Shading devices~~	~~Check for proper anchoring to building with proper flashing at wall connections.~~
~~Structural systems~~	~~Check for proper anchoring in accordance with construction documents, including metal connectors and beam supports.~~

~~*- delete –* **C402.5.1.1 Air barrier construction.**~~

~~*- add -* **C402.4.1.3 Air barrier construction.**~~
~~The *continuous air barrier* shall be constructed to comply with the following:~~

1. ~~The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.~~

2. ~~Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.~~

3. ~~Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the~~

~~manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.~~

~~4. Recessed lighting fixtures shall comply with Section C402.4.1.8. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.~~

~~5. Construction documents shall contain a diagram showing the building's pressure boundary in plan(s) and section(s) and a calculation of the area of the pressure boundary to be considered in the test.~~

~~*- delete –* **C402.5.1.2 Air barrier compliance options.**~~

~~*- add -* **C402.4.1.4 Air barrier compliance options.**~~
~~A continuous air barrier for the opaque building envelope shall comply with Section C402.4.1.4.1 or C402.4.1.4.2.~~

~~*- modify -* **C402.5.1.2.1 Materials** to **C402.4.1.4.1 Materials**~~

Exception: R-2 *building occupancies* six stories or less shall be tested at a pressure differential of 0.2 inch water gauge (50 Pa), and the measured air leakage shall not exceed 0.15 cfm/ft^2 of the *building thermal envelope* area.

delete and replace **C402.4.1.4.1 Materials.**

Materials with an air permeability not greater than 0.004 cfm/ft^2 (0.02 L/s • m^2) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than $^3/_8$ inch (10 mm).
2. Oriented strand board having a thickness of not less than $^3/_8$ inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).

5. Closed-cell spray foam having a minimum density of 1.5 pcf (2.4 kg/m^3) and having a thickness of not less than 1$^1/_2$ inches (38 mm).

6. Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).

7. Exterior or interior gypsum board having a thickness of not less than $^1/_2$ inch (12.7 mm).

8. Cement board having a thickness of not less than $^1/_2$ inch (12.7 mm).

9. Built-up roofing membrane.

10. Modified bituminous roof membrane.

11. Single-ply roof membrane.

12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than $^5/_8$ inch (15.9 mm).

13. Cast-in-place and precast concrete.

14. Fully grouted concrete block masonry.

15. Sheet steel or aluminum.

16. Solid or hollow masonry constructed of clay or shale masonry units.

delete ~~C402.5.1.2.2 Assemblies.~~

~~*add*~~ *and replace* **C402.4.1.4.2 Assemblies.**
Assemblies of materials and components with an average air leakage not greater than 0.04 cfm/ft^2(0.2 L/s • m^2) under a pressure differential of 0.3 inch of water gauge (w.g~~.)~~ ~~(~~.)(75 Pa) when tested in accordance with ASTM E2357, ASTM E1677, ASTM D8052 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 shall be deemed to comply, provided that joints are sealed and the requirements of Section C402.4.1.3 are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating.

2. Masonry walls constructed of clay or shale masonry units with a nominal width of 4 inches (102 mm) or more.

3. A Portland cement/sand parge, stucco or plaster not less than $^1/_2$ inch (12.7 mm) in thickness.

~~-~~*delete* ~~– **C402.5.2 Air leakage of fenestration.**~~

~~*- add -* **C402.4.1.5 Air leakage of fenestration.**~~
~~The air leakage of fenestration assemblies shall meet the provisions of Table C402.4.1.5. Testing shall be in accordance with the applicable reference test standard in Table C402.4.1.5 by an accredited, independent testing laboratory~~ *and* ~~*labeled* by the manufacturer.~~

> ~~**Exception:** Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.4.1.~~

~~*- modify -* **TABLE C402.5.2 MAXIMUM AIR LEAKAGE RATE FOR FENESTRATION ASSEMBLIES** to **TABLE C402.4.1.5 MAXIMUM AIR LEAKAGE RATE FOR FENESTRATION ASSEMBLIES**~~

~~*- delete –* **C402.5.3 Rooms containing fuel-burning appliances**~~

~~*- add -*~~<u>*replace*</u> **C402.4.1.6 Rooms containing fuel-burning appliances that are not direct vented.**
Where combustion air is supplied through openings in an exterior wall to a room or space containing a space-conditioning fuel-burning appliance, one of the following shall apply:

1. The room or space containing the appliance shall be located outside of the *building thermal envelope*.

2. The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the building thermal envelope. Such rooms shall comply with all of the following:

   2.1. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be insulated to be not less than equivalent to the insulation requirement of below-grade walls as specified in Table C402.1(~~1~~<u>2) and Table C402.1(3</u>).

   2.2. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.4.1.3.

   2.3. The doors into the enclosed room or space shall be fully gasketed.

   2.4. Water lines and ducts in the enclosed room or space shall be insulated in accordance with Section C403.

   2.5. Where an air duct supplying combustion air to the enclosed room or space passes through conditioned space, the duct shall be insulated to an *R*-value of not less than R-10.

Exception: Fireplaces and stoves complying with Section 2111.14 of the *International Building Code*.

~~- *delete* – **C402.5.4 Doors**~~ *and* ~~**access openings to shafts, chutes, stairways and elevator lobbies.**~~

~~- *add* - **C402.4.1.7 Doors and access openings to shafts, chutes, stairways and elevator lobbies.**~~
~~Doors and *access* openings from conditioned space to shafts, chutes stairways and elevator lobbies not within the scope of the fenestration assemblies covered by Section C402.4.1.5 shall be gasketed, weatherstripped or sealed.~~

~~**Exceptions:**~~

1. ~~Door openings required to comply with Section 716 of the *International Building Code.*~~

2. ~~Doors and door openings required to comply with UL 1784 by the *International Building Code.*~~

~~- *add* - **C402.4.1.8 Recessed lighting.**~~
~~Recessed luminaires and any other building component installed in the *building thermal envelope* shall be all of the following:~~

1. ~~IC-rated.~~

2. ~~Labeled as having an air leakage rate of not more 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a 1.57 psf (75 Pa) pressure differential.~~

3. ~~Sealed with a gasket or caulk between the housing and interior wall or ceiling covering.~~

~~- *add* -~~ *replace* **C402.4.2 Dwelling and sleeping unit ~~air infiltration.~~ enclosure testing.**

~~A sampling of dwelling units shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official or authority having jurisdiction and deemed to comply when the tested air leakage rate of each dwelling unit is not greater than 0.35 cfm/ft^2. For purposes of this section, enclosure surface area of a unit means the total surface area of all walls, floors, and ceiling, even if below grade. Testing and inspection shall be conducted by a third-party design professional/agency. A written report of the test results shall be signed by the party conducting the test and provided to the building owner or owner's representative. Testing shall be performed at any time after completion of all penetrations of the dwelling unit's thermal envelope. The sampling of dwelling units tested shall include at least 10 percent of the dwelling units in each building, at least one unit per floor, at least one corner unit, and approximately an equal number of units on each floor level. Each of these units~~

~~must be tested and pass without a failure. If a failure occurs, items causing the failure must be diagnosed, and corrected, and the unit retested until it passes. A minimum of at least two additional units in the same building must also be tested and pass. During testing:~~

~~1. The tested units will be randomly selected, and the construction contractor will not have prior knowledge as to which units will be tested.~~
~~2. Exterior windows and doors, fireplace doors and stove doors shall be closed, but not sealed beyond the intended weather stripping or other infiltration control measures.~~
~~3. Dampers, including exhaust, intake, makeup air, backdraft and flue dampers, shall be closed, but not sealed beyond intended infiltration control measures.~~
~~4. Interior doors, if installed at the time of the test, shall be open.~~
~~5. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.~~
~~6. Heating and cooling systems, if installed at the time of the test, shall be turned off.~~
~~7. Supply and return registers, if installed at the time of the test, shall be fully open.~~

~~*- modify -* **C402.5.5 Air intakes, exhaust openings, stairways and shafts to 402.4.3 Air intakes, exhaust openings, stairways and shafts**~~

~~–~~The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.15 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one building thermal envelope, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

delete ~~–~~*and replace* C402.~~5.6~~4.4 Loading dock ~~**weatherseals.**~~

~~***- add -*** C402.4.4 Loading dock weatherseals~~**weather seals**.
Cargo door openings and loading door openings shall be equipped with ~~**weatherseals**~~weather seals that restrict infiltration and provide direct contact along the top and sides of vehicles that are parked in the ~~**opening.**~~ doorway. If equipped with an interior dock leveler, the deck of the leveler ~~**and**~~, rear pit wall, and the deck plate shall be insulated with a minimum of 1.5 inches of sprayed closed cell foam. The side pit walls and pit slab shall be insulated ~~**per**~~in accordance with the ~~**slab**~~ ASTM E283 slab on grade standard found in Table C402.1(2) and Table C402.1(3). The spaces between the pit wall and the deck skirts for the leveler shall be weather-stripped. Provide each

dock board with an exterior face closure curtain to reduce air infiltration under the dock board.

~~*- delete* – **C402.5.7 Vestibules.**~~

~~*- add* - **C402.4.5 Vestibules.**~~
~~Building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the building entrance shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors. Interior and exterior doors shall have a minimum distance between them of not less than 7 feet. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space. Either the interior or exterior envelope of unconditioned vestibules shall comply with the requirements for a conditioned space.~~

~~**Exceptions:** Vestibules are not required for the following:~~

1. ~~Doors not intended to be used by the public or common occupants of the building, such as doors to mechanical or electrical equipment rooms.~~
2. ~~Doors opening directly from a *sleeping unit* or dwelling unit.~~
3. ~~Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.~~
4. ~~Revolving doors, where a required adjacent accessible entry has a complying vestibule enclosure.~~
5. ~~Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.~~
6. ~~Doors that have an air curtain with a velocity of not less than 6.56 feet per second (2 m/s) at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section C407.2.3.~~
7. ~~Elevator doors in parking garages provided that the elevators have an enclosed lobby at each level of the garage.~~
8. ~~Doors opening directly from a semi-conditioned space.~~

~~*- add* - **C402.4.5.1 Vestibule tempering.**~~
~~Where vestibule space tempering is included, a maximum temperature setting of 55°F (13°C) for heating mode shall be utilized. Mechanical cooling of vestibules is prohibited.~~

~~*- add* - **C402.4.5.2 Vestibule thermostatic controls.**~~
~~Vestibules meeting the requirements of Section C402.4.5.1 shall be zoned separately from~~

~~the conditioned building. Thermostats located inside vestibules shall be programmable, and~~

1. ~~Tamper-proof, or~~
2. ~~Placed in a location inaccessible to the general public.~~

~~**Exception:** Vestibule spaces served by radiant floor heating may utilize a non-programmable thermostat.~~

~~- *delete* – **C402.5.8 Recessed lighting.**~~

add **C402.4.6 Operable openings interlocking**. Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

Exceptions:

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

add **C402.4.6.1 Operable controls.** Controls shall comply with Section C403.14.

add **C402.5 Solar-ready zone**

add **C402.5.1 General.**
A solar-ready zone shall be located on the roof of buildings and are oriented between 110 degrees and 270 degrees of true north or have low-slope roofs. Solar-ready zones shall comply with Sections C402.5.2 through C402.5.8.

Exceptions:

1. A building with a permanently installed, on-site renewable energy system.
2. A building with a solar-ready zone that is shaded for more than 70 percent of daylight hours annually.
3. A building where the licensed design professional certifies that the incident solar radiation available to the building is not suitable for a solar-ready zone.
4. A building where the licensed design professional certifies that the solar zone area required by Section C402.5.3 cannot be met because of extensive rooftop equipment, skylights, vegetative roof areas or other obstructions.

add **C402.5.2 Construction document requirements for a solar-ready zone.**
Construction documents shall indicate the solar-ready zone.

add **C402.5.3 Solar-ready zone area.**
The total solar-ready zone area shall be not less than 40 percent of the roof area calculated as the horizontally projected gross roof area less the area covered by skylights, occupied roof decks, vegetative roof areas and mandatory access or set back areas as required by the *International Fire Code*. The solar-ready zone shall be a single area or smaller, separated sub-zone areas. Each sub-zone shall be not less than 5 feet (1524 mm) in width in the narrowest dimension.

add **C402.5.4 Obstructions.**
Solar ready zones shall be free from obstructions, including pipes, vents, ducts, HVAC equipment, skylights and roof-mounted equipment.

add **C402.5.5 Roof loads and documentation.**

A collateral dead load of not less than 5 pounds per square foot (5 psf) (24.41 kg/m^2) shall be included in the gravity and lateral design calculations for the solar-ready zone. The structural design loads for roof dead load and roof live load shall be indicated on the construction documents.

add **C402.5.6 Interconnection pathway.**
Construction documents shall indicate pathways for routing of conduit or piping from the solar-ready zone to the electrical service panel and electrical energy storage system area or service hot water system.

add **C402.5.7 Electrical energy storage system-ready area.**
The floor area of the electrical energy storage system-ready area shall be not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm) in another dimension and located in accordance with rules adopted by Vermont fire safety code. The location and layout diagram of the electrical energy storage system-ready area shall be indicated on the construction documents.

add **C402.5.8 Electrical service reserved space.**
The main electrical service panel shall have a reserved space to allow installation of a dual-pole circuit breaker for future solar electric and a dual-pole circuit breaker for future electrical energy storage system installation. These spaces shall be labeled "For Future Solar Electric and Storage." The reserved spaces shall be positioned at the end of the panel that is opposite from the panel supply conductor connection.

SECTION C403
BUILDING MECHANICAL SYSTEMS

~~-~~*delete and replace* ~~-~~**C403.1 General.**
In addition to the mechanical requirements of Section C403, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, mechanical enhancements may be needed ~~to meet the requirements of Section C406, Additional Efficiency Package Options. See Section C406~~.

The requirements of C403 that may be affected and the corresponding C406 references are summarized in Table C403.1(1). For a full list of potential measures see Table C406.2.1 and Table C406.3.1.

add **TABLE C403.1(1)**

TABLE C403.1(1):
C406 MEASURES AFFECTING MECHANICAL SYSTEMS

ID	C406 Measure Title	C403 Reference	C406 Section
H01	HVAC Performance	n/a	C406.2.2.1
H02	Heating efficiency	C403.3.2	C406.2.2.2

H03	Cooling efficiency	C403.3.2	C406.2.2.3
H04	Residential HVAC control	C403.7.6	C406.2.2.4
H05	Energy Recovery	C403.7.3	C406.2.2.5
Q04	Fault Detection	C403.2.3	C406.2.4
G02	HVAC Load Management	n/a	C406.3.3
G05	Cooling Energy Storage	n/a	C406.3.6
G07	Building Thermal Mass	n/a	C406.3.8

Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with ~~this section.~~one of the following:

1. ~~-~~Sections C403.1.1 and C403.2 through C403.14
2. Data Centers shall comply with C403.1.1, C403.1.2 and C403.6 through C403.14
3. Section C403.1.3 and Sections within Section C403 that are listed in Table C407.2

Exception: Data center systems are exempt from the requirements of Sections C403.4 and C403.5.

add **C403.1.2 Data centers.** Data center systems shall comply with Sections 6 and 8 of **ASHRAE 90.4** with the following changes:

1. Replace maximum design mechanical load component (MLC) values specified in Table 6.2.1.1 of the ASHRAE 90.4 with the value in Table C403.1.2(1).
2. Replace maximum annualized MLC values specified in Table 6.2.1.2 of the ASHRAE 90.4 with the value in Table C403.1.2(2).

add **TABLE C403.1.2(1)**

TABLE C403.1.2(1)
MAXIMUM DESIGN MECHANICAL LOAD COMPONENT (DESIGN MLC)

CLIMATE ZONE	DESIGN MLC AT 100% AND AT 50% ITE LOAD
6A	0.22

-

add **TABLE C403.1.2(2)**

TABLE C403.1.2(2)
MAXIMUM ANNUALIZED MECHANICAL LOAD COMPONENT (ANNUALIZED MLC)

CLIMATE ZONE	HVAC MAXIMUM ANNUALIZED MLC AT 100% AND AT 50% ITE LOAD
6A	0.17

add **C403.1.3 HVAC total system performance ratio (HVAC TSPR).**

HVAC systems serving buildings or portions of buildings listed in C403.1.3.1 that are not served by systems listed in C403.1.3.2 shall have an HVAC total system performance ratio (HVAC TSPR) of the proposed design HVAC systems that is greater than or equal to the

HVACTSPR of the standard reference design divided by the applicable mechanical performance factor (MPF) from Table C409.3.1. HVAC TSPR shall be calculated in accordance with Section C409, Calculation of HVAC Total System Performance Ratio. Systems using the HVAC TSPR method shall also meet requirements in C403.1.3.3. C403.1.3.1 Included Building Types. HVAC systems that serve the following building use types are allowed to use the TSPR Method:

1. occupancy group B,
2. occupancy group M,
3. occupancy group A-3,
4. occupancy group E,
5. occupancy group R-1,
6. the dwelling units and common areas within occupancy group R-2 multifamily buildings.

add **C403.1.3.2 Excluded Systems.** The following HVAC systems are excluded from using the TSPR Method:

1. HVAC Systems using
    - 1.1 district heating water, chilled water or steam
    - 2.1 small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or
    - 3.1 double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431
    - 4.1 packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr 5.(3500 kW)
    - 5.1 a common heating source serving both HVAC and service water heating equipment, or
2. HVAC systems that provide recovered heat for service water heating
3. HVAC systems not included in Table C409.5.2.10.1
4. HVAC systems included in table C409.5.2.10.1 with parameters in Table C409.5.2.10.2, 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 plants 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 that comply fully with ASHRAE Standard 170, including but not limited to surgical centers, or that are required by other applicable codes or standards to provide 24/7 air handling unit operation
11. HVAC systems serving laboratories with fume hoods
12. Locker rooms with more than 2 showers
13. Natatoriums and rooms with saunas
14. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h
15. Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.
16. Cafeterias and dining rooms

add **C403.1.3.3 TSPR Method Partial Prescriptive Requirements**. HVAC systems using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section C403 as follows:

1. Air economizers shall meet the requirements of Section C403.5.3.4 "relief of excess outdoor air" and Section C403.5.5 "Economizer fault detection and diagnostics."
2. Variable-air-volume system systems shall meet requirements of Sections C403.6.5, C403.6.6, and C403.6.9.
3. Hydronic systems shall meet the requirements of C403.4.4.
4. Plants with multiple chillers or boilers shall meet the requirements of Section C403.4.5.
5. Hydronic (Water Loop) Heat Pumps and Water-Cooled Unitary Air Conditioners shall meet the requirements of Section C403.4.3.3.
6. Cooling tower turndown shall meet requirements of Section C403.10.4.
7. Heating of unenclosed spaces shall meet the requirements of Section C403.13.1.
8. Hot-gas bypass shall meet the requirements of Section C403.3.3.
9. Systems shall meet the operable openings interlock requirements of Section C402.5.11.10.
10. Refrigeration systems shall meet the requirements of Section C403.11.

delete and replace ~~–~~**C403.2 System design** ~~**(Mandatory).**~~

Mechanical systems shall be designed to comply with Sections C403.2.1 through C403.2.~~4.~~3 Where elements of a building's mechanical systems are addressed in Sections C403.3 through C403.~~12~~14, such elements shall comply with the applicable provisions of those sections. Hydronic heating systems and associated equipment shall be sized for and operated at a maximum heating hot water temperature of 140F. Construction documents shall include submittal of a Sequence of Operations for all mechanical equipment, including a specification outlining each of the functions required by this section.

~~–~~*delete and replace* ~~–~~**C403.2.2 Ventilation** ~~**(Mandatory).**~~

Ventilation, either natural or mechanical, shall be provided in accordance with~~.~~ ASHRAE Standard 62.1. Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by ASHRAE Standard 62.1. The design professional shall utilize ventilation rates based on the expected occupancy level of the space. Life safety maximum allowable occupancy density shall not be used as a ventilation basis of design.

Exception: All Residential occupancies. See the ventilation requirements of Section 304 of the *Vermont Residential Building Energy Standards*.

~~*- add -* **C403.2.3 Electric resistance space heating.**~~

~~Building heating with electrical resistance units, including baseboard radiation, heat pump reheat coils, duct coils, boilers, outdoor air intake grids, and coils in terminal units and air systems, is prohibited.~~

~~**Exceptions:**~~

1. ~~Areas, such as stairways, that are not permitted to be penetrated with piping or duct and no other method of heating is possible.~~

2. ~~Special conditions of occupancy or use that require electrical resistance heat to maintain health, safety or environmental conditions.~~

3. ~~Limited areas where a practical application of resistance electrical heat is demonstrated (e.g., small interior space such as a restroom which is distant from the distribution system, hazardous material storerooms, stairwell or other means of emergency egress).~~

4. ~~Multifamily buildings with heating loads ≤ 6.0 Btu/hour/square foot at design temperature.*~~

5. ~~*Cold-Climate Heat Pump* where*:~~

   i. ~~the full heating demand can be met with the heat pump at an outside air temperature of 5°F; and~~
   ii. ~~the building thermal envelope shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) and deemed to comply with the provisions of Section C402.4.1 when the tested air leakage rate of the building thermal envelope is not greater than 0.20 cfm/ft2 (including the areas of the slab and below grade walls).~~

~~*Buildings served by the City of Burlington Electric (BED) must also receive approval from BED before installing electric resistance heating equipment.~~

~~*- add -*~~*delete and replace* **C403.2.4 Fault detection and diagnostics.** New buildings with an HVAC system serving a gross conditioned floor area of 100,000 square feet (9290 m2) or larger shall include a fault detection and diagnostics (FDD) system to monitor the HVAC system's performance and automatically identify faults. The FDD system shall:

1. Include permanently installed sensors and devices to monitor the HVAC system's performance.
2. Sample the HVAC system's performance at least once every 15 minutes.
3. Automatically identify and report HVAC system faults.
4. Automatically notify authorized personnel of identified HVAC system faults.
5. Automatically provide prioritized recommendations for repair of identified faults based on analysis of data collected from the sampling of HVAC system performance.
6. Be capable of transmitting the prioritized fault repair recommendations to remotely located authorized personnel.

Exception: R-1 and R-2 occupancies.

add **C403.2.~~4~~5 Mechanical systems commissioning and completion requirements.** Mechanical systems shall be commissioned and completed in accordance with Section C407~~.~~

~~***- delete and replace -***~~*delete and replace* **C403.3 Heating and cooling equipment efficiencies** Heating and cooling equipment installed in mechanical systems shall be sized in accordance with Section C403.3.1 and shall be not less efficient in the use of energy than as specified in Section C403.3.2.

delete and replace **C403.3.1 Equipment sizing ~~(Mandatory).~~**
The output capacity of heating and cooling equipment shall be not greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.1.1. A single piece of equipment providing both heating and cooling shall satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options. Heating and cooling equipment sizing is permitted to be up to ~~ten~~10 percent greater (to the next nearest available size) than the calculated peak heating and cooling loads to allow for building pickup and cool down after temperature setback conditions~~.~~ or for proper airflow volumes. Heat pump equipment shall not be sized greater than the calculated peak heating and cooling loads, as they are exempt from temperature setbacks and are significantly less efficient when oversized. Outdoor condensing units serving multiple indoor heat pump units shall be sized equal or less than the total capacity of the indoor units.

Exceptions:

1. Required standby equipment and systems provided with controls and devices that allow such systems or equipment to operate automatically only when the primary equipment is not operating.

2. Multiple units of the same equipment type with combined capacities exceeding the design load and provided with controls that are configured to sequence the operation of each unit based on load.

~~*- delete and replace -* **C403.3.2 HVAC equipment performance requirements (Mandatory).**~~
~~Equipment shall meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2(11) when tested and rated in accordance with the applicable test procedure. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirements of Table C403.3.2(12). The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements. Where components, such as indoor or outdoor coils, from different manufacturers are used, calculations and supporting data shall be furnished by the designer that demonstrates that the combined efficiency of the specified components meets the requirements herein.~~

~~- *delete and replace* - **TABLE C403.3.2(1) MINIMUM EFFICIENCY REQUIREMENTS:**~~

delete and replace **TABLE C403.3.2(1)**

TABLE C403.3.2(1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS[c, d]

~~**TABLE C403.3.2(1)**~~
~~**MINIMUM EFFICIENCY REQUIREMENTS:**~~
~~**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS**~~

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air conditioners, air cooled	< 65,000 Btu/h[b]	All	Split system, three phase	13.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/23 AHRI 210/240 – 2023 after 1/1/2023
			Single package, three phase	14.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/23	
~~Through-the-wall (air-cooled)~~Space constrained, aircooled	~~<~~≤30,000 Btu/h[b]	All	Split System, three phase	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	AHRI 210/240 – 2017 before 1/1/2023 AHRI 210/240 – 2023 after 1/1/2023
			Single package, three phase	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
Small -duct, high-velocity ~~(~~, air cooled~~)~~	< 65,000 Btu/h[b]	All	Split System, three phase	~~11~~12.0 SEER before 1/1/2023	AHRI 210/240 – 2017 before 1/1/2023

				12.1 SEER2 after 1/1/2023	AHRI 210/240 – 2023 after 1/1/2023
Air conditioners, air cooled	~~≥~~ ≥ 65,000 Btu/h and < 135,000 Btu/h	~~None~~Electric resistance (or none)	Split system and single package	11.2 EER 12.9 IEER before 1/1/2023 14.8 IEER after 1/1/2023	AHRI 340/360
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	11.0 EER 12.7 IEER before 1/1/2023 14.6 IEER after 1/1/2023	
	~~≥~~≥ 135,000 Btu/h and < 240,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	11.0 EER 12.4 IEER before 1/1/2023 14.2 IEER after 1/1/2023	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	10.8 EER 12.2 IEER before 1/1/2023 14.0 IEER after 1/1/2023	
	~~≥~~≥ 240,000 Btu/h and < 760,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	10.0 EER 11.6 IEER before 1/1/2023 13.2 IEER after 1/1/2023	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	9.8 EER 11.4 IEER before 1/1/2023 13.0 IEER after 1/1/2023	
	~~≥~~ ≥ 760,000 Btu/h	~~None~~ Electric resistance (or none)	~~Split System and Single Package~~	9.7 EER 11.2 IEER before 1/1/2023 12.5 IEER after 1/1/2023	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	9.5 EER 11.0 IEER	

				before 1/1/2023 12.3 IEER after 1/1/2023	
Air conditioners, water cooled	< 65,000 Btu/~~h[b]~~ h	All	Split system and single package	12.1 EER 12.3 IEER	AHRI 210/240
	~~≥~~ ≥ 65,000 Btu/h and < 135,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	12.1 EER 13.9 IEER	AHRI 340/360
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	11.9 EER 13.7 IEER	
	~~≥~~≥ 135,000 Btu/h and < 240,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	12.5 EER 13.9 IEER	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	12.3 EER 13.7 IEER	
	~~≥~~ ≥ 240,000 Btu/h and < 760,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	12.4 EER 13.6 IEER	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	12.2 EER 13.4 IEER	
	~~≥~~ ≥ 760,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	12.2 EER 13.5 IEER	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	12.0 EER 13.3 IEER	

~~*(continued)*~~

TABLE C403.3.2(1)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air conditioners, evaporatively cooled	< 65,000 Btu/h[b]	All	Split system and single package	12.1 EER 12.3 IEER	AHRI 210/240
	~~≥~~ ≥ 65,000 Btu/h and < 135,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	12.1 EER 12.3 IEER	AHRI 340/360
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	11.9 EER 12.1 IEER	
	~~≥~~ ≥ 135,000 Btu/h and < 240,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	12.0 EER 12.2 IEER	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	11.8 EER 12.0 IEER	
	~~≥~~ ≥ 240,000 Btu/h and < 760,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	11.9 EER 12.1 IEER	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	11.7 EER 11.9 IEER	
	~~≥~~≥ 760,000 Btu/h	~~None~~Electric resistance (or none)	~~Split System and Single Package~~	11.7 EER 11.9 IEER	
		~~Non-Electric[c]~~All other	~~Split System and Single Package~~	11.5 EER 11.7 IEER	
Condensing units, air cooled	~~≥~~≥ 135,000 Btu/h	—	—	10.5 EER 11.8 IEER	AHRI 365
Condensing units, water cooled	~~≥~~≥ 135,000 Btu/h	—	—	13.5 EER 14.0 IEER	AHRI 365
Condensing units, evaporatively cooled	~~≥~~≥ 135,000 Btu/h	—	—	13.5 EER 14.0 IEER	AHRI 365

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b. ~~b.~~ Single-phase, US air-cooled air conditioners less than 65,000 Btu/h are regulated ~~by NAECA.~~as consumer products by the US Department of Energy Code of Federal Regulations DOE 10 CFR 430. SEER and SEER2 values for single-phase products are ~~those~~ set by ~~NAECA~~the US Department of Energy.

~~c. Electric resistance space heating is prohibited per Section C403.2.3. Use "None" Heating Section Type category for exceptions to Section C403.2.3.~~

c. ~~–~~DOE 10 CFR 430 Subpart B Appendix M1 includes the test procedure updates effective 1/1/2023 that will be incorporated in AHRI 210/240—2023.
d. This table is a replica of ASHRAE 90.1 Table 6.8.1-1 Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements.

delete and replace ~~–~~**TABLE C403.3.2(2)** ~~**MINIMUM EFFICIENCY REQUIREMENTS:**~~

TABLE C403.3.2(2)

ELECTRICALLY OPERATED AIR-COOLED UNITARY ~~AND APPLIED~~ HEAT PUMPS

~~TABLE C403.3.2(2)~~
MINIMUM EFFICIENCY REQUIREMENTS~~:~~
~~ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS~~[c, d]

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY~~	~~HEATING SECTION TYPE~~	~~SUBCATEGORY OR RATING CONDITION~~	~~MINIMUM EFFICIENCY~~	~~TEST PROCEDURE~~[a]
~~Air cooled (cooling mode)~~	~~< 65,000 Btu/h~~[b]	~~All~~	~~Split System~~	~~14.0 SEER~~	~~AHRI 210/240~~
			~~Single Package~~	~~14.0 SEER~~	
~~Through-the-wall, air cooled~~	~~≤ 30,000 Btu/h~~[b]	~~All~~	~~Split System~~	~~12.0 SEER~~	
			~~Single Package~~	~~12.0 SEER~~	
~~Single-duct high-velocity air cooled~~	~~< 65,000 Btu/h~~[b]	~~All~~	~~Split System~~	~~11.0 SEER~~	
~~Air cooled (cooling mode)~~	~~≥ 65,000 Btu/h and < 135,000 Btu/h~~	~~None~~	~~Split System and Single Package~~	~~11.0 EER 12.0 IEER~~	~~AHRI 340/360~~
		~~Non-Electric~~[c]	~~Split System and Single Package~~	~~10.8 EER 11.8 IEER~~	
	~~≥ 135,000 Btu/h and < 240,000 Btu/h~~	~~None~~	~~Split System and Single Package~~	~~10.6 EER 11.6 IEER~~	
		~~Non-Electric~~[c]	~~Split System and Single Package~~	~~10.4 EER 11.4 IEER~~	
	~~≥ 240,000 Btu/h~~	~~None~~	~~Split System and Single Package~~	~~9.5 EER 10.6 IEER~~	
		~~Non-Electric~~[c]	~~Split System and Single Package~~	~~9.3 EER 9.4 IEER~~	
~~Water to Air: Water Loop (cooling mode)~~	~~< 17,000 Btu/h~~	~~All~~	~~86°F entering water~~	~~12.2 EER~~	~~ISO 13256-1~~
	~~≥ 17,000 Btu/h and < 65,000 Btu/h~~	~~All~~	~~86°F entering water~~	~~13.0 EER~~	
	~~≥ 65,000 Btu/h and < 135,000 Btu/h~~	~~All~~	~~86°F entering water~~	~~13.0 EER~~	
~~Water to Air: Ground Water (cooling mode)~~	~~< 135,000 Btu/h~~	~~All~~	~~59°F entering water~~	~~18.0 EER~~	~~ISO 13256-1~~
~~Brine to Air: Ground Loop (cooling mode)~~	~~< 135,000 Btu/h~~	~~All~~	~~77°F entering water~~	~~14.1 EER~~	~~ISO 13256-1~~
~~Water to Water: Water Loop~~	~~< 135,000 Btu/h~~	~~All~~	~~86°F entering water~~	~~10.6 EER~~	~~ISO 13256-2~~

~~(cooling mode)~~					
~~Water to Water: Ground Water (cooling mode)~~	~~< 135,000 Btu/h~~	~~All~~	~~59°F entering water~~	~~16.3 EER~~	
~~Brine to Water: Ground Loop (cooling mode)~~	~~< 135,000 Btu/h~~	~~All~~	~~77°F entering fluid~~	~~12.1 EER~~	

~~*(continued)*~~

~~TABLE C403.3.2(2)—continued~~
~~MINIMUM EFFICIENCY REQUIREMENTS:~~
~~ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS~~

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (~~heating~~cooling mode)	< ~~65~~66,000 Btu/~~h~~ ~~b~~ h	~~—~~All	Split system, three phase and applications outside US single phase[b]	~~10~~14.0 ~~HSPF~~SEER before 1/1/2023 14.3 SEER2 after 1/1/2023	AHRI 210/240 – 2017 before 1/1/2023 AHRI 210/240 – 2023 after 1/1/2023
		—	Single package, three phase and applications outside US single phase[b]	~~10~~14.0 ~~HSPF~~SEER before 1/1/2023 13.4 SEER2 after 1/1/2023	
~~Through-the-wall,~~ ~~(~~Space constrained, air cooled~~,~~ ~~heating~~ (cooling mode)	≤ 30,000 Btu/~~h~~ ~~b~~ ~~(cooling capacity)~~h	~~—~~All	Split system, three phase and applications outside US single phase[b]	~~10~~12.0 ~~HSPF~~SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
		—	Single package, three phase and applications outside US single phase[b]	~~10~~12.0 ~~HSPF~~SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
~~Small~~Single-duct, high-velocity ~~(~~, air cooled~~, heating~~ (cooling mode)	< 65,000 Btu/~~h~~ ~~b~~ h	~~—~~All	Split system, three phase and applications outside US single phase[b]	~~10.0 HSPF~~12.0 SEER before 1/1/2023 12.0 SEER2 after 1/1/2023	
Air cooled (~~heating~~cooling mode)	~~≥~~≥ 65,000 Btu/h and < 135,000 Btu/h ~~(cooling capacity)~~	~~—~~Electric resistance (or none)	~~47ºF db/43ºF wb outdoor air~~ Split system and single package	~~3.3 COP~~11.0 EER 12.2 IEER before 1/1/2023 14.1 IEER after 1/1/2023	AHRI 340/360
		All other	~~17ºF db/15ºF wb outdoor air~~	~~2.25 COP~~10.8 EER 12.0 IEER before 1/1/2023 13.9 IEER after 1/1/2023	

	~~≥~~ ≥ 135,000 Btu/h ~~(cooling capacity)~~ and < 240,000 Btu/h	~~—~~Electric resistance (or none)	~~47ºF db/43ºF wb outdoor air~~	~~3.2 COP~~10.6 EER 11.6 IEER before 1/1/2023 13.5 IEER after 1/1/2023	
		All other	~~17ºF db/15ºF wb outdoor air~~	~~2.05 COP~~10.4 EER 11.4 IEER before 1/1/2023 13.3 IEER after 1/1/2023	
	≥ 240,000 Btu/h	Electric resistance (or none)		9.5 EER 10.6 IEER before 1/1/2023 12.5 IEER after1/1/2023	
		All other		9.3 EER 10.4 IEER before 1/1/2023 12.3 IEER after 1/1/2023	
~~Water to~~ Air~~: Water Loop~~ cooled (heating mode)	<~~135~~65,000 Btu/~~h (cooling capacity)~~hr	~~—~~All	~~68°F entering water~~Split system, three phase and applications outside US single phase[b]	~~4.3 COP~~8.2 HSPF before 1/1/2023 7.5 HSPF2 after 1/1/2023	~~ISO 13256-1~~AHRI 210/240 – 2017 before 1//2023 AHRI 210/240-2023 after 1/1/2023
			Single package, three phase and applications outside US single phase[b]	8.0 HSPF before 1/1/2023 6.7 HSPF2 after 1/1/2023	
~~Water to Air: Ground Water~~ Space constrained, air cooled (heating mode)	~~< 135~~≤30,000 Btu/~~h (cooling capacity)~~hr	~~—~~All	~~50°F entering water~~Split system, three phase and applications outside US single phase[b]	~~3.7 COP~~7.4 HSPF before 1/1/2023 6.3 HSPF2 after 1/1/2023	AHRI 210/240 – 2017 before 1//2023 AHRI 210/240-2023 after 1/1/2023
			Single package, three phase and applications outside US single phase[b]	7.4 HSPF before 1/1/2023 6.3 HSPF2 after 1/1/2023	
~~Brine to Air: Ground Loop~~ Small duct, high velocity, air cooled (heating mode)	<~~135~~65,000 Btu/~~h (cooling capacity)~~hr	~~—~~All	~~32°F entering fluid~~Split system, three phase and applications outside US single phase[b]	~~3.2 COP~~3.30 COP_H before 1/1/2023 3.40 COP_H after 1/1/2023	AHRI 210/240 – 2017 before 1//2023 AHRI 210/240-2023 after 1/1/2023

~~Water to Water: Water Loop~~ Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling Capacity)	~~—~~All	~~68°F entering water~~47°F db/43°F wb outdoor air	~~3.7 COP~~3.30 COP_H before 1/1/2023 3.40 COP_H after 1/1/2023	
			17°F db/15°F wb outdoor air	2.25 COP_H	
~~Water to Water: Ground Water (heating mode)~~	~~<~~ ≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)	—	~~50°F entering water~~47°F db/43°F wb outdoor air	3.20 COP_H before 1-~~COP~~/1/2023 3.30 COP_H after 1/1/2023	~~ISO 13256-2~~AHRI 340/360
			17°F db/15°F wb outdoor air	2.05 COP_H	
~~Brine to Water: Ground Loop (heating mode)~~	~~< 135~~≥ 240,000 Btu/h (cooling capacity)	—	~~32°F entering fluid~~47°F db/43°F wb outdoor air	~~2.5 COP~~3.20 COP_H	
			17°F db/15°F wb outdoor air	2.05 COP_H	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) ~~—~~— 32]/1.8~~.~~, wb = wet bulb, db = dry bulb.

a. Chapter 6 contains a complete specification of the referenced ~~test procedure~~standards, which include test procedures, including the reference year version of the test procedure.

b. Single-phase, US air-cooled heat pumps less than 65,000 Btu/h are regulated ~~by NAECA.~~as consumer products by the US Department of Energy Code of Federal Regu- lations DOE 10 CFR 430. SEER, SEER2 and HSPF values for single-phase products are ~~those~~ set by ~~NAECA~~the US Department of Energy.

~~c. Electric resistance space heating is prohibited per Section C403.2.3. Use “None” Heating Section Type category for exceptions to Section C403.2.3.~~

~~–~~c. DOE 10 CFR 430 Subpart B Appendix M1 includes the test procedure updates effective 1/1/2023 that will be incorporated in AHRI 210/240—2023.
d. This table is a replica of ASHRAE 90.1 Table 6.8.1-2 Electrically Operated Air-Cooled Unitary Heat Pumps Minimum Efficiency Requirements.

delete and replace ~~–~~**TABLE C403.3.2(~~7) WATER CHILLING PACKAGES – EFFICIENCY REQUIREMENTS~~3)**

TABLE C403.3.2(~~7~~3)
WATER CHILLING PACKAGES – EFFICIENCY REQUIREMENTS[a, b, d]

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	Path A	Path B	TEST PROCEDURE[c]
Air-cooled chillers	< 150 Tons	EER (Btu/W)	≥ 10.100 FL ≥ 13.700 IPLV.IP	≥ 9.700 FL ≥ 15,800 IPLV.IP	AHRI 550/590
	≥ 150 Tons		≥ 10.100 FL ≥ 14.000 IPLV	≥ 9.700 FL ≥ 16.100 IPLV	
Air cooled without condenser, electrically operated	All capacities	EER (Btu/W)	Air-cooled chillers without condenser shall be rated with matching condensers and complying with air-cooled chiller efficiency requirements.		AHRI 550/590
Water cooled, electrically operated positive displacement	< 75 Tons	kW/ton	≤ 0.750 FL ≤ 0.600 IPLV.IP	≤ 0.780 FL ≤ 0.500 IPLV.IP	AHRI 550/590
	≥ 75 tons and < 150 tons		≤ 0.720 FL ≤ 0.560 IPLV.IP	≤ 0.750 FL ≤ 0.490 IPLV.IP	
	≥ 150 tons and < 300 tons		≤ 0.660 FL ≤ 0.540 IPLV.IP	≤ 0.680 FL ≤ 0.440 IPLV.IP	
	≥ 300 tons and < 600 tons		≤ 0.610 FL ≤ 0.520 IPLV.IP	≤ 0.625 FL ≤ 0.410 IPLV.IP	
	≥ 600 tons		≤ 0.560 FL ≤ 0.500 IPLV.IP	≤ 0.585 FL ≤ 0.380 IPLV.IP	
Water cooled, electrically operated centrifugal	< 150 Tons	kW/ton	≤ 0.610 FL ≤ 0.550 IPLV.IP	≤ 0.695 FL ≤ 0.440 IPLV.IP	AHRI 550/590
	≥ 150 tons and < 300 tons		≤ 0.610 FL ≤ 0.550 IPLV.IP	≤ 0.635 FL ≤ 0.400 IPLV.IP	
	≥ 300 tons and < 400 tons		≤ 0.560 FL ≤ 0.520 IPLV.IP	≤ 0.595 FL ≤ 0.390 IPLV.IP	

	≥ 400 tons and < 600 tons		≤ 0.560 FL ≤ 0.500 IPLV.IP	≤ 0.585 FL ≤ 0.380 IPLV.IP	
	≥ 600 Tons		≤ 0.560 FL ≤ 0.500 IPLV.IP	≤ 0.585 FL ≤ 0.380 IPLV.IP	
Air cooled, absorption, single effect	All capacities	COP (W/W)	≥ 0.600 FL	NA[c]	AHRI 560
Water cooled absorption, single effect	All capacities	COP (W/W)	≥ 0.700 FL	NA[c]	AHRI 560
Absorption, double effect, indirect fired	All capacities	COP (W/W)	≥ 1.000 FL ≥ .050 IPLV.IP	NA[c]	AHRI 560
Absorption double effect direct fired	All capacities	COP (W/W)	≥ 1.000 FL ≥ 1.000 IPLV	NA[c]	AHRI 560

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.
b. The requirements for centrifugal chillers shall be adjusted for nonstandard rating conditions per Section C403.3.2.1 and are applicable only for the range of conditions listed there. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.
c. Both the full-load and IPLV.IP requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.
d. NA means the requirements are not applicable for Path B, and only Path A can be used for compliance.
e. FL is the full-load performance requirements, and IPLV.IP is for the part-load performance requirements.
f. This table is a replica of ASHRAE 90.1 Table 6.8.1-3 Water-Chilling Packages—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(4)**

TABLE C403.3.2(4)

ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS, PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS, SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS - MINIMUM EFFICIENCY REQUIREMENTS[e]

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	~~UNITS~~SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST ~~PROCEDURE c~~ PROCEDURE[a]
			~~Path A~~	~~Path B~~	

~~Air-cooled chillers~~PTAC (cooling mode) standard size	~~< 150 Tons~~	~~EER~~ ~~(~~<7,000 Btu/~~W)~~h	~~≥ 10.100 FL~~95°F db/75°F wb outdoor air[c]	~~≥~~ 11.9~~.700 FL~~ EER	AHRI ~~550/590~~ 310/380
		~~≥ 13.700 IPLV~~	~~≥ 15,800 IPLV~~≥7,000 Btu/h and ≤15,000 Btu/h		14.0 – (0.300 × Cap/1000) EER[d]
		>15,000 Btu/h		9.5 EER	
PTAC (cooling mode) nonstandard size[a]		<7,000 Btu/h	95°F db/75°F wb outdoor air[c]	9.4 EER	AHRI 310/380
		~~≥ 150 Tons~~≥7,000 Btu/h and ≤15,000 Btu/h		~~≥ 10.100 FL~~10.9 - (0.213 × Cap/1000) EER[d]	~~≥ 9.700 FL~~
		>15,000 Btu/h		7.7 EER	
PTHP (cooling mode) standard size		<7,000 Btu/h	95°F db/75°F wb outdoor air[c]	11.9 EER	AHRI 310/380
		~~≥ 14.~~≥7,000 ~~IPLV~~Btu/h and ≤15,000 Btu/h	~~≥ 16.100 IPLV~~	14.0 - (0.300 × Cap/1000) EER[d]	
		>15,000 Btu/h		9.5 EER	
PTHP (cooling mode) nonstandard size[b]		<7,000 Btu/h	95°F db/75°F wb outdoor air[c]	9.3 EER	AHRI 310/380
~~Air cooled without condenser, electrically operated~~		~~All capacities~~≥7,000 Btu/h and ≤15,000 Btu/h	~~EER (Btu/W)~~	~~Air-cooled chillers without condenser shall be~~	

			~~rated with matching condensers and complying with air-cooled chiller efficiency requirements.~~ 10.8 - (0.213 × Cap/1000) EER[d]	
	>15,000 Btu/h		7.6 EER	
PTHP (heating mode) standard size	<7,000 Btu/h	47°F db/43°F wb outdoor air[c]	3.3 COP_H	AHRI 310/380
~~Water cooled, electrically operated positive displacement~~	~~< 75 Tons~~≥7,000 Btu/h and ≤15,000 Btu/h	~~kW/ton~~	~~≤ 0.750 FL~~3.7 - (0.052 × Cap/1000) COP_H[d]	~~≤ 0.780 FL~~
	>15,000 Btu/h		2.9 COP_H	
PTHP (heating mode) nonstandard size[b]	<7,000 Btu/h	47°F db/43°F wb outdoor air[c]	2.7 COP_H	AHRI 310/380
	≥7,000 Btu/h and ≤15,000 Btu/h		~~≤ 0.600 IPLV~~ 2.9 - (0.026 × Cap/1000) COP_H[d]	~~≤ 0.500 IPLV~~
	>15,000 Btu/h		2.5 COP_H	

	~~≥ 75 tons and < 150 tons~~SPVAC (cooling mode) single and three phase	< 65,000 Btu/h	~~≤ 0.720 FL~~95°F db/ 75°F wb outdoor air	~~≤~~ 11.0~~.750 FL~~ EER	AHRI 390
		≥ 65,000 Btu/h and < 135,000 Btu/h		~~≤~~ 10.0~~.560 IPLV~~ EER	~~≤ 0.490 IPLV~~
		≥ ~~150 tons~~135,000 Btu/h and ~~< 300 tons~~ < 240,000 Btu/h		~~≤~~ 10.0~~.660 FL~~ EER	~~≤ 0.680 FL~~
SPVHP (cooling mode)		< 65,000 Btu/h	95°F db/ 75°F wb outdoor air	~~≤~~ 11.0~~.540 IPLV~~ EER	~~≤ 0.440 IPLV~~
		≥ ~~300 tons~~65,000 Btu/h and ~~< 600 tons~~ < 135,000 Btu/h		~~≤~~ 10.0~~.610 FL~~ EER	~~≤ 0.625 FL~~
		≥ 135,000 Btu/h and < 240,000 Btu/h		10.1 EER	
SPVHP (heating mode)		< 65,000 Btu/h	47°F db/ 43°F wb outdoor air	3.3 COP_H	AHRI 390
		≥ 65,000 Btu/h and < 135,000 Btu/h		~~≤~~ 3.0~~.520 IPLV~~ COP_H	~~≤ 0.410 IPLV~~

	~~≥ 600 tons~~≥ 135,000 Btu/h and < 240,000 Btu/h		~~≤~~ 3.0~~.560 FL~~ COP_H	~~≤ 0.585 FL~~	
Room air conditioners without reverse cycle with louvered sides	< 6,000 Btu/h	—	~~≤~~ 11.0~~.500 IPLV~~ CEER	~~≤ 0.380 IPLV~~ ANSI/AHAMRAC-1	
~~Water cooled, electrically operated centrifugal~~	~~< 150 Tons~~≥ 6,000 Btu/h and < 8,000 Btu/h	~~kW/ton~~—	~~≤~~ 11.0~~.610 FL~~ CEER	~~≤ 0.695 FL~~	
	≥ 8,000 Btu/h and < 14,000 Btu/h	—	~~≤ 0.550 IPLV~~ 10.9 CEER	~~≤ 0.440 IPLV~~	
	≥ ~~150 tons~~14,000 Btu/h and ~~< 300 tons~~ < 20,000 Btu/h	—	~~≤ 0.610 FL~~10.7 CEER	~~≤ 0.635~~	

				~~FL~~	
			~~≤ 0.550 IPLV~~	~~≤ 0.400 IPLV~~	
	≥ ~~300 tons~~20,000 Btu/h and ~~< 400 tons~~ ≤ 28,000 Btu/h	—	~~≤ 0.560 FL~~9.4 CEER	~~≤ 0.595 FL~~	
	> 28,000 Btu/h	—	~~≤~~ 9.0~~.520 IPLV~~ CEER	~~≤ 0.390 IPLV~~	
Room air conditioners without louvered sides	< 6,000 Btu/h	—	10.0 CEER	ANSI/AHAM RAC-1	
	≥ ~~400 tons~~6,000 Btu/h and ~~< 600 tons~~ < 8,000 Btu/h	—	~~≤~~ 10.0~~.560 FL~~ CEER	~~≤ 0.585 FL~~	
	≥ 8,000 Btu/h and < 11,000 Btu/h	—	~~≤ 0.500 IPLV~~ 9.6 CEER	~~≤ 0.380 IPLV~~	
	~~≥ 600 Tons~~≥ 11,000 Btu/h and < 14,000 Btu/h	—	~~≤ 0.560 FL~~9.5 CEER	~~≤ 0.585 FL~~	

	≥ 14,000 Btu/h and < 20,000 Btu/h	—	~~≤ 0.500 IPLV~~ 9.3 CEER	~~≤ 0.380 IPLV~~	
~~Air cooled, absorption, single effect~~	~~All capacities~~≥ 20,000 Btu/h	~~COP~~—	~~≥ 0.600 FL~~9.4 CEER	~~NAc~~	~~AHRI 560~~
~~Water cooled absorption, single effect~~	~~All capacities~~	~~COP~~	~~≥ 0.700 FL~~	~~NA~~[c]	
~~Absorption, double effect, indirect fired~~Room airconditioners with reverse cycle, with louvered sides for applications outside US	~~All capacities~~< 20,000 Btu/h	~~COP~~—	9.8 CEER	~~≥ 1.000 FL~~ ANSI/AHAMRAC-1	~~NAc~~
	≥ 20,000 Btu/h	—	~~≥ 1.050 IPLV~~ 9.3 CEER		
~~Absorption double effect direct fired~~Room air-conditioners with reverse cycle without louvered sides for applications outside US	~~All capacities~~< 14,000 Btu/h	~~COP~~—	9.3 CEER	~~≥ 1.000 FL~~A	~~NAc~~

				NSI/AHAMRAC-1		
	≥ 14,000 Btu/h	—	~~≥ 1.050 IPLV~~ 8.7 CEER			

~~a. The requirements for centrifugal chiller shall be adjusted for nonstandard rating conditions in accordance with Section C403.3.2.1 and are only applicable for the range of conditions listed in Section C403.3.2.1. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.~~

~~b. Both the full-load and IPLV requirements shall be met or exceeded to comply with this standard. Where there is a Path B, compliance can be with either Path A or Path B for any application.~~

~~c. NA means the requirements are not applicable for Path B and only Path A can be used for compliance.~~

~~d. FL represents the full-load performance requirements and IPLV the part-load performance requirements.~~

~~- add -~~ (continued)

TABLE C403.3.2(~~10)~~ 4)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED ~~VARIABLE-REFRIGERANT-FLOW~~PACKAGED TERMINAL AIR CONDITIONERS

~~TABLE C403.3.2(10)~~
~~MINIMUM EFFICIENCY~~
~~ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW~~,
PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS, SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS

T TYPE	SIZE CATEGORY (INPUT)	~~HEATING SECTION TYPE~~	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TE ~~PROC~~ PROCE
~~< 65,000 Btu/h~~	All		~~VRF multisplit system~~—	~~13.0 SEER~~9.5 CEER	AH ~~1230~~ AHAM
	~~≥ 65,000 Btu/h and < 135,000 Btu/h~~	~~None~~	~~VRF multisplit system~~	~~11.2 EER 15.5 EER~~	
	~~≥ 135,000 Btu/h and < 240,000 Btu/h~~	~~None~~	~~VRF multisplit system~~	~~11.0 EER 14.9 IEER~~	
sement slider for	~~≥ 240,000 Btu/h~~All	~~None~~—	~~VRF multisplit system~~	10.~~0 EER 13.9 IEER~~4 CEER	

~~add~~ For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8, wb = wet bulb, db = dry bulb. "Cap" = The rated cooling capacity of the project in Btu/h. Where the unit's capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. Where the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculations.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Nonstandard size units must be factory labeled as follows: "MANUFACTURED FOR NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW STANDARD PROJECTS." Nonstandard size efficiencies apply only to units being installed in existing sleeves having an external wall opening of less than 16 inches (406 mm) high or less than 42 inches (1067 mm) wide and having a cross-sectional area less than 670 square inches (0.43 m2).

c. The cooling-mode wet bulb temperature requirement only applies for units that reject condensate to the condenser coil.

d. "Cap" in EER and COPH equations for PTACs and PTHPs means cooling capacity in Btu/h at 95°F outdoor dry-bulb temperature.

e. This table is a replica of ASHRAE 90.1 Table 6.8.1-4 Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single- Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(5)**

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[g]

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[d, e]	TEST PROCEDURE[a]
Warm-air furnaces, gas fired	< 225,000 Btu/h	Maximum capacity[c]	80% E_t[b,d] before 1/1/2023 81%E_t[d] after 1/1/2023	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnaces, oil fired	< 225,000 Btu/h	Maximum capacity[c]	80% E_t before 1/1/2023 82%E_t[d] after 1/1/2023	Section 42, Combustion, UL 727
Warm-air duct furnaces, gas fired	All capacities	Maximum capacity[c]	80%E_c[e]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, gas fired	All capacities	Maximum capacity[c]	80%E_c[e,f]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, oil fired	All capacities	Maximum capacity[c]	80%E_c[e,f]	Section 40, Combustion, UL 731

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. Combination units (i.e., furnaces contained within the same cabinet as an air conditioner) not covered by DOE 10

CFR 430 (i.e., three-phase power or with cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating. All other units greater than 225,000 Btu/h sold in the US must meet the AFUE standards for consumer products and test using USDOE's AFUE test procedure at DOE 10 CFR 430, Subpart B, Appendix N.

c. Compliance of multiple firing rate units shall be at the maximum firing rate.

d. Et = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

e. Ec = combustion efficiency (100 percent less flue losses). See test procedure for detailed discussion.

f. Units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

g. This table is a replica of ASHRAE 90.1 Table 6.8.1-5 Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(6)**

TABLE C403.3.2(6)
GAS- AND OIL-FIRED BOILERS: MINIMUM EFFICIENCY REQUIREMENTS[i]

EQUIPMENT TYPE[a]	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY[d, e]	EFFICIENCY AS OF 3/2/2022	TEST PROCEDURE
Boilers, hot water	Gas fired	< 300,000 Btu/h[g, h]	82% AFUE	82% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	80% E_t[d]	80% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	82% E_c[c]	82% E_c[c]	
	Oil fired[f]	< 300,000 Btu/h[g]	84% AFUE	84% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[b]	82% E_t[d]	82% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[a]	84% E_c[c]	84% E_c[c]	
Boilers, steam	Gas fired	< 300,000 Btu/h[g]	80% AFUE	80% AFUE	DOE 10 CFR 430 Appendix N
	Gas fired- all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	79% *v*	79% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	79% E_t[d]	79% E_t[d]	
	Gas fired-natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	77% E_t[d]	79% E_t[d]	
		> 2,500,000 Btu/h[b]	77% E_t[d]	79% E_t[d]	
	Oil-fired[f]	< 300,000 Btu/h[g]	82% AFUE	82% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	81% E_t[d]	81% E_t[d]	DOE 10 CFR 431.86

		> 2,500,000 Btu/h[b]	81% E_t^a	81% E_t^a	

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.
b. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum effi- ciency requirements for boilers cover all capacities of packaged boilers.
c. Ec = Combustion efficiency (100 percent less flue losses).
d. Et = Thermal efficiency.
e. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
f. Includes oil-fired (residual).
g. Boilers shall not be equipped with a constant burning pilot light.
h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
i. This table is a replica of ASHRAE 90.1 Table 6.8.1-6 Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements

delete and replace **TABLE C403.3.2(7)**

TABLE C403.3.2(7)

PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE[a]	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION[i]	PERFORMANCE REQUIRED[b, c, d, g, h]	TEST PROCEDURE[e, f]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥ 40.2 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥ 20.0 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥ 16.1 gpm/hp	CTI ATC-105S and CTI STD-201 RS
Centrifugal fan closed- circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥ 7.0 gpm/hp	CTI ATC-105S and CTI STD-201 RS
Propeller or axial fan dry coolers (Air-	All	115°F entering water 105°F leaving water 95°F entering wb	≥ 4.5 gpm/hp	CTI ATC-105DS

cooled fluid coolers)				
Propeller or axial fan evaporative condensers	All	R-448A Test Fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥ 160,000 Btu/hr x hp	CTI ATC-106
Propeller or axial fan evaporative condensers	All	Ammonia Test Fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥ 134,000 Btu/h × hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-448A Test Fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥137,000 Btu/h × hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia Test Fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥ 110,000 Btu/h × hp	CTI ATC-106
Air-cooled condensers	All	125°F Condensing Temperature 190°F Entering Gas Temperature 15°F subcooling 95°F entering db	≥ 176,000 Btu/h × hp	AHRI 460

For SI: °C = [(°F) – 32]/1.8, L/s × kW = (gpm/hp)/(11~~)~~.83), COP = (Btu/h × hp)/(2550.7), db = dry bulb temperature, wb = wet bulb temperature.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. For purposes of this table, open-circuit cooling tower performance is defined as the water-flow rating of the tower at the thermal rating condition listed in the table divided by the fan motor nameplate power.

c. For purposes of this table, closed-circuit cooling tower performance is defined as the process water-flow rating of the tower at the thermal rating condition listed in the table divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

d. For purposes of this table, dry-cooler performance is defined as the process water-flow rating of the unit at the thermal rating condition listed in the table divided by the total fan motor nameplate power of the unit, and air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the total fan motor nameplate power of the unit.

e. The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field-erected cooling towers.

f. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.

g. For purposes of this table, evaporative condenser performance is defined as the heat rejected at the specified rating condition in the table, divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.

h. Requirements for evaporative condensers are listed with ammonia (R-717) and R-448A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-448A must meet the minimum efficiency requirements listed with R-448A as the test fluid. For ammonia, the condensing temperature is defined as the saturation temperature corresponding to the refrigerant pressure at the condenser entrance. For R-448A, which is a zeotropic refrigerant, the condensing temperature is defined as the arithmetic average of the dew point and the bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance.

i. This table is a replica of ASHRAE 90.1 Table 6.8.1-7 Performance Requirements for Heat Rejection Equipment—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(8)**

TABLE C403.3.2(8)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS – MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
VRF air conditioners, air cooled	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.2 EER 15.5 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.0 EER 14.9 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.0 EER 13.9 IEER	

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.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-8 Electrically Operated Variable-Refrigerant-Flow Air Conditioners—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(9)**

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

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
VRF air cooled (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000	Electric resistance (or none)	VRF multisplit system	11.0 EER14.6 IEER	

	Btu/h		VRF multisplit system with heat recovery	10.8 EER 14.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		VRF multisplit system	10.6 EER 13.9 IEER	
			VRF multisplit system with heat recovery	10.4 EER 13.7 IEER	
	≥ 240,000 Btu/h		VRF multisplit system	9.5 EER 12.7 IEER	
			VRF multisplit system with heat recovery	9.3 EER 12.5 IEER	
VRF water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system 86°F entering water	12.0 EER 16.0 IEER	AHRI 1230
			VRF multisplit system 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	
VRF	< 135,000 Btu/h	All	VRF multisplit	16.2 EER	AHRI 1230

groundwater source (cooling mode)		-	VRF multisplit system 59°F entering water		
			VRF multisplit system with heat recovery 59°F entering water	16.0 EER	
	≥ 135,000 Btu/h		VRF multisplit system 59°F entering water	13.8 EER	
			VRF multisplit system with heat recovery 59°F entering water	13.6 EER	
VRF ground source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 77°F entering water	13.4 EER	AHRI 1230
			VRF multisplit system with heat recovery 77°F entering water	13.2 EER	
	≥ 135,000 Btu/h		VRF multisplit system 77°F entering water	11.0 EER	
			VRF multisplit system with heat recovery 77°F entering water	10.8 EER	
VRF air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)	-	VRF multisplit system	7.7 HSPF	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb outdoor air	3.3 COPh	
			17°F db/15°F wb outdoor air	2.25 COPh	
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb outdoor air	3.2 COPh	
			17°F db/15°F wb outdoor air	2.05 COPh	
VRF water source (heating	<65,000 Btu/hr (cooling capacity)		VRF multisplit system	4.2 COPh 4.3 COPh	AHRI 1230

mode)			68°F entering water		
	≥ 65,000 Btu/hr and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.2 COPh 4.3 COPh	
	≥ 135,000 Btu/h and <240,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	3.9 COPh 4.0 COPh	
	≥240,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	3.9 COPh	

TABLE C403.3.2(9)—(continued)

MINIMUM EFFICIENCY ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR-TO-AIR AND APPLIED HEAT PUMPS

~~**TABLE C403.3.2(11)**~~

~~**MINIMUM EFFICIENCY ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR-TO-AIR AND APPLIED HEAT PUMPS**~~

EQUIPMENT ~~TYPE~~aTYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
~~VRF air cooled (cooling mode)~~	~~< 65,000 Btu/h~~	~~All~~	~~VRF multisplit system~~	~~13.0 SEER~~	~~AHRI 1230~~
	~~≥ 65,000 Btu/h and < 135,000 Btu/h~~	~~None~~	~~VRF multisplit system~~	~~11.0 EER 14.6 IEER~~	
	~~≥ 65,000 Btu/h and < 135,000 Btu/h~~	~~None~~	~~VRF multisplit system with heat recovery~~	~~10.8 EER 14.4 IEER~~	
	~~≥ 135,000 Btu/h and < 240,000 Btu/h~~	~~None~~	~~VRF multisplit system~~	~~10.6 EER 13.9 IEER~~	
	~~≥ 135,000 Btu/h and < 240,000 Btu/h~~	~~None~~	~~VRF multisplit system with heat recovery~~	~~10.4 EER 13.7 EER~~	
	~~≥ 240,000 Btu/h~~	~~None~~	~~VRF multisplit system~~	~~9.5 EER 12.7 IEER~~	
	~~≥ 240,000 Btu/h~~	~~None~~	~~VRF multisplit system with heat recovery~~	~~9.3 EER 12.5 IEER~~	

VRF ~~water~~ groundwater source ~~(cooling~~ (heating mode)	~~< 65~~< 135,000 Btu/h (cooling capacity)	All	VRF multisplit system ~~86~~ 50°F entering water	~~12.0 EER 16.0 IEER~~3.6 COPh	AHRI 1230
	~~< 65,000 Btu/h~~	~~All~~	~~VRF multisplit system with heat recovery 86°F entering water~~	~~11.8 EER 15.8 IEER~~	
	~~≥ 65,000 Btu/h and <~~≥ 135,000 Btu/h (cooling capacity)	~~All~~	VRF multisplit system ~~86~~ 50°F entering water	~~12.0 EER 16.0 IEER~~3.3 COPh	
	~~≥ 65,000 Btu/h and < 135,000 Btu/h~~	~~All~~	~~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~~	~~All~~	~~VRF multisplit system 86°F entering water~~	~~10.0 EER 14.0 IEER~~	
	~~≥ 135,000 Btu/h and < 240,000 Btu/h~~	~~All~~	~~VRF multisplit system with heat recovery 86°F entering water~~	~~9.8 EER 13.8 IEER~~	
	~~≥ 240,000 Btu/h~~	~~All~~	~~VRF multisplit system 86°F entering water~~	~~10.0 EER 12.0 IEER~~	
	~~≥ 240,000 Btu/h~~	~~All~~	~~VRF multisplit system with heat recovery 86°F entering water~~	~~9.8 EER 11.8 IEER~~	
VRF groundwater source ~~(cooling~~ (heating mode)	< 135,000 Btu/h (cooling capacity)	~~All~~	VRF multisplit system ~~59~~ 32°F entering water	~~16.2 EER~~3.1 COPh	AHRI 1230
	~~< 135,000 Btu/h~~	~~All~~	~~VRF multisplit system with heat recovery 59°F entering water~~	~~16.0 EER~~	
	~~≥ 135,000 Btu/h~~	~~All~~	~~VRF multisplit system 59°F entering water~~	~~13.8 EER~~	

	~~≥ 135,000 Btu/h~~	~~All~~	~~VRF multisplit system with heat recovery 59°F entering water~~	~~13.6 EER~~	
~~VRF ground source (cooling mode)~~	~~<~~≥ 135,000 Btu/h (cooling capacity)	~~All~~	VRF multisplit system ~~77~~ 32°F entering water	~~13.4 EER~~2.8 COPh	~~AHRI 1230~~
	~~< 135,000 Btu/h~~	~~All~~	~~VRF multisplit system with heat recovery 77°F entering water~~	~~13.2 EER~~	
	~~≥ 135,000 Btu/h~~	~~All~~	~~VRF multisplit system 77°F entering water~~	~~11.0 EER~~	
	~~≥ 135,000 Btu/h~~	~~All~~	~~VRF multisplit system with heat recovery 77°F entering water~~	~~10.8 EER~~	
~~VRF air cooled (heating mode)~~	~~< 65,000 Btu/h (cooling capacity)~~	~~—~~	~~VRF multisplit system~~	~~10.0 HSPF~~	~~AHRI 1230~~
	~~≥ 65,000 Btu/h and < 135,000 Btu/h~~	~~—~~	~~VRF multisplit system 47°F db/43°F wb outdoor air~~	~~3.3 COP$_H$~~	
			~~17°F db/15°F wb outdoor air~~	~~2.25 COP$_H$~~	
	~~≥ 135,000 Btu/h (cooling capacity)~~	~~—~~	~~VRF multisplit system 47°F db/43°F wb outdoor air~~	~~3.2 COP$_H$~~	
			~~17°F db/15°F wb outdoor air~~	~~2.05 COP$_H$~~	
~~VRF water source (heating mode)~~	~~< 135,000 Btu/h~~	~~—~~	~~VRF multisplit system 68°F entering water~~	~~4.3 COP$_H$~~	~~AHRI 1230~~
	~~≥ 135,000 Btu/h~~	~~—~~	~~VRF multisplit system 68°F entering water~~	~~4.0 COP$_H$~~	
~~VRF groundwater source (heating mode)~~	~~< 135,000 Btu/h~~	~~—~~	~~VRF multisplit system 50°F entering water~~	~~3.6 COP$_H$~~	~~AHRI 1230~~
	~~≥ 135,000 Btu/h~~	~~—~~	~~VRF multisplit system 50°F entering water~~	~~3.3 COP$_H$~~	

~~VRF groundwater source (heating mode)~~	~~< 135,000 Btu/h~~	—	~~VRF multisplit system 32°F entering water~~	~~3.1 COP_H~~	~~AHRI 1230~~
	~~≥ 135,000 Btu/h~~	—	~~VRF multisplit system 32°F entering water~~	~~2.8 COP_H~~	

~~*modify*~~ For SI: °C = [(°F) – 32]/1.8, 1 British thermal unit per hour = 0.2931 W, db = dry bulb temperature, wb = wet bulb temperature.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-9 Electrically Operated Variable-Refrigerant-Flow and Applied Heat Pumps—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(10)**

~~HEAT TRANSFER EQUIPMENT~~ ~~to~~ TABLE C403.3.2(~~12)~~ 10)
FLOOR MOUNTED AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS – MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	STANDARD MODEL	NET SENSIBLE COOLING CAPACITY	MINIMM NET SENSIBLE COP	RATING CONDITIONS RETURN AIR (dry bulb/dew point)	TEST PROCEDURE[a]
Air cooled	Downflow	<80,000 Btu/h	2.70	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.58		
		≥295,000 Btu/h	2.36		
	Upflow-ducted	<80,000 Btu/h	2.67		
		≥80,000 Btu/h and <295,000 Btu/h	2.55		
		≥295,000 Btu/h	2.33		
	Upflow-nonducted	65,000 Btu/h	2.16	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	2.04		
		≥240,000 Btu/h	1.89		
	Horizontal	<65,000 Btu/h	2.65	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.55		
		≥240,000 Btu/h	2.47		
Air cooled with fluid economizer	Downflow	<80,000 Btu/h	2.70	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.58		
		≥295,000 Btu/h	2.36		
	Upflow-ducted	<80,000 Btu/h	2.67		
		≥80,000 Btu/h and <295,000 Btu/h	2.55		
		≥295,000 Btu/h	2.33		
	Upflow-nonducted	65,000 Btu/h	2.16	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	2.04		
		≥240,000 Btu/h	1.89		
	Horizontal	<65,000 Btu/h	2.65	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.55		
		≥240,000 Btu/h	2.47		
Water cooled	Downflow	<80,000 Btu/h	2.82		AHRI 1360

		≥80,000 Btu/h and <295,000 Btu/h	2.73	85°F/52°F (Class 1)	
		≥295,000 Btu/h	2.67		
	Upflow-ducted	<80,000 Btu/h	2.79		
		≥80,000 Btu/h and <295,000 Btu/h	2.70		
		≥295,000 Btu/h	2.64		
	Upflow-nonducted	65,000 Btu/h	2.43	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	2.32		
		≥240,000 Btu/h	2.20		
	Horizontal	<65,000 Btu/h	2.79	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.70		
		≥240,000 Btu/h	2.64		
Water cooled with fluid economizer	Downflow	<80,000 Btu/h	2.77	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.68		
		≥295,000 Btu/h	2.61		
	Upflow-ducted	<80,000 Btu/h	2.74		
		≥80,000 Btu/h and <295,000 Btu/h	2.65		
		≥295,000 Btu/h	2.58		
	Upflow-nonducted	65,000 Btu/h	2.35	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	2.24		
		≥240,000 Btu/h	2.12		
	Horizontal	<65,000 Btu/h	2.71	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.60		
		≥240,000 Btu/h	2.54		
Glycol cooled	Downflow	<80,000 Btu/h	2.56	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.24		
		≥295,000 Btu/h	2.21		
	Upflow-ducted	<80,000 Btu/h	2.53		
		≥80,000 Btu/h and <295,000 Btu/h	2.21		
		≥295,000 Btu/h	2.18		
	Upflow-nonducted	65,000 Btu/h	2.08	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	1.90		
		≥240,000 Btu/h	1.81		
	Horizontal	<65,000 Btu/h	2.48	95°F/52°F (Class 3)	
		≥65,000 Btu/h and <240,000 Btu/h	2.18		
		≥240,000 Btu/h	2.18		
Glycol cooled with fluid economizer	Downflow	<80,000 Btu/h	2.51	85°F/52°F (Class 1)	AHRI 1360
		≥80,000 Btu/h and <295,000 Btu/h	2.19		
		≥295,000 Btu/h	2.15		
	Upflow-ducted	<80,000 Btu/h	2.48		
		≥80,000 Btu/h and <295,000 Btu/h	2.16		
		≥295,000 Btu/h	2.12		
	Upflow-nonducted	65,000 Btu/h	2.00	75°F/52°F (Class 1)	
		≥65,000 Btu/h and <240,000 Btu/h	1.82		
		≥240,000 Btu/h	1.73		
	Horizontal	<65,000 Btu/h	2.44		

		≥65,000 Btu/h and <240,000 Btu/h	2.10	95°F/52°F (Class 3)	
		≥240,000 Btu/h	2.10		

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8, COP = (Btu/h × hp)/(2,550.7).
a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.
b. This table is a replica of ASHRAE 90.1 Table 6.8.1-10 Floor-Mounted Air Conditioners and Condensing Units Serving Computer Rooms—Minimum Effi- ciency Requirements.

delete and replace **TABLE C403.3.2(11)**

Table C403.3.2(11) VAPOR-COMPRESSION BASED INDOOR POOL DEHUMIDIFIERS – MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[b]
Single package indoor (with or without economizer)	Rating Conditions: A or C	3.5 MRE	AHRI 910
Single package indoor water cooled (with or without economizer)	Rating Conditions: A, B or C	3.5 MRE	
Single package indoor air cooled (with or without economizer)	Rating Conditions: A, B or C	3.5 MRE	
Single package indoor air cooled (with or without economizer)	Rating Conditions: A, B or C	2.5 MRE	

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.
b. This table is a replica of ASHRAE 90.1 Table 6.8.1-12 Vapor-Compression-Based Indoor Pool Dehumidifiers—Minimum Efficiency Requirements.

delete and replace **TABLE C403.3.2(12)**

TABLE C403.3.2(12) ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITHOUT ENERGY RECOVERY– MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (dehumidification mode)	-	4.0 ISMRE	AHRI 920
Air-source heat pumps (dehumidification mode)	-	4.0 ISMRE	AHRI 920
Water cooled (dehumidification mode)	Cooling tower condenser water	4.9 ISMRE	AHRI 920
	Chilled water	6.0 ISMRE	
Air-source heat pump (dehumidification mode)	-	2.7 ISCOP	AHRI 920

Water-source heat pump (dehumidification mode)	Ground source, closed loop	4.8 ISMRE	AHRI 920
	Ground-water source	5.0 ISMRE	
	Water source	4.0 ISMRE	
Water-source heat pump (heating mode)	Ground source, closed loop	2.0 ISCOP	AHRI 920
	Ground-water source	3.2 ISCOP	
	Water source	3.5 ISCOP	

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-13 Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, without Energy Recovery—Minimum Efficiency Requirements.

add **TABLE C403.3.2(13)**

Table C403.3.2(13)
ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITH ENERGY RECOVERY– MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (dehumidification mode)	-	5.2 ISMRE	AHRI 920
Air-source heat pumps (dehumidification mode)	-	5.2 ISMRE	AHRI 920
Water cooled (dehumidification mode)	Cooling tower condenser water	5.3 ISMRE	AHRI 920
	Chilled water	6.6 ISMRE	
Air-source heat pump (dehumidification mode)	-	3.3 ISCOP	AHRI 920
Water-source heat pump (dehumidification mode)	Ground source, closed loop	5.2 ISMRE	AHRI 920
	Ground-water source	5.8 ISMRE	
	Water source	4.8 ISMRE	
Water-source heat pump (heating mode)	Ground source, closed loop	3.8 ISCOP	AHRI 920
	Ground-water source	4.0 ISCOP	
	Water source	4.8 ISCOP	

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-14 Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, with Energy Recovery—Minimum Efficiency Requirements.

add **TABLE C403.3.2(14)**

TABLE C403.3.2(14)

ELECTRICALLY OPERATED WATER-SOURCE HEAT PUMPS– MINIMUM EFFICIENCY REQUIREMENTS[c]

EQUIPMENT TYPE	SIZE CATEGORY[b]	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Water-to-air, water loop (cooling mode)	<17,000 Btu/h	All	86°F entering water	12.2 EER	ISO 13256-1
	≥17,000 Btu/h and <65,000 Btu/h			13.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h			13.0 EER	
Water-to-air, ground water (cooling mode)	<135,000 Btu/h (cooling capacity)	All	59°F entering water	18.0 EER	ISO 13256-1
Brine-to-air, ground loop (cooling mode)	<135,000 Btu/h (cooling capacity)	All	77°F entering water	14.1 EER	ISO 13256-1
Water-to-water, water loop (cooling mode)	<135,000 Btu/h (cooling capacity)	All	86°F entering water	10.6 EER	ISO 13256-2
Water-to-water, ground water (cooling mode)	<135,000 Btu/h (cooling capacity)	All	59°F entering water	16.3 EER	ISO 13256-2
Brine-to-water, ground loop (cooling mode)	<135,000 Btu/h (cooling capacity)	All	77°F entering water	12.1 EER	ISO 13256-2
Water-to-water, water loop (heating mode)	<135,000 Btu/h (cooling capacity)	-	68°F entering water	4.3 COP_H	ISO 13256-1
Water-to-air, ground water (heating mode)	<135,000 Btu/h (cooling capacity)	-	50°F entering water	3.7 COP_H	ISO 13256-1
Brine-to-air, ground loop (heating mode)	<135,000 Btu/h (cooling capacity)	-	32°F entering water	3.2 COP_H	ISO 13256-1
Water-to-water, water loop (heating mode)	<135,000 Btu/h (cooling capacity)	-	68°F entering water	3.7 COP_H	ISO 13256-1
Water-to-water, ground water (heating mode)	<135,000 Btu/h (cooling capacity)	-	50°F entering water	3.1 COP_H	ISO 13256-1
Brine-to-water, ground loop (heating mode)	<135,000 Btu/h (cooling capacity)	-	32°F entering water	2.5 COP_H	ISO 13256-1

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Single-phase, US air-cooled heat pumps less than 19 kW are regulated as consumer products by DOE 10 CFR 430. SCOPC, SCOP2C, SCOPH and SCOP2H values for single-phase products are set by the USDOE.

c. This table is a replica of ASHRAE 90.1 Table 6.8.1-15 Electrically Operated Water-Source Heat Pumps—Minimum Efficiency Requirements.

add **TABLE C403.3.2(15)**

TABLE C403.3.2(15)
HEAT ~~TRANSFER EQUIPMENT~~ PUMP AND HEAT RECOVERY CHILLER PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY, tonR	COOLING-ONLY OPERATION COOLING EFFICIENCY[c] AIR SOURCE EET (FL/IPLV), Btu/W x h WATER-SOURCE POWER INPUT PER CAPACITY (FL/IPLV), kW/tonR		HEATING SOURCE CONDITIONS (entering/ leaving water) OR OAT (db/wb), °F	Heating Operation: HEAT-PUMP HEATING FULL-LOAD EFFICIENCY (COPH)b, W/W				HEAT RECOVERY CHILLER FULL-LOAD EFFICIENCY (COPHR)c,d, W/W SIMULTANEOUS COOLING AND HEATING FULL-LOAD EFFICIENCY (COPSHC)c, W/W				Test Procedure[a]
					Leaving Heating Water Temperature				Leaving Heating Water Temperature				
					Low	Medium	High	Boost	Low	Medium	High	Boost	
		Path A	Path B		105°F	120°F	140°F	140°F	105°F	120°F	140°F	140°F	
Air source	All sizes	≥ 9.595 FL	≥ 9.595 FL	47 db	≥ 3.290	≥ 2.770	≥ 2.310	NA	NA	NA	NA	NA	AHRI 550/590
		≥ 13.02 IPLV.IP	≥ 13.02 IPLV.IP	43 wb[e]	≥ 2.230	≥ 1.950	≥ 1.630	NA	NA	NA	NA	NA	
Water-source electrically operated positive displacement	<75	≤ 0.7885 FL	≤ 0.7875 FL ≤ 0.5145 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	AHRI 550/590
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	6.150	
	≥75 and <150	≤ 0.6316 IPLV.IP	≤ 0.7140 FL ≤ 0.4620 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	6.150	
	≥150 and<300	≤ 0.7579 FL ≤ 0.5895 IPLV.IP	≤ 0.7140 FL ≤ 0.4620 IPLV.IP	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
				75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	6.150	
	≥300 and <600	≤ 0.6947 FL ≤ 0.5684 IPLV.IP	≤ 0.6563 FL ≤ 0.4305 IPLV.IP	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000	NA	
				75/65[f]	NA	NA	NA	≥ 3.900	NA	NA	NA	≥ 6.850	
	≥600	≤ 0.6421 FL ≤ 0.5474 IPLV.IP	≤ 0.6143 FL ≤ 0.3990 IPLV.IP	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000		
				75/65[f]	NA	NA	NA	≥ 3.900	NA	NA	NA	≥ 6.850	
Water-source electrically operated centrifugal	<75	≤ 0.6421 FL	≤ 0.7316 FL	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	AHRI 550/590
		≤ 0.5789 IPLV.IP	≤ 0.4632 IPLV.IP	75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	≥ 6.150	
	≥75 and <150	≤ 0.5895 FL ≤ 0.5474 IPLV.IP	≤ 0.6684 FL	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
			≤ 0.4211 IPLV.IP	75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	≥ 6.150	
	≥150 and<300	≤ 0.5895 FL	≤ 0.6263 FL	54/44[f]	≥ 4.640	≥ 3.680	≥ 2.680	NA	≥ 8.330	≥ 6.410	≥ 4.420	NA	
		≤ 0.5263 IPLV.IP	≤ 0.4105 IPLV.IP	75/65[f]	NA	NA	NA	≥ 3.550	NA	NA	NA	≥ 6.150	
	≥300 and <600	≤ 0.5895 FL	≤ 0.6158 FL	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000	NA	
		≤ 0.5263 IPLV.IP	≤ 0.4000 IPLV.IP	75/65[f]	NA	NA	NA	≥ 3.900	NA	NA		≥ 6.850	
	≥600	≤ 0.5895 FL	≤ 0.6158 FL	54/44[f]	≥ 4.930	≥ 3.960	≥ 2.970	NA	≥ 8.900	≥ 6.980	≥ 5.000	NA	
		≤ 0.5263 IPLV.IP	≤ 0.4000 IPLV.IP	75/65[f]	NA	NA	NA	≥ 3.900	NA	NA	NA	≥ 6.850	

For SI: °C = [(°F) – 32]/1.8.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Cooling-only rating conditions are standard rating conditions defined in AHRI 550/590, Table 1.

c. Heating full-load rating conditions are at rating conditions defined in AHRI 550/590, Table 1.

d. For water-cooled heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser, the COPHR applies to operation at full load with 100 percent heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table C403.3.2(3).

e. Outdoor air entering dry-bulb (db) temperature and wet-bulb (wb) temperature.

f. Source-water entering and leaving water temperature.

g. This table is a replica of ASHRAE 90.1 Table 6.8.1-16 Heat-Pump and Heat Recovery Chiller Packages—Minimum Efficiency Requirements.

add **TABLE C403.3.2(16)**

TABLE C403.3.2(16)
CEILING-MOUNTED COMPUTER-ROOM AIR CONDITIONERS-MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	STANDARD MODEL	NET SENSIBLE COOLING CAPACITY	MINIMM NET SENSIBLE COP	RATING CONDITIONS RETURN AIR (dry bulb/dew point)	TEST PROCEDURE[a]
Air cooled with freeair discharge condenser	Ducted	<29,000 Btu/h	2.05	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	2.02		
		≥65,000 Btu/h	1.92		
		<29,000 Btu/h	2.08		
		≥29,000 Btu/h and <65,000 Btu/h	2.05		
		≥65,000 Btu/h	1.94		
	Nonducted	<29,000 Btu/h	2.01		
		≥29,000 Btu/h and <65,000 Btu/h	1.97		
		≥65,000 Btu/h	1.87		
		<29,000 Btu/h	2.04		
		≥29,000 Btu/h and <65,000 Btu/h	2.00		
		≥65,000 Btu/h	1.89		
Air cooled with freeair discharge condenser with fluid economizer	Ducted	<29,000 Btu/h	1.86	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.83		
		≥65,000 Btu/h	1.73		
		<29,000 Btu/h	1.89		
		≥29,000 Btu/h and <65,000 Btu/h	1.86		
		≥65,000 Btu/h	1.75		
	Nonducted	<29,000 Btu/h	1.82		
		≥29,000 Btu/h and <65,000 Btu/h	1.78		
		≥65,000 Btu/h	1.68		
		<29,000 Btu/h	1.85		
		≥29,000 Btu/h and <65,000 Btu/h	1.81		
		≥65,000 Btu/h	1.70		
Air cooled with ducted condenser	Ducted	<29,000 Btu/h	2.38	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	2.28		

		≥65,000 Btu/h	2.18		
		<29,000 Btu/h	2.41		
		≥29,000 Btu/h and <65,000 Btu/h	2.31		
		≥65,000 Btu/h	2.20		
	Nonducted	<29,000 Btu/h	2.05		
		≥29,000 Btu/h and <65,000 Btu/h	2.02		
		≥65,000 Btu/h	1.92		
		<29,000 Btu/h	2.08		
		≥29,000 Btu/h and <65,000 Btu/h	2.05		
		≥65,000 Btu/h	1.94		
Air cooled with fluid economizer and ducted condenser	Ducted	<29,000 Btu/h	2.01	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.97		
		≥65,000 Btu/h	1.87		
		<29,000 Btu/h	2.04		
		≥29,000 Btu/h and <65,000 Btu/h	2.00		
		≥65,000 Btu/h	1.89		
	Nonducted	<29,000 Btu/h	1.86		
		≥29,000 Btu/h and <65,000 Btu/h	1.83		
		≥65,000 Btu/h	1.73		
		<29,000 Btu/h	1.89		
		≥29,000 Btu/h and <65,000 Btu/h	1.86		
		≥65,000 Btu/h	1.75		
Water cooled	Ducted	<29,000 Btu/h	1.82	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.78		
		≥65,000 Btu/h	1.68		
		<29,000 Btu/h	1.85		
		≥29,000 Btu/h and <65,000 Btu/h	1.81		
		≥65,000 Btu/h	1.70		
	Nonducted	<29,000 Btu/h	2.38		
		≥29,000 Btu/h and <65,000 Btu/h	2.28		
		≥65,000 Btu/h	2.18		
		<29,000 Btu/h	2.41		
		≥29,000 Btu/h and <65,000 Btu/h	2.31		
		≥65,000 Btu/h	2.20		
Water cooled with fluid economizer	Ducted	<29,000 Btu/h	2.33	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	2.23		

		≥65,000 Btu/h	2.13		
		<29,000 Btu/h	2.36		
		≥29,000 Btu/h and <65,000 Btu/h	2.26		
		≥65,000 Btu/h	2.16		
	Nonducted	<29,000 Btu/h	1.97		
		≥29,000 Btu/h and <65,000 Btu/h	1.93		
		≥65,000 Btu/h	1.78		
		<29,000 Btu/h	2.00		
		≥29,000 Btu/h and <65,000 Btu/h	1.98		
		≥65,000 Btu/h	1.81		
Glycol cooled	Ducted	<29,000 Btu/h	1.92	75°F/52°F (Class 1)	AHRI 1360
		≥29,000 Btu/h and <65,000 Btu/h	1.88		
		≥65,000 Btu/h	1.73		
Glycol cooled with fluid economizer	Nonducted	<29,000 Btu/h	1.95		
		≥29,000 Btu/h and <65,000 Btu/h	1.93		
		≥65,000 Btu/h	1.76		

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) – 32]/1.8, COP = (Btu/h × hp)/(2,550.7).
a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.
b. This is a replica of ASHRAE 90.1 Table 6.8.1-17 Ceiling-Mounted Computer-Room Air Conditioners—Minimum Efficiency Requirements.

delete and replace~~–~~ **C403.3.2.1 Water-cooled centrifugal chilling packages** ~~**(Mandatory).**~~

Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F (7°C) leaving chilled-water temperature and 2.4 gpm/ton evaporator fluid flow and 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 I/s • kW) condenser water flow shall have maximum full-load kW/ton (FL) and part-load ratings requirements adjusted using Equations 4-5 and 4-6.

$FL_{adj} = FL/K_{adj}$ **(Equation 4-5)**

$PLV_{adj} = IPLV.IP/K_{adj}$ **(Equation 4-6)**

~~where:~~

K_{adj} = A × B

FL = Full-load kW/ton value as specified in Table C403.3.2(~~7~~3).

FL_{adj}	=	Maximum full-load kW/ton rating, adjusted for nonstandard conditions.
$IPLV.IP$	=	~~Value as specified in~~IPLV.IP value from Table C403.3.2(~~7~~2).
PLV_{adj}	=	Maximum *NPLV* rating, adjusted for nonstandard conditions.
A	=	$0.00000014592 \times (LIFT)^4$ - $0.0000346496 \times (LIFT)^3 +$ $0.00314196 \times (LIFT)^2$ ~~–~~- $0.147199 \times (LIFT) +$ 3.~~9302~~93073
B	=	$0.0015 \times L_{vg}E_{vap} + 0.934$
$LIFT$	=	$L_{vg}Cond$ ~~–~~- $L_{vg}E_{vap}$
$L_{vg}Cond$	=	Full-load condenser leaving fluid temperature (°F).
$L_{vg}E_{vap}$	=	Full-load evaporator leaving temperature (°F).

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

1. ~~Minimum evaporator leaving temperature:~~ 36.00°F~~.~~ $\leq L_{vg}E_{vap} \leq$ 60.00°F

2. Maximum condenser leaving temperature: 115°F.

3. 20°F ≤ LIFT ≤ 80°F.

~~-~~Manufacturers shall calculate the FL_{adj} and PLV_{adj} before determining whether to label the chiller. Centrifugal chillers designed to operate outside of these ranges are not covered by this code.

add **C403.3.2.2 Positive Displacement (Air- and water-cooled) chilling packages**
Equipment with a leaving fluid temperature higher than 32°F (0°C) and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115°F (46°C) shall meet the requirements of Table C403.3.2(7) when tested or certified with water at standard rating conditions, in accordance with the referenced test procedure.

delete and replace ~~-~~**C403.3.3 Hot gas bypass**~~.~~
~~The~~ **limitation.**
Cooling systems shall not use ~~of~~ hot gas bypass ~~is prohibited in all systems.~~ or other evaporator pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of the hot gas bypass shall be limited as indicated in Table C403.3.3. as limited by Section 403.5.1.

~~*- delete -*~~*add* **Table C403.3.3**

Table C403.3.3
MAXIMUM HOT GAS BYPASS CAPACITY

RATED CAPACITY	MAXIMUM HOT GAS BYPASS CAPACITY (% of total capacity)
≤ 240,000 Btu/h	50
> 240,000 Btu/h	25

delete ~~*and replace -*~~**(Mandatory)** from **C403.4.1 Thermostatic controls (Mandatory)**

delete and replace **C403.4.1.1 Heat pump supplementary heat** ~~**(Mandatory).**~~
Heat pumps having supplementary electric resistance heat shall ~~be certified *cold-climate heat pumps* meeting the requirements of section C403.2.3.~~have controls that limit supplemental heat operation to only those times when one of the following applies:

~~*- delete and replace -* **C403.4.1.4 Heated vestibules (Mandatory).**~~
~~The heating system for heated vestibules and air curtains with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than 55°F (16°C). Vestibule heating systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 55°F (16°C). Cooling of the vestibule is prohibited.~~

> ~~**Exception:** Control of heating or cooling provided by site-recovered energy or transfer air that would otherwise be exhausted.~~

1. ~~- delete and replace -~~The vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
2. The heat pump is operating in defrost mode.
3. Only for buildings that require heat for health and safety: the vapor compression cycle malfunctions.
4. Only for buildings that require heat for health and safety: the thermostat malfunctions.

delete **(Mandatory)** from **C403.4.1.2 Deadband (Mandatory)**
delete **(Mandatory)** from **C403.4.1.3 Setpoint overlap restriction (Mandatory)**
delete **or cooled** and **(Mandatory)** from **C403.4.1.4 Heated or cooled vestibules (Mandatory)**
delete **(Mandatory)** from **C403.4.1.5 Hot water boiler outdoor temperature setback control (Mandatory**~~).~~
~~Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have a setback control that lowers the boiler water temperature based on the outdoor temperature or based on building terminal loads.~~**)**

~~- delete and replace -~~*delete* **(Mandatory)** from **C403.4.2 Off-hour controls (Mandatory)**
delete **(Mandatory)** from **C403.4.2.1 Thermostatic setback (Mandatory**~~).~~
~~Thermostatic~~**)**
delete **(Mandatory)** from **C403.4.2.2 Automatic setback and shutdown (Mandatory)**

delete and replace **C403.4.2.3 Automatic start and stop**
Automatic start controls shall be provided for each HVAC system. The automatic start controls shall be configured to ~~set back or temporarily operate~~automatically adjust the daily start time of the HVAC system in order to ~~maintain zone temperatures down~~bring each space to ~~60°F (13°C) or up~~the desired occupied temperature immediately prior to ~~80°F (29°C).~~scheduled occupancy. Automatic stop controls shall be provided for each HVAC system with direct digital control of individual zones. The automatic stop controls shall be configured to reduce the HVAC system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 2°F (0.555ºC) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.

~~**Exceptions:**~~

~~Zones served exclusively by~~Exception: Cold-climate heat ~~pumps.~~pump systems

~~-~~*delete and replace* ~~-~~**C403.4.3.3.2 Heat rejection.**
The following shall apply to hydronic water loop heat pump systems:

1. Where a closed-circuit cooling tower is used directly in the heat pump loop, either an automatic valve shall be installed to bypass the flow of water around the closed-circuit cooling tower, except for any flow necessary for freeze protection, or low-leakage positive-closure dampers shall be provided.

2. Where an open-circuit cooling tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the open-circuit cooling tower.

3. Where an open-circuit or closed-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the open-circuit cooling tower from the heat pump loop, heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

Exception: Where it can be demonstrated that a heat pump system will be required to reject heat throughout the year.

~~-~~*delete and replace*~~-~~ **C403.4.3.3.3 Two-position valve.**
Each hydronic heat pump on the hydronic system shall have a two-position ~~valve.~~automatic valve interlocked to shut off the water flow when the compressor is off.

~~- *delete and replace* - **C403.4.4 Part-load controls.**~~
~~Hydronic systems greater than or equal to 300,000 Btu/h (146.5 kW) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that are configured to do all of the following:~~

~~1. Automatically reset the supply-water temperatures in response to varying building heating and cooling demand using coil valve position, zone-return water temperature, building-return water temperature or outside air temperature. The temperature shall be reset by not less than 25 percent of the design supply-to-return water temperature difference.~~

~~2. Automatically vary fluid flow for hydronic systems with a combined pump motor capacity of 2 hp (1.5 kW) or larger with three or more control valves or other devices by reducing the system design flow rate by not less than 50 percent or the maximum reduction allowed by the equipment manufacturer for proper operation of equipment by valves that modulate or step open and close, or pumps that modulate or turn on and off as a function of load.~~

~~3. Automatically vary pump flow on heating-water systems, chilled-water systems and heat rejection loops serving water-cooled unitary air conditioners as follows:~~

~~3.1. Where pumps operate continuously or operate based on a time schedule, pumps with nominal output motor power of 1 hp or more shall have a variable speed drive.~~

~~3.2. Where pumps have automatic direct digital control configured to operate pumps only when zone heating or cooling is required, a variable speed drive shall be provided. for pumps with nominal output motor power of 2 hp or more.~~

~~4. Where a variable speed drive is required by Item 3 of this Section, pump motor power~~

~~input shall be not more than 30 percent of design wattage at 50 percent of the design water flow. Pump flow shall be controlled to maintain one control valve nearly wide open. In systems where pump speed is controlled by a differential pressure setpoint, that setpoint shall be incrementally indexed down to maintain at least one valve nearly wide open. There shall be no lower limit to the differential pressure except to remain within the tolerances and accuracy of the controlling sensor.~~

~~**Exceptions:**~~

1. ~~Supply-water temperature reset is not required for chilled-water systems supplied by off-site district chilled water or chilled water from ice storage systems.~~

2. ~~Variable pump flow is not required on dedicated coil circulation pumps where needed for freeze protection.~~

3. ~~Variable pump flow is not required on dedicated equipment circulation pumps where configured in primary/secondary design to provide the minimum flow requirements of the equipment manufacturer for proper operation of equipment.~~

4. ~~For renovations, variable speed drives are not required on heating water pumps where more than 50 percent of annual heat is generated by a pre-existing electric boiler.~~

~~*- delete -* **TABLE C403.4.4 VARIABLE SPEED DRIVE (VSD) REQUIREMENTS FOR DEMAND-CONTROLLED PUMPS**~~

~~*- delete and replace -* **C403.5 Economizers (Prescriptive).**~~
delete and replace **C403.5 Economizers.**
Economizers shall comply with Sections C403.5.1 through C403.5.5.

An air or water economizer shall be provided for the following cooling systems:

1. Chilled water systems with a total cooling capacity, less cooling capacity provided with air economizers, as specified in Table C403.5.

2. Individual fan systems with cooling capacity greater than or equal to 54,000 Btu/h (15.8 kW) in buildings having other than a *Group R* occupancy~~,~~.

3. Individual fan systems with cooling capacity greater than or equal to 270,000 Btu/h (79.1 kW) in buildings having a *Group R* occupancy.

~~**Exceptions**~~**Exception:** Economizers are not required for the following systems.

1. In hospitals and ambulatory surgery centers, where more than 75~~%~~ percent of the air designed to be supplied by the system is to spaces that are required to be humidified above 35°F (1.7°C) dew-point temperature to comply with applicable codes or accreditation standards.

2. Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F (1.7°C) dew-point temperature to satisfy process needs.

3. Systems expected to operate less than 20 hours per week.

4. Systems that include a heat recovery system in accordance with Section C403.9.5.

~~*- delete -* **TABLE C403.5 (1) MINIMUM CHILLED-WATER SYSTEM COOLING CAPACITY FOR DETERMINING ECONOMIZER COOLING REQUIREMENTS**~~

~~*- delete -* **TABLE C403.5(2) EQUIPMENT EFFICIENCY PERFORMANCE EXCEPTION FOR ECONOMIZERS**~~

~~*- add -* **TABLE C403.5 MINIMUM CHILLED-WATER SYSTEM COOLING CAPACITY FOR DETERMINING ECONOMIZER COOLING REQUIREMENTS**~~

~~**TABLE C403.5**~~

~~**MINIMUM CHILLED-WATER SYSTEM COOLING CAPACITY FOR DETERMINING ECONOMIZER COOLING REQUIREMENTS**~~

~~TOTAL CHILLED-WATER SYSTEM CAPACITY LESS CAPACITY OF COOLING UNITS WITH AIR ECONOMIZERS~~	
~~**Local Water-cooled Chilled-water Systems**~~	~~**Air-cooled Chilled-water Systems or District Chilled-Water Systems**~~
~~1,320,000 Btu/h~~	~~1,720,000 Btu/h~~

~~For SI: 1 British thermal unit per hour = 0.2931 W.~~
~~–~~VRF systems installed with a dedicated outdoor air system.

delete and replace ~~- **C403.5.1 Integrated economizer control.**~~
~~Economizer systems~~ **C403.5.3.3 High-limit shutoff.**
Air economizers shall be ~~integrated with the mechanical cooling system and be~~ configured to ~~provide partial cooling even where additional mechanical cooling is required to provide the remainder of the cooling load. Controls~~automatically reduce *outdoor air* intake to the design minimum *outdoor air* quantity when *outdoor air* intake will not reduce cooling energy usage. High-limit shutoff control types shall ~~not be capable of creating a false load in the mechanical cooling systems by limiting or disabling the economizer or any other means, except at the lowest stage of mechanical cooling.~~

~~Units that include an air economizer shall comply with the following:~~

~~1. Unit controls shall have the mechanical cooling capacity~~be chosen from Table C403.5.3.3. High-limit shutoff control ~~interlocked with the air economizer controls such that the outdoor air damper is at the 100-percent open position when mechanical cooling is on and the outdoor air damper does not begin to close to prevent coil freezing due to minimum compressor run time until the leaving air temperature is less than 45°F (7°C).~~

~~2. Direct expansion (DX) units that~~settings for these control ~~75,000 Btu/h (22 kW) or greater of rated capacity of the capacity of the mechanical cooling directly based on occupied space temperature shall have not fewer than three stages (off / 1st stage / 2nd stage) of~~

~~mechanical cooling capacity.~~

~~3. Other DX units, including~~ types shall be those ~~that control space temperature by modulating the airflow to the space, shall be in accordance with Table C403.5.1.~~

~~**Exception:** Direct expansion (DX) units with one variable displacement compressor can have fewer than three stages provided the constant displacement compressor is no more than the percent of full load in accordance with~~ specified in Table C403.5.~~1~~3.3.

~~-~~*delete and replace* ~~- **TABLE C403.5.1 DX COOLING STAGE REQUIREMENTS FOR MODULATING AIRFLOW UNITSTABLE C403.5.1**~~

~~**DX COOLING STAGE REQUIREMENTS FOR MODULATING AIRFLOW UNITS**~~

~~**RATING CAPACITY**~~	~~**MINIMUM NUMBER OF MECHANICAL COOLING STAGES**~~	~~**MINIMUM COMPRESSOR DISPLACEMENT**[a]~~
~~≥ 75,000 Btu/h and < 240,000 Btu/h~~	~~3 stages~~	~~≤ 35% of full load~~
~~≥ 240,000 Btu/h~~	~~4 stages~~	~~≤ 25% full load~~

~~For SI: 1 British thermal unit per hour = 0.2931 W.~~

~~a. For mechanical cooling stage control that does not use variable compressor displacement, the percent displacement shall be equivalent to the mechanical cooling capacity reduction evaluated at the full load rating conditions for the compressor.~~

~~-~~ *delete and replace* ~~- **TABLE C403.5.3.3 HIGH-LIMIT SHUTOFF CONTROL SETTING FOR AIR ECONOMIZERSbTABLE C403.5.3.3**~~

~~**HIGH-LIMIT SHUTOFF CONTROL SETTING FOR AIR ECONOMIZERS**[b]~~

~~**DEVICE TYPE**~~	~~**REQUIRED HIGH LIMIT (ECONOMIZER OFF WHEN):**~~	
	~~**Equation**~~	~~**Description**~~
~~Fixed dry bulb~~	~~$T_{OA} > 70°F$~~	~~Outdoor air temperature exceeds 70°F~~
~~Differential dry bulb~~	~~$T_{OA} > T_{RA}$~~	~~Outdoor air temperature exceeds return air temperature~~
~~Fixed enthalpy with fixed dry-bulb temperatures~~	~~$h_{OA} > 28$ Btu/lb[a] or $T_{OA} > 75°F$~~	~~Outdoor air enthalpy exceeds 28 Btu/lb of dry air[a] or Outdoor air temperature exceeds 75°F~~
~~Differential enthalpy with fixed dry-bulb temperature~~	~~$h_{OA} > h_{RA}$ or $T_{OA} > 75°F$~~	~~Outdoor air enthalpy exceeds return air enthalpy or Outdoor air temperature exceeds 75°F~~

~~For SI: 1 foot = 305 mm, °C = (°F - 32)/1.8, 1 Btu/lb = 2.33 kJ/kg.~~

~~a. At altitudes substantially different than sea level, the fixed enthalpy limit shall be set to the enthalpy value at 75°F and 50-percent relative humidity. As an example, at approximately 6,000 feet elevation, the fixed enthalpy limit is~~

~~approximately 30.7 Btu/lb.~~
~~b. Devices with selectable setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.~~

~~- delete and replace -~~ **C403.5.5 Economizer fault detection and diagnostics ~~(Mandatory).~~.** Air-cooled unitary direct-expansion units listed in ~~Tables~~the tables in Section C403.3.2~~(1) through C403.3.2(3)~~ and ~~Tables C403.3.2(10) through C403.3.2(11)~~variable refrigerant flow (VRF) units that are ~~15~~10 tons (~~180~~120,000 Btu/h) or greater and equipped with an economizer in accordance with Section C403.5 through C403.5.4 shall include a fault detection and diagnostics system complying with the following:

1. The following temperature sensors shall be permanently installed to monitor system operation:

   1.1. Outside air.

   1.2. Supply air.

   1.3. Return air.

2. Indoor temperature sensors shall have an accuracy of ±2°F (1.1°C) over the range of 40°F to 80°F (4°C to 26.7°C). Outdoor temperature sensors shall have an accuracy of ±2°F (1.1°C) over the range of -40°F to 100°F (-40°C to 37.8°C).

3. Refrigerant pressure sensors, where used, shall have an accuracy of ±3 percent of full scale.

4. The unit controller shall be configured to provide system status by indicating the following:

   4.1. Free cooling available.

   4.2. Economizer enabled.

   4.3. Compressor enabled.

   4.4. Heating enabled.

   4.5. Mixed air low limit cycle active.

   4.6. The current value of each sensor.

5. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.

6. The unit shall be configured to report faults to a fault management application available for *access* by day-to-day operating or service personnel or annunciated locally on zone thermostats.

7. The fault detection and diagnostics system shall be configured to detect the following faults:

   7.1. Air temperature sensor failure/fault.

   7.2. Not economizing when the unit should be economizing.

   7.3. Economizing when the unit should not be economizing.

   7.4. Damper not modulating.

   7.5. Excess outdoor air.

~~-~~*delete and replace*~~-~~ **C403.6.1 Variable air volume and multiple-zone systems.** Supply air systems serving multiple zones shall be variable air volume (VAV) systems that have zone controls configured to reduce the volume of air that is reheated, recooled or mixed in each zone to one of the following:

1. Twenty percent of the zone design peak supply for systems with ~~DDC~~direct digital control (DDC) and 30 percent for other systems.

2. Systems with DDC where all of the following apply:

   2.1. The airflow rate in the deadband between heating and cooling does not exceed 20 percent of the zone design peak supply rate or higher allowed rates under Items 3, 4 and 5 of this section.

   2.2. The first stage of heating modulates the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the deadband flow rate.

   2.3. The second stage of heating modulates the airflow rate from the deadband flow rate up to the heating maximum flow rate that is less than 50 percent of the zone design peak supply rate.

3. The outdoor airflow rate required to meet the minimum ventilation requirements of ASHRAE Standard 62.1.

4. Any higher rate that can be demonstrated to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system as approved by the code official.

5. The airflow rate required to comply with applicable codes or accreditation standards such as pressure relationships or minimum air change rates.

6. Zones where special humidity levels are required to satisfy process needs.

Exception: The following individual zones or entire air distribution systems are exempted from the requirement for VAV control:

~~5.~~1. *Zones* or supply air systems where not less than 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered, including condenser heat, or site-solar energy source.

~~5.~~2. Systems that prevent reheating, recooling, mixing or simultaneous supply of air that has been previously cooled, either mechanically or through the use of economizer systems, and air that has been previously mechanically heated.

~~*- delete -* **C403.6.3 Dual-duct and mixing VAV systems, terminal devices.** *- delete -* **C403.6.4 Single-fan dual-duct and mixing VAV systems, economizers.**~~

~~*- modify -* **C403.6.5**~~ *delete and replace* **C403.6.3 Supply-air temperature reset controls** ~~**to C403.6.3 Supply-air temperature reset controls**~~

~~*- delete –* **C403.6.6**~~ **.**
Multiple-*zone* ~~**VAV system ventilation optimization control.**~~

~~*- add -* **C403.6.4 Multiple-zone VAV system ventilation optimization control.**~~
~~Multiple-zone VAV systems with direct digital control of individual zone boxes reporting to a central control panel shall have automatic controls~~ HVAC systems shall include controls that are capable of and configured to ~~reduce outdoor air intake flow below design rates~~ automatically reset the supply-air temperature in response to ~~changes in system *ventilation* efficiency (E_v).~~

~~**Exceptions:**~~

~~1. VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.~~

~~2. Systems where total design exhaust airflow is more than 70 percent of total design outdoor air intake flow requirements.~~

~~*- modify -* **C403.6.7 Parallel-flow fan-powered VAV air terminal control** to **C403.6.5 Parallel-flow fan-powered VAV air terminal control**~~

~~*- modify -* **C403.6.8 Setpoints for direct digital control** to **C403.6.6 Setpoints for direct digital control**~~

~~*- delete –* **C403.6.9 Static pressure sensor location.**~~

~~*- add -* **C403.6.7 Static pressure sensor location.**~~
~~Static pressure sensors used to control VAV fans~~ representative building loads, or to outdoor air temperature. The controls shall be ~~located such that the controller setpoint is not greater than 1.2 inches w.g. (299 Pa), or 1.7 w.g. (432.4 Pa) in systems with HEPA or ULPA filters. Where this results in one or more sensors being located downstream of major duct splits,~~ configured to reset the supply air temperature not less than ~~one sensor shall be located~~ 25 percent of the difference between the design supply-air temperature and the design room air

temperature. Controls that adjust the reset based on ~~each major branch to ensure~~ zone humidity are allowed. HVAC zones that ~~static pressure can be maintained in each branch. Location of the static pressure sensor near the supply fan discharge would result in non-compliance.~~ are expected to experience relatively constant loads, shall have maximum airflow designed to accommodate the fully reset supply-air temperature.

Exceptions:

1. Systems that prevent reheating, recooling or mixing of heated and cooled supply air.
2. Seventy-five percent of the energy for reheating is from site-recovered or site-solar energy sources.

delete **(Mandatory)** from **C403.7 Ventilation and exhaust systems (Mandatory)**

delete and replace **C403.7.1 Demand control ventilation ~~(Mandatory).~~.**
Demand control ventilation (DCV) shall be provided for all single-zone systems required to comply with Sections C403.5 through C403.5.3 and spaces larger than 500 square feet (46.5 m^2) and with an average occupant load of ~~25~~15 people or greater per 1,000 square feet (93 m^2) of floor area, as established in Table 6.1 of ASHRAE 62.1, and served by systems with one or more of the following:

1. An air-side economizer.
2. Automatic modulating control of the outdoor air damper.
3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

Exceptions:

1. Systems with energy recovery complying with Section C403.7.4.2.
2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.
3. Spaces where more than 75 percent of the ~~supply~~space design outdoor airflow ~~rate minus any~~ is required for makeup air that is exhausted from the space or ~~outgoing~~ transfer air ~~requirement is less than 1,200 cfm (566 L/s).~~ that is required for makeup air that is exhausted from other spaces.

~~4. Ventilation provided only for process loads.~~

4. Spaces with one of the following occupancy classifications as defined in Table 403.3.1.1 of the International Mechanical Code: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas.

delete and replace ~~–~~**C403.7.2 Enclosed parking garage ventilation controls** ~~**(Mandatory).**~~**.** Enclosed parking garages used for storing or handling automobiles operating under their own power shall employ ~~contamination-sensing devices~~carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors and automatic controls configured to stage fans or modulate fan average airflow rates as stipulated in the Vermont Fire ~~&~~ and Building Safety Code enforced by the Vermont Department of Public Safety's Division of Fire Safety. Failure of contamination-sensing devices shall cause the exhaust fans to operate continuously at design airflow.

~~–~~Exceptions:

1. Garages with a total exhaust capacity less than 4,000 cfm (1,888 L/s) with ventilation systems that do not utilize heating or mechanical cooling.
2. Garages that have a garage area to ventilation system motor nameplate power ratio that exceeds 1,125 cfm/hp (710 L/s/kW) and do not utilize heating or mechanical cooling.

delete ~~*and replace*~~ **(Mandatory)** from **C403.7.3 Ventilation air heating control (Mandatory**~~**).**~~
~~Units that provide ventilation air to multiple zones and operate in conjunction with zone heating and cooling~~**)**

delete and replace **C403.7.4 Energy recovery ventilation systems.** Energy recovery ventilation systems shall ~~not use heating to warm supply air to a~~ be provided as specified in either Section C403.7.4.1 or C403.7.4.2, as applicable. Energy recovery ventilation systems that utilize dehumidification, not fewer than one humidity control device shall be provided for each humidity control system. A humidity control device is a device that measures relative humidity or enthalpy (dry bulb temperature sensors do not qualify as humidity control devices).

add **C403.7.4.1 Nontransient dwelling units.** Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems with an enthalpy recovery ratio of not less than 60 percent at cooling design condition and not less than 70 percent at heating design condition.

Exception:
1. Systems with a minimum sensible recovery efficiency (SRE) of 75 percent at 32°F (0°C), determined in accordance with HVI Publication 920 at an airflow greater than ~~60°F (16°C) when representative building loads or outdoor air temperatures indicate that~~ or equal to the ~~majority of zones require cooling~~design airflow.

~~*- delete and replace -* **C403.7.4 Energy recovery systems (Mandatory).**~~*add* **C403.7.4.2 Spaces other than nontransient dwelling units.**
Where the supply airflow rate of ~~an air system~~ a fan system serving a space other than a nontransient dwelling unit exceeds the values specified in ~~Table~~Tables C403.7.4.2, the system shall include an energy recovery system. The energy recovery system shall ~~be configured to~~ provide ~~a change in the~~an enthalpy ~~of the outdoor air supply~~recovery ratio of not less than 50 percent of the difference between the outdoor air and return air enthalpies, at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by ASHRAE Standard 62.1.

2. Laboratory fume hood systems that include not fewer than one of the following features:

    2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.

    2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.

3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.

4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy.

5. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.

6. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.

7. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.

8. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

~~-~~*delete* -*and replace* **TABLE C403.7.4**~~**(1)**~~

TABLE C403.7.4

ENERGY RECOVERY REQUIREMENT

~~- *add* - **TABLE C403.7.4 ENERGY RECOVERY REQUIREMENT**~~

~~**TABLE C403.7.4**~~

~~**ENERGY RECOVERY REQUIREMENT**~~

~~**(Air**~~

(Ventilation systems operating not less than 3,000 hours per year~~**)**~~

PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE							
~~≥~~≥ 10% and < 20%	~~≥~~≥ 20% and < 30%	~~≥~~≥ 30% and < 40%	~~≥~~≥ 40% and < 50%	~~≥~~≥ 50% and < 60%	□ ≥ 60% and < 70%	~~≥~~≥ 70% and < 80%	□ ≥ 80%
Design Supply Fan Airflow Rate (cfm)							
~~≥~~≥ 10,500	~~≥~~≥ 6,500	~~≥~~≥ 5,500	~~≥~~≥ 4,500	~~≥~~≥ 3,500	~~≥~~≥ 2,000	~~≥~~≥ 1,000	> 120

For SI: 1 cfm = 0.4719 L/s.

~~-~~*delete* ~~- **TABLE C403.7.4(2) ENERGY RECOVERY REQUIREMENT**~~

~~- *delete and replace* -~~**(Mandatory)** from **C403.7.5 Kitchen exhaust systems (Mandatory**~~).~~

~~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.~~

~~Where total kitchen hood exhaust airflow rate is greater than 5,000 cfm (2360 L/s), each hood shall be a factory-built commercial exhaust hood listed by a nationally recognized testing laboratory in compliance with UL 710. Each hood shall have a maximum exhaust rate as specified in Table C403.7.5 and shall comply with one of the following:~~

~~1. Not less than 50 percent of all replacement air shall be transfer air that would otherwise be exhausted.~~

~~2. Demand ventilation systems on not less than 75 percent of the exhaust air that are configured to provide not less than a 50-percent reduction in exhaust and replacement air system airflow rates, including automatic controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle.~~

~~3. Listed~~ *delete* **(Mandatory)** from **C403.7.6 Automatic control of HVAC systems serving guestrooms (Mandatory)**

delete and replace **C403.7.6.1 Temperature setpoint controls.**

Controls shall be provided on each HVAC system that are capable of and configured with three modes of temperature control.

1. When the guestroom is rented but unoccupied, the controls shall automatically raise the cooling setpoint and lower the heating setpoint by not less than 4°F (2°C) from the occupant setpoint within 30 minutes after the occupants have left the guestroom.
2. When the guestroom is unrented and unoccupied, the controls shall automatically raise the cooling setpoint to not lower than 80°F (27°C) and lower the heating setpoint to not higher than 60°F (16°C). Unrented and unoccupied guestroom mode shall be initiated within 16 hours of the guestroom being continuously occupied or where a networked guestroom control system indicates that the guestroom is unrented and the guestroom is unoccupied for more than 20 minutes. A networked guestroom control system that is capable of returning the thermostat setpoints to default occupied setpoints 60 minutes prior to the time a guestroom is scheduled to be occupied is not precluded by this section. Cooling that is capable of limiting relative humidity with a setpoint not lower than 65- percent relative humidity during unoccupied periods is not precluded by this section.

3. When the guestroom is occupied, HVAC setpoints shall return to their occupied setpoints once occupancy is sensed.

Exceptions: Zones served exclusively by cold-climate heat pumps.

delete and replace **C403.7.6.2 Ventilation controls.**
Controls shall be provided on each HVAC system that are capable of and configured to automatically turn off the ventilation and exhaust fans within 20 minutes of the occupants leaving the guestroom, or *isolation devices* shall be provided to each guestroom that are capable of automatically shutting off the supply of outdoor air to and exhaust air from the guestroom.

Exception: Guestroom ventilation systems are not precluded from having an automatic daily pre-occupancy purge cycle that provides daily outdoor air ventilation during unrented periods at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change.

delete **(Mandatory)** from **C403.7.7 Shutoff dampers (Mandatory)**
delete **(Mandatory)** from **C403.8.1 Allowable fan horsepower (Mandatory)**

delete and replace **C403.8.2 Motor nameplate horsepower.**
For each fan, the fan brake horsepower shall be indicated on the construction documents and the selected motor shall be not larger than the first available motor size greater than the following:

1. For fans less than 6 bhp (4476 W), 1.5 times the fan brake horsepower.

2. For fans 6 bhp (4476 W) and larger, 1.3 times the fan brake horsepower.

Exceptions:
1. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.
2. Fans with a fan nameplate electrical input power of less than 0.89 kW.
3. Systems complying with Section C403.8.1 fan system motor nameplate hp (Option 1).
4. Fans with motor nameplate horsepower less than 1 hp (746 W)

delete and replace **C403.8.3 Fan efficiency.**
Each fan and fan array shall have a fan energy ~~recovery devices with a sensible heat recovery effectiveness~~index (FEI) of not less than ~~40 percent on not less than 50 percent~~1.00 at the design point of ~~the total exhaust airflow.~~

~~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.~~

~~**Exception:** Where not less than 75 percent of all the replacement air is transfer air that would otherwise be exhausted.~~

~~*- delete and replace -* **C403.7.7 Shutoff dampers (Mandatory).**~~

~~Outdoor air intake and exhaust openings and stairway and shaft vents shall be provided with Class I motorized dampers. The dampers shall have an air leakage rate not greater than 4 cfm/ft^2 (20.3 L/s • m^2) of damper surface area at 1.0 inch water gauge (249 Pa) and shall be labeled by an approved agency when tested~~operation, as determined in accordance with AMCA ~~500D for such purpose.~~

~~Outdoor air intake and exhaust dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the systems served require outdoor or exhaust air in accordance with ASHRAE Standard 62.1 or the dampers are opened to provide intentional economizer cooling.~~

~~Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.~~

> ~~**Exception:** Nonmotorized gravity dampers shall be an alternative to motorized dampers for exhaust and relief openings where the design exhaust capacity is not greater than 300 cfm (142 L/s).~~

~~Nonmotorized gravity dampers shall have an air leakage rate not greater than 20 cfm/ft^2 (101.6 L/s • m^2) where not less than 24 inches (610 mm) in either dimension and 40 cfm/ft^2 (203.2 L/s • m^2) where less than 24 inches (610 mm) in either dimension. The rate of air leakage shall be determined at 1.0 inch water gauge (249 Pa) when tested in accordance with AMCA 500D for such purpose. The dampers shall be labeled by an approved agency.~~

~~*- delete and replace -* **C403.8.3 Fan efficiency (Mandatory).**~~
~~Fans shall have a fan efficiency grade (FEG) of not less than 70, as determined in accordance with AMCA 205~~208 by an *approved*, independent testing laboratory and labeled by the manufacturer. ~~The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan~~Each fan and fan array used for a variable-air-volume system shall have an FEI of not less than 0.95 at the design point of operation as determined in accordance with the AMCA 208 by an approved independent testing laboratory and labeled by the manufacturer. The FEI for fan arrays shall be calculated in accordance with AMCA 208 Annex C.

> **~~Exception~~Exceptions:** The following fans are not required to have a fan ~~efficiency grade~~energy index:

1. Fans ~~of 1 hp (0.75 kW) or less as follows:~~

~~1.1.~~ ~~Individual~~that are not embedded fans with ~~a~~ motor nameplate horsepower of less than 1.0 hp (0.75 kW) or ~~less, unless Exception 1.2 applies.~~with a nameplate electrical input power of less than 0.89 kW.

~~1.2.~~ 2. Embedded fans that have a motor nameplate horsepower of 5 hp (3.7 kW) or less, or with a fan system electrical input power of 4.1 kW or less

3. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of ~~2 hp~~ (5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1~~.5~~ kW~~)~~ or less ~~and are operated as the functional equivalent of a single fan~~.

~~2.~~ 4. Fans that are part of equipment covered in Section C403.3.2.

~~3~~5. Fans included in an equipment package certified by an *approved agency* for air or energy performance.

~~4. Powered wall/roof ventilators.~~

~~5. Fans outside the scope of AMCA 205.~~

~~6~~6. Ceiling fans, which are defined as nonportable devices suspended from a ceiling or overhead structure for circulating air via the rotation of the blades.

7. Fans used for moving gases at temperatures above 425°F (250°C)

8. Fans used for operation in explosive atmospheres.

9. Reversible fans used for tunnel ventilation.

10. Fans that are intended to operate only during emergency conditions.

11. ~~–~~Fans outside the scope of AMCA 208.

delete ~~*and replace*~~ **(Mandatory)** from **C403.8.4 Fractional hp fan motors (Mandatory)**~~.~~ ~~Motors for~~ **)**

delete and replace **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.

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 ~~are not less than $^{1}/_{12}$ hp (0.082 kW) and less than 1 hp (0.746 kW)~~operate intermittently.

Add **TABLE C403.8.5**

TABLE C403.8.5
LOW-CAPACITY VENTILATION FAN EFFICACYa

FAN LOCATION	AIRFLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIRFLOW RATE MAXIMUM (CFM)
HRV or ERV	Any	1.2 cfm/watt	Any
In-line fan	Any	3.8 cfm/watt	Any

Bathroom, utility room	10	2.8 cfm/watt	<90
Bathroom, utility room	90	3.5 cfm/watt	Any

For SI: 1 cfm/ft = 47.82 W.

a. Airflow shall be ~~electronically commutated motors or NEMA Premium efficiency motors rated~~tested in accordance with ~~DOE 10 CFR 431. These motors shall have the means to adjust motor speed for either balancing or remote~~HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. 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. 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.

delete and replace **C403.8.6 Fan control.** ~~The use of belt-driven fans to sheave adjustments for airflow balancing instead of a varying motor speed shall be permitted.~~

~~**Exceptions:** The following motors are not required to comply with this section:~~

~~1. Motors that are an integral part of specialized process equipment.~~

~~2. Where the motor is integral to a listed piece of equipment for which no complying motor has been approved.~~

~~3. Motors in the airstream within fan coils and terminal units that only provide heating to the space served.~~

~~4. Motors in space-conditioning equipment that comply~~
Controls shall be provided for fans in accordance with Section C403.~~3.2 or Sections C403.8.1. through C403.8.3.~~

~~5. Motors that comply with~~8.5.1 and as required for specific systems provided in Section ~~C405.7.~~C403.

delete and replace **C403.8.~~5~~6.1 Fan airflow control.**
Each cooling system listed in Table C403.8.~~5~~6.1 shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

1. Direct expansion (DX) and chilled water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have not fewer than two stages of fan control. Low or minimum speed shall not be greater than 66 percent of full speed. At low or minimum speed, the fan system shall draw not more than 40 percent of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

2. Other units including DX cooling units and chilled water units that control the space temperature by modulating the airflow to the space shall have modulating

fan control. Minimum speed shall be not greater than 50 percent of full speed. At minimum speed the fan system shall draw not more than 30 percent of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

3. Units that include an air-side economizer in accordance with Section C403.5 shall have modulating fan control during economizer operation.

Exceptions:

1. Modulating fan control is not required for chilled water and evaporative cooling units with fan motors of less than 1 hp (0.746 kW) where the units are not used to provide *ventilation air* and the indoor fan cycles with the load.
2. Where the volume of outdoor air required to comply with the ventilation requirements of ASHRAE Standard 62.1 at low speed exceeds the air that would be delivered at the speed defined in Section C403.8.5, the minimum speed shall be selected to provide the required v*entilation air*.

~~*- delete and replace -*~~

renumber TABLE C403.8.5.1 ~~**COOLING SYSTEMS**~~

to **TABLE C403.8.~~5~~6.1**
~~COOLING SYSTEMS~~

~~**COOLING SYSTEM TYPE**~~	~~**FAN MOTOR SIZE**~~	~~**MECHANICAL COOLING CAPACITY**~~
~~DX cooling~~	~~Any~~	~~≥ 24,000 Btu/h~~
~~Chilled water and evaporative cooling~~	~~$\geq {}^{1}/_{4}$ hp~~	~~Any~~

~~For SI: 1 British thermal unit per hour = 0.2931 W; 1 hp = 0.746 kW.~~

~~*- delete and replace -* **C403.9.1 Fan speed control.**~~
~~Each fan system powered by an individual motor or array of motors with connected power, including the motor service factor, totaling 2 hp (1.5 kW) or more shall have controls and devices configured to automatically modulate the fan speed to control the leaving fluid temperature or condensing temperature and pressure of the heat rejection device. Fan motor power input shall be not more than 30 percent of design wattage or 50 percent of the design airflow.~~

~~**Exceptions:**~~

~~1. Fans serving multiple refrigerant or fluid cooling circuits.~~

~~2. Condenser fans serving flooded condensers.~~

~~*- delete and replace -*~~ *add* **C403.9 Large-diameter ceiling fans.** Where provided, large-diameter ceiling fans shall be tested and labeled in accordance with AMCA 230.

renumber **C403.9 Heat rejection equipment** to **C403.10 Heat rejection equipment.**

renumber **C403.9.1 Fan speed control** to **C403.10.1 Fan speed control**
renumber **C403.9.2 Multiple-cell heat rejection equipment.** to **C403.10.2 Multiple-cell heat rejection equipment.**
renumber **C403.9.3 Limitation on centrifugal fan open-circuit cooling towers.** to **C403.10.3 Limitation on centrifugal fan open-circuit cooling towers** ~~with a combined rated capacity of 550gpm (2032L/m) or greater at 95°F (35°C) condenser water return, 85°F (29°C) condenser water supply, and 75°F (24°C) outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table C403.3.2(8).~~**.**

> ~~**Exception:** Centrifugal open-circuit cooling towers that are designed with inlet or discharge ducts or require external sound attenuation.~~

~~*- delete and replace -*~~ renumber **C403.9.4 Tower flow turndown.** to **C403.10.4 Tower flow turndown.**
renumber **C403.9.5 Heat recovery for service water heating.**
~~Condenser~~ to **C403.10.5 Heat recovery** ~~shall be installed~~ **for** ~~heating or reheating of~~ **service** ~~hot~~ **water** ~~provided that the facility operates 24 hours a day, the total installed heat capacity of water-cooled systems exceeds 6,000,000 Btu/hr (1 758 kW) of heat rejection, and the design service water heating load exceeds 1,000,000 Btu/h (293 kW).~~ **heating.**

~~The required heat recovery system shall have the capacity to provide the smaller of the following:~~

1. ~~Sixty percent of the peak heat rejection load at design conditions.~~
2. ~~The preheating required to raise the peak service hot water draw to 85°F (29°C).~~

~~**Exceptions:**~~

1. ~~Facilities that employ condenser heat recovery for space heating or reheat purposes with a heat recovery design exceeding 30 percent of the peak water-cooled condenser load at design conditions.~~
2. ~~Facilities that provide 60 percent of their service water heating from site solar or site recovered energy or from other sources.~~
3. ~~If compliance with Section C403.9.5 will be detrimental to chiller operating efficiency due to conflicts with optimized chiller head pressure control.~~

~~-~~ *delete* ~~*and replace -*~~ **C403.10 Refrigeration equipment performance**~~.~~
and replace **C403.11 Refrigeration equipment** ~~shall have an energy use in kWh/day not greater than the values of Tables C403.10.1(1) and C403.10.1(5) when tested and rated in accordance with AHRI Standard 1200~~ **performance**
Refrigeration equipment performance shall be determined in accordance with Sections C403.11.1 and C403.11.2 for commercial refrigerators, freezers, refrigerator-freezers, walk-in coolers, walk-in freezers and refrigeration equipment. The energy use shall be verified through certification under an approved certification program or, where a certification program does not exist, the energy use shall be supported by data furnished by the equipment manufacturer.

~~*- delete and replace -* **C403.10.1 Walk-in coolers, walk-in freezers, refrigerated warehouse**~~

~~**coolers and refrigerated warehouse freezers (Mandatory).**~~

~~*Refrigerated warehouse coolers*, *refrigerated warehouse freezers*, *walk-in coolers* and *walk-in freezers* shall comply with the following:~~

1. ~~Be equipped with automatic door-closers that firmly close walk-in doors that have been closed to within 1 inch (25 mm) of full closure.~~

   ~~**Exception:** Automatic closers are not required for doors more than 45 inches (1143 mm) in width or more than 7 feet (2134 mm) in height.~~

2. ~~Doorways shall have strip doors, curtains, spring-hinged doors or other method of minimizing infiltration when doors are open.~~

3. ~~*Walk-in coolers* and *refrigerated warehouse coolers* shall contain wall, ceiling, and door insulation of not less than R-25 and *walk-in freezers* and *refrigerated warehouse freezers* shall contain wall, ceiling and door insulation of not less than R-32.~~

   ~~**Exception:** Glazed portions of doors or structural members need not be insulated.~~

4. ~~*Walk-in freezers* shall contain floor insulation of not less than R-28.~~

5. ~~Transparent reach-in doors for *walk-in freezers* and windows in opaque *walk-in freezer* doors shall be of triple-pane glass, either filled with inert gas or with heat-reflective treated glass.~~

6. ~~Windows and transparent reach-in doors for *walk-in coolers* shall be of double-pane or triple-pane, inert gas-filled, heat-reflective treated glass.~~

7. ~~Evaporator fan motors that are less than 1 hp (0.746 kW) and less than 460 volts shall use electronically commutated motors, brushless direct-current motors, or 3-phase motors.~~

8. ~~Condenser fan motors that are less than 1 hp (0.746 kW) shall use electronically commutated motors, permanent split capacitor-type motors or 3-phase motors.~~

9. ~~Antisweat heaters shall have a total door rail, glass and frame heater power draw of not more than 7.1 W/ft^2 (76 W/m^2) of door opening for *walk-in freezers* and 3.0 W/ft^2 (32 W/m^2) of door opening for *walk-in coolers*.~~

10. ~~Antisweat heaters shall have controls that reduce the energy use of the antisweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.~~

11. ~~Lights in *walk-in coolers*, *walk-in freezers*, *refrigerated warehouse coolers* and *refrigerated warehouse freezers* shall be LED with an efficacy of 90 lpw or more and have occupancy controls that turns off the lights within 15 minutes when the space is not occupied.~~

~~*- delete -* **C403.10.2**~~ **Exception:** Walk-in coolers and walk-in freezers regulated under federal law in accordance with Subpart R of DOE 10 CFR 431

delete **C403.10.1Commercial refrigerators, refrigerator-freezers and refrigeration** *and replace* **C403.11.1Commercial refrigerators, refrigerator-freezers and refrigeration** Refrigeration equipment, defined in DOE 10 CFR Part 431.62, shall have an energy use in kWh/day not greater than the values of Table C403.11.1 when tested and rated in accordance with AHRI Standard 1200.

Delete **TABLE C403.10.1 (1) and replace TABLE C403.11.1 (1)**

TABLE C403.11.1 (1)
MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL REFRIGERATORS AND FREEZERS AND REFRIGERATION

EQUIPMENT CATEGORY	CONDENSING UNIT CONFIGURATION	EQUIPMENT FAMILY	RATING TEMP., °F	OPERATING TEMP., °F	EQUIPMENT CLASSIFICATION[a,c]	MAXIMUM DAILY ENERGY CONSUMPTION, kWh/day[d,e]	TEST STANDARD
Remote condensing commercial refrigerators and commercial freezers	Remote (RC)	Vertical open (VOP)	38 (M)	≥32	VOP.RC.M	0.64 x TDA + 4.07	AHRI 1200
			0 (L)	<32	VOP.RC.L	2.20 x TDA + 6.85	
		Semivertical open (SVO)	38 (M)	≥32	SVO.RC.M	0.66 x TDA + 3.18	
			0 (L)	<32	SVO.RC.L	2.20 x TDA + 6.85	
		Horizontal open (HZO)	38 (M)	≥32	HZO.RC.M	0.35 x TDA + 2.88	
			0 (L)	<32	HZO.RC.L	0.55 x TDA + 6.88	
		Vertical closed transparent (VCT)	38 (M)	≥32	VCT.RC.M	0.15 x TDA + 1.95	
			0 (L)	<32	VCT.RC.L	0.49 x TDA + 2.61	
		Horizontal closed transparent (HCT)	38 (M)	≥32	HCT.RC.M	0.16 x TDA + 0.13	
			0 (L)	<32	HCT.RC.L	0.34 x TDA + 0.26	
		Vertical closed solid (VCS)	38 (M)	≥32	VCS.RC.M	0.10 x V + 0.26	
			0 (L)	<32	VCS.RC.L	0.21 x V + 0.54	
		Horizontal closed solid (HCS)	38 (M)	≥32	HCS.RC.M	0.10 x V + 0.26	
			0 (L)	<32	HCS.RC.L	0.21 x V + 0.54	
		Service over counter (SOC)	38 (M)	≥32	SOC.RC.M	0.44 x TDA + 0.11	
			0 (L)	<32	SOC.RC.L	0.93 x TDA + 0.22	
Self-contained commercial refrigerators and commercial freezers with and without doors	Self-contained (SC)	Vertical open (VOP)	38 (M)	≥32	VOP.SC.M	0.64 x TDA + 4.07	AHRI 1200
			0 (L)	<32	VOP.SC.L	2.20 x TDA + 6.85	
		Semivertical open (SVO)	38 (M)	≥32	SVO.SC.M	0.66 x TDA + 3.18	
			0 (L)	<32	SVO.SC.L	2.20 x TDA + 6.85	
		Horizontal open (HZO)	38 (M)	≥32	HZO.SC.M	0.35 x TDA + 2.88	
			0 (L)	<32	HZO.SC.L	0.55 x TDA + 6.88	
		Vertical closed transparent (VCT)	38 (M)	≥32	VCT.SC.M	0.15 x TDA + 1.95	
			0 (L)	<32	VCT.SC.L	0.49 x TDA + 2.61	
		Horizontal closed transparent (HCT)	38 (M)	≥32	HCT.SC.M	0.16 x TDA + 0.13	
			0 (L)	<32	HCT.SC.L	0.34 x TDA + 0.26	
		Vertical closed solid (VCS)	38 (M)	≥32	VCS.SC.M	0.10 x V + 0.26	
			0 (L)	<32	VCS.SC.L	0.21 x V + 0.54	
		Horizontal closed solid (HCS)	38 (M)	≥32	HCS.SC.M	0.10 x V + 0.26	
			0 (L)	<32	HCS.SC.L	0.21 x V + 0.54	
		Service over counter (SOC)	38 (M)	≥32	SOC.SC.M	0.44 x TDA + 0.11	
			0 (L)	<32	SOC.SC.L	0.93 x TDA + 0.22	
Self-contained commercial refrigerators with transparent doors for pull-down temperature applications	Self-contained (SC)	Pull-down (PD)	38 (M)	≥32	PD.SC.M	0.11 x V + 0.81	AHRI 1200
Commercial ice cream freezers	Remote (RC)	Vertical open (VOP)	-15 (I)	≤-5[b]	VOP.RC.I	2.79 x TDA + 8.70	AHRI 1200
		Semivertical open (SVO)			SVO.RC.I	2.79 x TDA + 8.70	
		Horizontal open (HZO)			HZO.RC.I	0.70 x TDA + 8.74	
		Vertical closed transparent (VCT			VCT.RC.I	0.58 x TDA + 3.05	
		Horizontal closed transparent (HCT)			HCT.RC.I	0.40 x TDA + 0.31	
		Vertical closed solid (VCS)			VCS.RC.I	0.25 x V + 0.63	

		Horizontal closed solid (HCS			HCS.RC.I	0.25 x V + 0.63	
		Service over counter (SOC)			SOC.SC.I	1.09 x TDA + 0.26	
	Self-contained (SC)	Vertical open (VOP)			VOP.SC.I	5.40 x TDA + 15.02	AHRI 1200
		Semivertical open (SVO)			SVO.SC.I	5.41 x TDA + 14.63	
		Horizontal open (HZO)			HZO.SC.I	2.42 x TDA + 9.00	
		Vertical closed transparent (VCT			VCT.SC.I	0.62 x TDA + 3.29	
		Horizontal closed transparent (HCT)			HCT.SC.I	0.56 x TDA + 0.43	
		Vertical closed solid (VCS)			VCS.SC.I	0.34 x V + 0.88	
		Horizontal closed solid (HCS			HCS.SC.I	0.34 x V + 0.88	
		Service over counter (SOC)			SOC.SC.I	1.53 x TDA + 0.36	

For SI: 1 square foot = 0.0929 m2, 1 cubic foot = 0.02832 m3, °C = (°F – 32)/1.8.
a. The meaning of the letters in this column is indicated in the columns to the left.
b. Ice cream freezer is defined in DOE 10 CFR 431.62 as a commercial freezer that is designed to operate at or below -5 °F and that the manufacturer designs, markets or intends for the storing, displaying or dispensing of ice cream.
c. Equipment class designations consist of a combination [in sequential order separated by periods (AAA).(BB).(C)] of the following:
- (AAA)—An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed transparent doors, VCS = vertical closed solid doors, HCT = horizontal closed transparent doors, HCS = horizontal closed solid doors, and SOC = service over counter);
- (BB)—An operating mode code (RC = remote condensing and SC = self-contained); and
- (C)—A rating temperature code [M = medium temperature (38°F), L = low temperature (0°F), or I = ice cream temperature (-15°F)].
- For example, "VOP.RC.M" refers to the "vertical open, remote condensing, medium temperature" equipment class.

d. V is the volume of the case (ft3) as measured in AHRI 1200, Appendix C.
e. TDA is the total display area of the case (ft2) as measured in AHRI 1200, Appendix D.

add **C403.11.2 Walk-in coolers and walk-in freezers.**
Walk-in cooler and walk-in freezer refrigeration systems, except for walk-in process cooling refrigeration systems as defined in DOE 10 CFR 431.302, shall meet the requirements of Tables C403.11.2.1(1), C403.11.2.1(2), and C403.11.2.1(3).

add **C403.11.2.1 Performance standards.**
Walk-in coolers and walk-in freezers ~~**(Mandatory**~~shall meet the requirements of Tables C403.11.2.1(1), C403.11.2.1(2) and C403.11.2.1(3).

~~- *delete* - **C403.10.2.1 Performance standards (Mandatory).**~~

~~- modify -~~ **TABLE C403.10.~~2.1(1) WALK-IN COOLER AND FREEZER DISPLAY DOOR EFFICIENCY REQUIREMENTS~~ ~~to~~1(2)**

delete **TABLE C403.10.1(3)** *and replace* **TABLE C403.11.1(2)**

TABLE C403.11.1(2)
WALK-IN COOLER AND FREEZER DISPLAY DOOR EFFICIENCY
~~REQUIREMENTS~~REQUIREMENTS[a]

~~- modify -~~

CLASS DESCRIPTOR	CLASS	MAXIMUM ENERGY CONSUMPTION (kWh/day)[a]

Display door, medium temperature	DD, M	$0.04 \times A_{dd} + 0.41$
Display door, low temperature	DD, L	$0.15 \times A_{dd} + 0.29$

a. A_{dd} is the surface area of the display door.

delete **TABLE C403.10.~~2.~~1(~~2)~~ 4)** *and replace* **TABLE C403.11.1(3)**

TABLE C403.11.1(3)
WALK-IN COOLER AND FREEZER NONDISPLAY DOOR EFFICIENCY ~~REQUIREMENTS to TABLE C403.10.1(4) WALK-IN COOLER AND FREEZER NONDISPLAY DOOR EFFICIENCY REQUIREMENTS~~REQUIREMENTS[a]

~~- modify -~~

CLASS DESCRIPTOR	CLASS	MAXIMUM ENERGY CONSUMPTION (kWh/day)[a]
Passage door, medium temperature	PD, M	$0.05 \times A_{nd} + 1.7$
Passage door, low temperature	PD, L	$0.14 \times A_{nd} + 4.8$
Freight door, medium temperature	FD, M	$0.04 \times A_{nd} + 1.9$
Freight door, low temperature	FD, L	$0.12 \times A_{nd} + 5.6$

a. A_{nd} is the surface area of the nondisplay door.

delete **TABLE C403.10.~~2.1(3) WALK-IN COOLER AND FREEZER REFRIGERATION SYSTEM EFFICIENCY REQUIREMENTS to~~1(5)** *and replace* **TABLE C403.~~10~~11.1(~~5)~~ 4)**

TABLE C403.11.1(4)
WALK-IN COOLER AND FREEZER REFRIGERATION SYSTEM EFFICIENCY REQUIREMENTS

~~- modify -~~

CLASS DESCRIPTOR	CLASS	MINIMUM ANNUAL WALK-IN ENERGY FACTOR AWEF (Btu/W-h)[a]	TEST PROCEDURE
Dedicated condensing, medium temperature, indoor system	DC.M.I	5.61	AHRI 1250
Dedicated condensing, medium temperature, outdoor system	DC.M.O	7.60	
Dedicated condensing, low temperature, indoor system, net capacity (q_{net}) <6,500 Btu/h	DC.L.I, <6,500	$9.091 \times 10^{-5} \times q_{net} + 1.81$	
Dedicated condensing, low temperature, indoor system, net capacity (q_{net}) ≥6,500 Btu/h	DC.L.I, ≥6,500	2.40	

Dedicated condensing, low temperature, outdoor system, net capacity (q_{net}) <6,500 Btu/h	DC.L.O, <6,500	$6.522 \times 10^{-5} \times q_{net} + 2.73$	
Dedicated condensing, low temperature, outdoor system, net capacity (q_{net}) ≥6,500 Btu/h	DC.L.O, ≥6,500	3.15	
Unit cooler, medium	UC.M	9.00	
Unit cooler, low temperature, net capacity (q_{net}) <15,500 Btu/h	UC.L, < 15,500	$1.575 \times 10^{-5} \times q_{net} + 3.91$	
Unit cooler, low temperature, net capacity (q_{net}) ≥15,500 Btu/h	UC.L, ≥15,500	4.15	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. q_{net} is net capacity (Btu/h) as determined in accordance with **AHRI 1250**.

delete **C403.10.~~3~~2 Refrigerated display cases (Mandatory**~~) to **C403.10.2 Refrigerated display cases (Mandatory)**~~
~~).~~

~~-~~*delete* ~~–~~**C403.10.~~4~~3 Refrigeration systems**~~.~~

~~- add –~~ *and replace* **C403.~~10~~11.3 Refrigeration systems.**
Refrigerated display cases, *walk-in coolers* or *walk-in freezers* that are served by remote compressors and remote condensers not located in a condensing unit, shall comply with Sections C403.~~10~~11.3.1 and C403.~~10~~11.3.2.

Exception: Systems where the working fluid in the refrigeration cycle goes through both subcritical and super-critical states (transcritical) or that use ammonia refrigerant are exempt.

~~- modify -~~ ~~**C403.10.4.1 Condensers serving refrigeration systems to**~~ *delete* **C403.10.3.1 Condensers serving refrigeration systems** *and replace* **C403.11.3.1 Condensers serving refrigeration systems.**

~~-~~*delete* ~~–~~**C403.10.~~4~~3.2 Compressor systems.**

~~- add –~~ *and replace* **C403.~~10~~11.3.2 Compressor systems.**
~~Refrigeration compressor systems shall comply with the following:~~

~~1. Compressors and multiple-compressor system suction groups shall include control systems that use floating suction pressure control logic to reset the target suction pressure temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.~~

~~**Exception:** Controls are not required for the following:~~

~~1.1 Single-compressor systems that do not have variable capacity capability.~~

~~1.2 Suction groups that have a design saturated suction temperature of 30°F (-1.1°C) or higher, suction groups that comprise the high stage of a two-stage or cascade system, or suction groups that primarily serve chillers for~~

~~secondary cooling fluids.~~

~~2. Liquid subcooling shall be provided for all low-temperature compressor systems with a design cooling capacity equal to or greater than 100,000 Btu/hr (29.3 kW) with a design-saturated suction temperature of -10°F (-23°C) or lower. The sub-cooled liquid temperature shall be controlled at a maximum temperature setpoint of 50°F (10°C) at the exit of the subcooler using either compressor economizer (interstage) ports or a separate compressor suction group operating at a saturated suction temperature of 18°F (-7.8°C) or higher.~~

~~2.1. Insulation for liquid lines with a fluid operating temperature less than 60°F (15.6°C) shall comply with Table C403.11.3.~~

~~3. Compressors that incorporate internal or external crankcase heaters shall provide a means to cycle the heaters off during compressor operation.~~

~~- *delete and replace* -~~*delete* **C403.11 Construction of HVAC system elements (Mandatory)** *and replace* **C403.12 Construction of HVAC system elements.**

delete **C403.11.1 Duct and plenum insulation and sealing (Mandatory~~).~~)** *and replace* **C403.12.1 Duct and plenum insulation and sealing.**
Supply and return air ducts and plenums shall be insulated with not less than R-~~8~~12 insulation where located in unconditioned spaces and where located outside the building with not less than R-~~12~~20 insulation. Where located ~~within a building envelope assembly, the~~in conditioned space or semi-conditioned space, any duct that will transport or ~~plenum~~hold air at temperature differentials greater than 40F between inside and outside the duct shall be ~~separated from the building exterior or unconditioned or exempt spaces by~~insulated with not less than R-12 insulation. Buried ducts shall be insulated to a minimum of R-6.

Exceptions:

1. Where located within equipment.

2. Where the design temperature difference between the interior and exterior of the duct or plenum is not greater than 15°F (8°C).

Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with the ANSI/SMACNA 006 HVAC Duct Construction Standards.

~~-~~*delete* ~~*and replace* -~~ **C403.11.2 Duct construction (Mandatory~~).~~**
~~Ductwork shall be constructed and erected in accordance with the ANSI/SMACNA 006 HVAC~~**)** *and replace* **C403.12.2 Duct construction.**

~~- *delete and replace* - **C403.11.2.1 Low-pressure duct systems (Mandatory).**~~
~~Longitudinal and transverse joints, seams and connections of supply and return ducts operating at a static pressure less than or equal to 2 inches water gauge (w.g.) (498 Pa) shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mas-tic-plus-embedded-fabric systems or tapes installed in accordance with the manufacturer's instructions. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the ANSI/SMACNA 006 HVAC Duct~~

~~Construction.~~

> **~~Exception:~~** ~~Locking-type longitudinal joints and seams, other than the snap-lock and button-lock types, need not be sealed as specified in this section.~~

~~-~~*delete* **C403.11.2.1 Low-pressure duct systems (Mandatory)** *and replace* **C403.12.2.1 Low-pressure duct systems.**

delete ~~*and replace* -~~**C403.11.2.2 Medium-pressure duct systems (Mandatory**~~).~~ ~~Ducts and plenums designed to operate at a static~~ **)** *and replace* **C403.12.2.2 Medium-pressure** ~~greater than 2 inches water gauge (w.g.) (498 Pa) but less than 3 inches w.g. (747 Pa) shall be insulated and sealed in accordance with Section C403.11.1. Pressure classifications specific to the~~ **duct** ~~system shall be clearly indicated on the construction documents in accordance with the ANSI/SMACNA 006 HVAC Duct Construction~~**systems.**

~~-~~ *delete* ~~*and replace* -~~ **C403.11.2.3 High-pressure duct systems (Mandatory**~~).~~**)** *and replace* **C403.12.2.3 High-pressure duct systems.**

Ducts and plenums designed to operate at static pressures equal to or greater than 3 inches water gauge (747 Pa) shall be insulated and sealed in accordance with Section C403.11.1. In addition, ducts and plenums shall be leak tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual and shown to have a rate of air leakage (CL) less than or equal to 4.0 as determined in accordance with Equation 4-7.

$$CL = F/P^{0.65} \qquad \textbf{(Equation 4-7)}$$

where:

F	=	The measured leakage rate in cfm per 100 square feet of duct surface.
P	=	The static pressure of the test.

Documentation shall be furnished ~~by the designer~~ demonstrating that representative sections totaling not less than 25 percent of the duct area have been tested and that all tested sections comply with the requirements of this section.

~~-~~*delete* ~~*and replace* -~~**C403.11.3 Piping insulation (Mandatory**~~).~~**)** *and replace* **C403.12.3 Piping insulation.**

Piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.~~11~~12.3.

Exceptions:

1. Factory-installed piping within HVAC equipment tested and rated in accordance with a test procedure referenced by this code.

2. Factory-installed piping within room fan-coils and unit ventilators tested and rated according to AHRI 440 (except that the sampling and variation provisions of Section 6.5 shall not apply) and AHRI 840, respectively.

3. Piping that conveys fluids that have a design operating temperature range between 60°F (15°C) and 85°F (29°C~~)~~).

4. Strainers, control valves, and balancing valves associated with piping 1 inch (25 mm) or less in diameter.

5. Direct buried piping that conveys fluids at or below 60°F (15°C).

6. ~~- delete and replace -~~In radiant heating systems, sections of piping intended by design to radiate heat.

7. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.

renumber **TABLE C403.11.3** ~~**MINIMUM PIPE INSULATION THICKNESS (in inches)**~~
to **TABLE C403.~~11.3~~**
~~**MINIMUM PIPE INSULATION THICKNESS (in inches)**~~~~[a, c]~~**12.3**

delete **C403.11.3.1 Protection of piping insulation (Mandatory)** *and replace* **C403.12.3.1 Protection of piping insulation.**

delete **C403.12 Mechanical systems located outside of the building thermal envelope. (Mandatory)** *and replace* **C403.13 Mechanical systems located outside of the building thermal envelope.**

delete **C403.12.1 Heating outside a building** *and replace* **C403.13.1 Heating outside a building**

delete **C403.12.2 Snow- and ice-melt system controls** *and replace* **C403.13.2 Snow- and ice-melt system controls.**

delete **C403.12.3 Freeze protection system controls** *and replace* **C403.13.3 Freeze protection system controls.**

SECTION C404
SERVICE WATER HEATING

delete and replace **C404.1 General.**
In addition to the service water heating requirements of Section C404, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, service water heating enhancements may be needed.

The requirements of C404 that may be affected and the corresponding C406 references are summarized in Table C404.1(1). For a full list of potential measures see Table C406.2.1 and Table C406.3.1.

add **TABLE C404.1(1):**

TABLE C404.1(1):

C406 MEASURES AFFECTING SERVICE WATER HEATING

~~FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)~~ID	~~INSULATION CONDUCTIVITY~~ C406 Measure Title	~~NOMINAL PIPE OR TUBE SIZE (inches)~~C404 Reference	C406 Section
W01	~~Conductivity Btu • in./(h • ft² • °F)~~[b] SHW preheat recovery	~~Mean Rating Temperature, °F~~C403.10.5 ~~< 1~~	C406.2.3.1 ~~to < 1 1/2~~ .1 ~~1 1/2 to < 4~~ ~~4 to < 8~~ ~~≥ 8~~
~~≥ 350~~W02	~~0.32 – 0.34~~Heat pump water heater	~~250~~n/a	~~4.5~~C406.2.3.1.2 ~~5.0~~ ~~5.0~~ ~~5.0~~ ~~5.0~~
~~251 – 350~~W04	~~0.29 – 0.32~~SHW pipe insulation	~~200~~C404.4	C406.2.3.~~0~~3.1 ~~4.0~~ ~~4.5~~ ~~4.5~~ ~~4.5~~
~~201 – 250~~W05	~~0.27 – 0.30~~Point of use water heaters	~~150~~n/a ~~2.5~~ ~~2.5~~ ~~2.5~~	C406.2.3.~~0~~3.2 ~~3.0~~
W06	Thermostatic bal. valves	n/a	C406.2.3.3.3
~~141 – 200~~W07	~~0.25 – 0.29~~SHW heat trace system ~~125~~ ~~1.5~~ ~~1.5~~	C404.6.2.~~0~~	C406.2.~~0~~3.3.4 ~~2.0~~
W08	SHW submeters	n/a	C406.2.3.4
~~85 – 140~~W09	~~0.21 – 0.28~~SHW distribution sizing	~~100~~n/a ~~1.0~~ ~~1.0~~	~~1~~C406.2.3.5 ~~1.5~~ ~~1.5~~
~~40 – 60~~W10	~~0.21 – 0.27~~Shower heat recovery	~~75~~C404.7	~~0.5~~C406.2.3.6 ~~0.5~~ ~~1.0~~ ~~1.0~~ ~~1.0~~
~~< 40~~G06	~~0.20 – 0.26~~SHW Energy Storage	~~50~~n/a	~~0.5~~C406.3.7 ~~1.0~~ ~~1.0~~ ~~1.0~~ ~~1.5~~

~~For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.~~

~~a. For piping smaller than 1 $^1/_2$ inches and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.~~

~~b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:~~

$$\cancel{T = r\,[(1 + t/r)^{K/k} - 1]}$$

~~where:~~

~~T = minimum insulation thickness,~~
~~r = actual outside radius of pipe,~~
~~t = insulation thickness listed in the table for applicable fluid temperature and pipe size,~~
~~K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu • in/h • ft^2 • °F) and~~
~~k = the upper value of the conductivity range listed in the table for the applicable fluid temperature.~~

~~c. For direct-buried heating and hot water system piping, reduction of these thicknesses by 1 $^1/_2$ inches (38 mm) shall be permitted (before thickness adjustment required in footnote b but not to thicknesses less than 1 inch.~~

~~*- delete and replace -* **C403.11.3.1 Protection of piping insulation (Mandatory).**~~
~~Piping insulation exposed to the weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted. Piping insulation shall comply with both of the following requirements:~~

1. ~~Insulation exposed to weather shall be suitable for outdoor service and shall be protected by aluminum, sheet metal, painted canvas, plastic cover, or other similar materials approved by the building official. Cellular foam insulation shall be protected as above or painted with a coating that is water-retardant and provides shielding from solar radiation; and~~

2. ~~Unless the insulation is vapor-retardant, insulation covering chilled-water piping or refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation. All penetrations and joints shall be sealed~~

~~*- delete and replace -* **C403.12.1 Heating outside a building.**~~
~~Systems installed to provide heat outside a building shall be radiant systems. Electric resistance heating is prohibited for heating spaces outside a building.~~

~~Such heating systems shall be controlled by an occupancy sensing device or a timer switch, so that the system is automatically de-energized when occupants are not present.~~

~~*- delete and replace -* **C403.12.2 Snow- and ice-melt system controls.**~~
~~Snow-and ice-melting systems shall include automatic controls configured to shut off the system when the outdoor temperature is above 40°F (4°C) and the slab temperature as measured not less than 2" below the surface is 50°F (10°C).~~

~~SECTION C404~~
~~SERVICE WATER HEATING (MANDATORY)~~

~~*- delete and replace -* **C404.1 General.**~~
~~In addition to the service water heating requirements of Section C404, service water heating enhancements may be needed to meet the requirements of Section C406, Additional Efficiency Package Options. See Section C406.~~

This section covers the minimum efficiency of, and controls for, service water-heating equipment and insulation of service hot water piping.

~~*- add -* **C404.1.1 Electrical water heating limitation.**~~
~~Individual electric service water heating units shall be limited to a maximum of 7.5 kW total power input.~~

~~**Exceptions:**~~

1. ~~Instantaneous electric water heaters used to serve emergency showers and emergency eye wash stations.~~
2. ~~Hybrid heat pump service water heaters which utilize supplemental electric resistance elements and meeting the following requirements:~~
    a. ~~No less than 60% of maximum heating demand can be met with the heat pump alone.~~
    b. ~~For new buildings, if serving showers, the shower heads must have a maximum flow rate of no greater than 2.0 gpm.~~
    c. ~~For new buildings, if serving dishwashing equipment, this equipment must be ENERGY STAR labeled.~~

- delete and replace ~~- TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT~~

~~TABLE C404.2~~
~~MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT~~

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY (input)~~	~~SUBCATEGORY OR RATING CONDITION~~	~~PERFORMANCE REQUIRED~~ [~~a, b~~]	~~TEST PROCEDURE~~
~~Water heaters, electric~~	~~≤ 7.5 kW~~	~~Tabletop~~ [~~e~~] ~~-~~	~~0.93 - 0.00132V, EF~~	~~DOE 10 CFR Part 430~~
		~~Resistance~~	~~0.960 - 0.0003V, EF~~	
		~~Grid-enabled~~ [~~f~~] ~~> 75 gallons and ≤ 120 gallons~~	~~1.061 - 0.00168V, EF~~	
	~~≤ 24 amps and ≤ 250 volts~~	~~Heat pump > 55 gallons and ≤ 120 gallons~~	~~2.057 - 0.00113V, EF~~	~~DOE 10 CFR Part 430~~
~~Storage water heaters, gas~~	~~≤ 75,000 Btu/h~~	~~≥ 20 gallons and ≤ 55 gallons~~	~~0.675 - 0.0015V, EF~~	~~DOE 10 CFR Part 430~~
		~~> 55 gallons and ≤ 100 gallons~~	~~0.8012 - 0.00078V, EF~~	
	~~> 75,000 Btu/h and ≤ 155,000 Btu/h~~	~~< 4,000 Btu/h/gal~~	~~80% E_t (Q/800 + 110√V)SL, Btu/h~~	~~ANSI Z21.10.3~~
	~~> 155,000 Btu/h~~	~~< 4,000 Btu/h/gal~~	~~80% E_t (Q/800 + 110√V)SL, Btu/h~~	
~~Instantaneous water heaters, gas~~	~~> 50,000 Btu/h and < 200,000 Btu/h~~ [~~c~~]	~~≥ 4,000 (Btu/h)/gal and < 2 gal~~	~~0.82 - 0.00 19V, EF~~	~~DOE 10 CFR Part 430~~
	~~≥ 200,000 Btu/h~~	~~≥ 4,000 Btu/h/gal and < 10 gal~~	~~80% E_t~~	~~ANSI Z21.10.3~~
	~~≥ 200,000 Btu/h~~	~~≥ 4,000 Btu/h/gal and ≥ 10 gal~~	~~80% E_t (Q/800 + 110√V)SL, Btu/h~~	
~~Storage water heaters, oil~~	~~≤ 105,000 Btu/h~~	~~≥ 20 gal and ≤ 50 gallons~~	~~0.68 - 0.0019V, EF~~	~~DOE 10 CFR Part 430~~
	~~≥ 105,000 Btu/h~~	~~< 4,000 Btu/h/gal~~	~~80% E_t (Q/800 + 110√V)SL, Btu/h~~	~~ANSI Z21.10.3~~
~~Instantaneous water heaters, oil~~	~~≤ 210,000 Btu/h~~	~~≥ 4,000 Btu/h/gal and < 2 gal~~	~~0.59 - 0.0019V, EF~~	~~DOE 10 CFR Part 430~~
	~~> 210,000 Btu/h~~	~~≥ 4,000 Btu/h/gal and < 10 gal~~	~~80% E_t~~	~~ANSI Z21.10.3~~
	~~> 210,000 Btu/h~~	~~≥ 4,000 Btu/h/gal and ≥ 10 gal~~	~~78% E_t (Q/800 + 110√V)SL, Btu/h~~	
~~Hot water supply boilers, gas and oil~~	~~≥ 300,000 Btu/h and < 12,500,000 Btu/h~~	~~≥ 4,000 Btu/h/gal and < 10 gal~~	~~80% E_t~~	~~ANSI Z21.10.3~~
~~Hot water supply boilers, gas~~	~~≥ 300,000 Btu/h and < 12,500,000 Btu/h~~	~~≥ 4,000 Btu/h/gal and ≥ 10 gal~~	~~80% E_t (Q/800 + 110√V)SL, Btu/h~~	
~~Hot water supply boilers, oil~~	~~> 300,000 Btu/h and < 12,500,000 Btu/h~~	~~> 4,000 Btu/h/gal and > 10 gal~~	~~78% E_t (Q/800 + 110√V)SL, Btu/h~~	
~~Pool heaters, gas and oil~~	~~All~~	~~—~~	~~82% E_t -~~	~~ASHRAE 146~~

~~*(continued)*~~

~~**TABLE C404.2—continued**~~
~~**MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT**~~

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY (input)~~	~~SUBCATEGORY OR RATING CONDITION~~	~~PERFORMANCE REQUIRED[a, b]~~	~~TEST PROCEDURE~~
~~Heat pump pool heaters~~	~~All~~	~~—~~	~~4.0 COP~~	~~AHRI 1160~~
~~Unfired storage tanks~~	~~All~~	~~—~~	~~Minimum insulation requirement R-12.5 (h • ft^2 • °F)/Btu~~	~~(none)~~

~~For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.~~

~~a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements. In the EF equation, *V* is the rated volume in gallons.~~

~~b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, *Q* is the nameplate input rate in Btu/h. In the equations for electric water heaters, V is the rated volume in gallons and V_m is the measured volume in gallons. In the SL equation for oil and gas water heaters and boilers, *V* is the rated volume in gallons.~~

~~c. Instantaneous water heaters with input rates below 200,000 Btu/h shall comply with these requirements where the water heater is designed to heat water to temperatures 180°F or higher.~~

~~d. A tabletop water heater is a water heater that is enclosed in a rectangular cabinet with a flat top surface not more than 3 feet in height.~~

~~e. A grid-enabled water heater is an electric resistance water heater that meets all of the following:~~
   ~~1. Has a rated storage tank volume of more than 75 gallons.~~
   ~~2. Was manufactured on or after April 16, 2015.~~
   ~~3. Is equipped at the point of manufacture with an activation lock.~~
   ~~4. Bears a permanent label applied by the manufacturer that complies with all of the following:~~
      ~~4.1. Is made of material not adversely affected by water.~~
      ~~4.2. Is attached by means of nonwater-soluble adhesive.~~
      ~~4.3. Advises purchasers and end users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: "IMPORTANT INFORMATION: This water heater is intended only for use as part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this product."~~

~~*- delete and replace -*~~ **C404.2.1 High input service water-heating systems.**
Gas-fired water-heating equipment installed in new buildings shall be in compliance with this section. Where a singular piece of water-heating equipment serves the entire building and is 1,000,000 Btu/h (293 kW) or greater, such equipment shall have a thermal efficiency, E_t, of not less than 92 percent. Where multiple pieces of water-heating equipment serve the building and the combined input rating of the water-heating equipment is 1,000,000 Btu/h (293 kW) or greater, the combined input-capacity-weighted-average thermal efficiency, E_t, shall be not less than 92 percent.

Exceptions:

1. 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 thermal efficiency requirements of this section shall not apply.

2. 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.

3. The input rating of water heaters with an input rating of not greater than 100,000 Btu/h (29.3 kW) shall not be required to be included in the total input rating of *service water-heating* equipment for a building.

~~-~~*delete and replace* ~~-~~**C404.3 Heat traps for hot water storage tanks.**
Vertical pipe risers serving storage water heaters and storage tanks not having integral heat traps and serving a nonrecirculating system shall have heat traps on both the inlet and outlet piping as close as practical to the storage tank.

~~- *delete* - **C404.5.1 Maximum allowable pipe length method.**~~

~~- *delete* - **TABLE C404.5.1 PIPING VOLUME AND MAXIMUM PIPING LENGTHS**~~

~~- *delete* - **C404.5.2 Maximum allowable pipe volume method.**~~

~~- *delete* - **C404.5.2.1 Water volume determination.**~~

~~- *delete and replace* - **C404.6.1 Circulation systems.**~~
~~Heated~~ Tank inlets and outlets associated with solar water heating system circulation ~~systems~~loops shall ~~be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermo-syphon circulation systems shall be prohibited. Systems designed to maintain usage temperatures in hot-water pipes, such as recirculating hot-water systems or heat trace, shall:~~
~~Be equipped with automatic time switches that can be set to switch off the usage temperature maintenance system during periods when hot water is~~ not be required~~, or~~ to have heat traps.

~~2. Use a modulating pump, controlled by an aquastat at the return side of the pump, to maintain the minimum hot water temperature~~

~~**Exception:** in healthcare and other facilities with immunocompromised populations in accordance with ASHRAE Standard 188 – Legionellosis: Risk Management for Building Water Systems.~~

~~***- delete***~~

delete and replace **C404.4 Insulation of piping.**
Piping from a water heater to the termination of the heated water fixture supply pipe shall be insulated in accordance with Table C403.12.3. On both the inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 8 feet (2438 mm) of piping, whichever is less, shall be insulated. Piping that is heat traced shall be insulated in accordance with Table C403.12.3 or the heat trace manufacturer's instructions. Tubular pipe insulation shall be installed in accordance with the insulation manufacturer's instructions. Pipe insulation shall be continuous except where the piping passes through a framing member. The minimum insulation thickness requirements of this section shall not supersede any greater insulation thickness

requirements necessary for the protection of piping from freezing temperatures or the protection of personnel against external surface temperatures on the insulation.

Exception: Tubular pipe insulation shall not be required on the following:

1. The tubing from the connection at the termination of the fixture supply piping to a plumbing fixture or plumbing appliance.
2. Valves, pumps, strainers and threaded unions in piping that is 1 inch (25 mm) or less in nominal diameter.
3. Piping from user-controlled shower and bath mixing valves to the water outlets.
4. Cold-water piping of a demand recirculation water system.
5. Tubing from a hot drinking-water heating unit to the water outlet.
6. Piping at locations where a vertical support of the piping is installed.
7. Piping surrounded by building insulation with a thermal resistance (*R*-value) of not less than R-3.

delete **C404.7 Demand recirculation controls.**

delete **C404.8 Drain water heat recovery units** *and replace* ~~-~~*with* **C404.7 Drain water heat recovery units.**

delete **C404.9 Energy consumption of pools and permanent spas (Mandatory)**
and replace with **C404.~~9~~8 Energy consumption of pools and permanent spas.**

delete **C404.9.1 Heaters** *and replace with* **C404.8.1 Heaters.**

delete **C404.9.2 Time switches** *and replace with* **C404.8.2 Time switches.**

delete **C404.9.3 Covers** *and replace with* **C404.8.3 Covers.**
Outdoor heated pools and outdoor permanent spas shall be provided with a vapor-retardant cover or other *approved* vapor-retardant means. Hot tubs and spas capable of being heated to more than 90°F (32°C) shall be provided with a cover having a minimum insulation value of R-12.

Exception: Where more than 75 percent of the energy for heating, computed over an operating season of not fewer than 3 calendar months, is from ~~site-recovered energy such as from~~ a heat pump or an on-site renewable energy system, covers or other vapor-retardant means shall not be required.

~~-~~delete ~~*and replace -*~~**C404.10 Energy Consumption of portable spas (Mandatory**~~).~~
~~The energy consumption of electric-powered~~**)** *and replace with* **C404.9 Portable spas** ~~shall be controlled by the requirements of the Association of Pool & Spa Professionals (APSP) 14-2014~~**.**

~~-~~delete ~~*and replace -*~~ **C404.11 Service water-heating system commissioning and completion requirements** *and replace with* **C404.10 Service water-heating system commissioning and completion requirements**.

~~Service water-heating systems, swimming pool water-heating systems, spa water- heating systems and the controls for those systems shall be commissioned and completed in accordance with Section C407.2.~~

SECTION C405
ELECTRICAL POWER AND LIGHTING SYSTEMS

~~-~~*delete and replace* ~~-~~**C405.1 General** ~~**(Mandatory).**~~**.**

In addition to the electrical power and lighting systems requirements of Section C405, projects must achieve the required number of credits based on building occupancy group as outlined in Table C406.1.1 and Table C406.1.2. To achieve the required credits, electrical power and lighting enhancements may be needed ~~to meet~~ .

The requirements of ~~Section C406, Additional Efficiency Package Options. See Section C406~~C405 that may be affected and the corresponding C406 references are summarized in Table C405.1. For a full list of potential measures see Table C406.2.1 and Table C406.3.1.

~~This section covers~~ *add* **TABLE C405.1**

TABLE C405.1

C406 MEASURES AFFECTING ELECTRICAL POWER AND LIGHTING SYSTEMS

ID	**C406 Measure Title**	**C405 Reference**	**C406 Section**
P01	Energy monitoring	C405.12	C406.2.4
L02	Enhanced digital lighting controls	C405.2	C406.2.5.2
L03	Increase occupancy sensor	C405.2.1, C405.2.2	C406.2.5.3
L04	Increase daylight area	C405.2.3	C406.2.5.4
L05	Residential light control	C405.2.1.1	C406.2.5.5
L06	Reduced lighting power	C405.3.2.2, C405.2	C406.2.5.6
Q01	Efficient elevator equipment	C405.9	C406.2.6.1
Q02	Commercial kitchen equip.	n/a	C406.2.6.2
Q03	Residential kitchen equip.	n/a	C406.2.6.3
R01	On-Site Renewable Energy	n/a	C406.3.1
G01	Lighting Load Management	n/a	C406.3.2
G04	Electric Energy Storage	n/a	C406.3.5

Lighting system controls, the maximum lighting power for interior and exterior applications and electrical energy consumption~~.~~ shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with either Section C405.1.1 or C405.3. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

~~*Dwelling units* and *Sleeping Units* within Group R-2 buildings (see *occupancy classifications in section C202*) shall install lamps or fixtures where not less than 90 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 90 percent of the permanently installed lighting fixtures shall be high-efficacy fixtures or contain only high-efficacy lamps. Lighting installed in walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with the lighting requirements of Section C403.10.1.~~

~~–~~Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

add **C405.1.1 Lighting for dwelling and sleeping units.** All permanently installed lighting serving dwelling units and sleeping units, excluding kitchen appliance lighting, shall contain only high-efficacy lighting sources.

Exception: Buildings other than multifamily dwellings shall comply with Section C405.1.1 or Sections C405.2.4 and C405.3.

delete and replace ~~–~~**C405.2 Lighting controls** ~~**(Mandatory).**~~**.**
Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.~~6~~8.

2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.~~4~~5 and C405.2.~~5~~6. The LLLC luminaire shall be independently capable of:

   2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.

   2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.

   2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

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

2. Interior exit stairways, interior exit ramps and exit passageways.

3. Emergency egress lighting that is normally off.

4. *Dwelling units* and *sleeping units* within Group R-2 buildings (see *occupancy classifications*).

5. *Dwelling units* within buildings other than Group R-2, provided that ~~not less than 90 percent~~all of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps ~~or not less than 90 percent~~and all of the permanently installed lighting fixtures shall be high-efficacy fixtures or contain only high-efficacy lamps.

6. Industrial or manufacturing process areas, as may be required for production and safety.

~~-~~*delete and replace* ~~-~~**C405.2.1**~~.~~ **Occupant sensor controls.**
Occupant *sensor controls* shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.

2. Conference/meeting/multipurpose rooms.

3. Copy/print rooms.

4. Lounges/breakrooms.

5. Enclosed offices.

6. Open plan office areas.

7. Restrooms.

8. Storage rooms.

9. Locker rooms.

10. Corridors.

11. Warehouse storage areas.

12. Other spaces 300 square feet (28 m^2) or less that are enclosed by floor-to-ceiling height partitions.

Exception: Luminaires that are required to have specific application controls in accordance with Section C405.2.5.

delete and replace **C405.2.1.1 Occupant sensor control function.**

Occupant sensor controls in warehouses shall comply with Section C405.2.1.2. Occupant sensor controls in open plan office areas shall comply with Section C405.2.1.3. Occupant sensor controls in corridors shall comply with Section C405.2.1.4. Occupant sensor controls for egress illumination~~.~~ shall comply with Section C405.2.1.5. Occupant sensor controls for all other spaces specified in Section C405.2.1 shall comply with the following:

~~Luminaires providing means of egress illumination where the means of egress shall be illuminated at all times the room or space is occupied shall be controlled by occupancy sensors, or a signal from another building control system, that automatically reduces the lighting power by at least 50% when unoccupied for a period longer than 15 minutes.~~

~~**Exceptions:**~~

~~1. Egress areas not exceeding 50% of the space-by-space interior lighting power allowance provided in Table C405.3.2(2).~~

~~2. Means of egress illumination that does not exceed 0.02 watts per square foot of building area is exempt from this requirement.~~

~~3. Emergency lighting designated to meet National Fire Protection Association (NFPA) 1 or NFPA 101.~~

1. They shall automatically turn off lights within 20 minutes after all occupants have left the space.
2. They shall be manual on or controlled to automatically turn on the lighting to not more than 50-percent power.
3. They shall incorporate a manual control to allow occupants to turn off lights.

Exception: Full automatic-on controls with no manual control shall be permitted in corridors, stairways, restrooms, locker rooms, lobbies, library stacks and areas where manual operation would endanger occupant safety or security.

delete and replace **C405.~~2.~~2.1~~ Time-switch~~.2 Occupant sensor control function~~.~~ in warehouse storage areas.**

~~Each space provided with *time-switch controls*~~ Lighting in warehouse storage areas shall be ~~provided~~ controlled as follows:

1. Lighting in each aisleway shall be controlled independently of lighting in all other aisleways and open areas.
2. Occupant sensors shall automatically reduce lighting power within each controlled area to an occupied setpoint of not more than 50 percent within 20 minutes after all occupants have left the controlled area.
3. Lights that are not turned off by occupant sensors shall be turned off by time-switch control complying with Section C405.2.2.1.
4. A manual control shall be provided to allow occupants to turn off lights in the space.

delete and replace **C405.2.1.3 Occupant sensor control function in open plan office areas.**

Occupant sensor controls in open plan office spaces less than 300 square feet (28 m^2) in area shall comply with Section C405.2.1.1. Occupant sensor controls in all other open plan office spaces shall comply with all of the following:

1. The controls shall be configured so that general lighting can be controlled separately in control zones with floor areas not greater than 600 square feet (55 m^2) within the open plan office space.

2. General lighting in each control zone shall be permitted to automatically turn on upon occupancy within the control zone. General lighting in other unoccupied zones within the open plan office space shall be permitted to turn on to not more than 20 percent of full power or remain unaffected.

3. The controls shall automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the open plan office space.

Exception: Where general lighting is turned off by time-switch control complying with Section C405.2.2.1.

4. General lighting in each control zone shall turn off or uniformly reduce lighting power to an unoccupied setpoint of not more than 20 percent of full power within 20 minutes after all occupants have left the control zone.

add **C405.2.1.4 Occupant sensor control function in corridors.**
Occupant sensor controls in corridors shall uniformly reduce lighting power to not more than 50 percent of full power within 20 minutes after all occupants have left the space.
Exception: Corridors provided with less than two footcandles of illumination on the floor at the darkest point with all lights on.

delete **C405.2.1.4 Occupant sensor control function for ~~light reduction~~egress illumination**
and replace with **C405.2.1.5 Occupant sensor control function for egress illumination**

delete and replace **C405.2.2 Time-switch controls.**
Each area of the building that is not provided with *occupant sensor controls* complying with Section C405.2.1.1 shall be provided with *time-switch controls* complying with Section C405.2.2.1.

Exceptions:

1. Luminaires that are required to have specific application controls in accordance with Section C405.2.~~2.2. Time-switch controls shall include an override switching device that complies with the following:~~4.

~~1~~2. Spaces where patient care is directly provided.

3. Spaces where an automatic shutoff would endanger occupant safety or security.

4. Lighting intended for continuous operation.

5. Shop and laboratory classrooms.

delete and replace **C405.2.2.1 Time-switch control function.**
Time-switch con*trols* shall comply with all of the following:

1. Automatically turn off lights when the space is scheduled to be unoccupied.

2. Have a minimum 7-day clock.

~~2~~3. Be capable of being set for seven different day types per week.

~~3~~4. Incorporate an automatic holiday “shutoff” feature, which turns off all controlled lighting loads for not fewer than 24 hours and then resumes normally scheduled operations.

~~4~~5. Have program backup capabilities, which prevent the loss of program and time settings for not fewer than 10 hours, if power is interrupted.

~~5~~6. Include an override switch that complies with the following:

~~5~~6.1. The override switch shall be a manual control.

~~5~~6.2. The override switch, when initiated, shall permit the controlled lighting to remain on for not more than 2 hours.

~~5~~6.3. Any individual override switch shall control the lighting for an area not larger than 5,000 square feet (465 m^2).

~~**Exceptions:**~~

~~1.~~ **Exception:** Within mall concourses, auditoriums, sales areas, manufacturing facilities and sports arenas:

~~1.~~1. The time limit shall be permitted to be greater than 2 hours, provided that the switch is a captive key device.

~~1.~~2. The area controlled by the override switch shall not be limited to 5,000 square feet (465 m^2) provided that such area is less than 20,000 square feet (1860 m^2).

~~2. Where provided with manual control, the following areas are not required to have light reduction control:~~

~~2.1. Spaces that have only one luminaire with a rated power of less than 50 watts.~~

~~2.2. Spaces that use less than 0.3 watts per square foot (3.2 W/m^2).~~

~~2.3. Corridors, lobbies, electrical rooms and or mechanical rooms.~~

~~-~~*delete* ~~*and replace -*~~ **C405.2.2.2 Light-reduction controls~~.~~**
~~Spaces required to have~~ *and replace with* **C405.2.3 Light-reduction controls** ~~shall have a *manual control* that allows the~~
Where not provided with occupant ~~to reduce the connected~~sensor controls complying with Section C405.2.1.1, general lighting ~~load in a reasonably uniform illumination pattern by not less than 50 percent. Lighting reduction~~ shall be ~~achieved by one of the following or another *approved* method:~~provided with light-reduction controls complying with Section C405.2.3.1.

1. ~~Controlling all lamps or luminaires.~~
2. ~~Dual switching of alternate rows of luminaires, alternate luminaires or alternate lamps.~~
3. ~~Switching the middle lamp luminaires independently of the outer lamps.~~
4. ~~Switching each luminaire or each lamp.~~

Exceptions:

1. ~~Light reduction controls are not required in *daylight zones* with~~Luminaires controlled by daylight responsive controls complying with Section C405.2.~~3~~4.

~~2~~2. Luminaires controlled by special application controls complying with Section C405.2.5.

3. Where provided with manual control, the following areas are not required to have light-reduction control:

~~2~~3.1. Spaces that have only one luminaire with a rated power of less than 50 watts.

~~2~~3.2. Spaces that use less than 0.3 watts per square foot (3.2 W/m^2).

~~2.~~3.3. Corridors, ~~equipment rooms, public~~ lobbies, electrical and/or mechanical rooms.

~~-~~*delete* ~~*and replace -*~~ **C405.2.3 Daylight-responsive controls~~.~~**
and replace with **C405.2.4 Daylight-responsive controls**
Daylight-responsive controls complying with Section C405.2.~~3~~4.1 shall be provided to control the ~~electric lights~~ within *daylight zones* in the following spaces:

1. Spaces with a total of more than 150 watts of gen*eral lighting* within sidelit zones complying with Section C405.2.~~3.2 *General lighting* does not include lighting that is required to have specific application control in accordance with Section C405.2.4~~4.2.

~~2~~2. Spaces with a total of more than 300 watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.

3. Spaces with a total of more than 150 watts of *general lighting* within toplit daylight zones complying with Section C405.2.~~3~~4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.

2. ~~Lighting that is required to have specific application control in accordance with Section C405.2.4.~~

~~3.~~ Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies. ~~(See *Occupancy classifications* in Section C202.)~~

~~4.~~ 3. Daylight zones where the total proposed lighting power density is less than 35 percent of the lighting power allowance ~~per~~in accordance with Section C405.3.2.

~~5~~4. New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPA_{adj}) calculated in accordance with Equation 4-8:

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)] \qquad \textbf{(Equation 4-8)}$$

where:

LPA_{adj}	=	Adjusted building interior lighting power allowance in watts.
LPA_{norm}	=	Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.~~3~~2.5.6 where reduced lighting power is used to comply with the requirements of Section C406.
$UDZFA$	=	Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.~~3~~4.2 and C405.2.~~3~~4.3, that do not have daylight responsive controls.
$TBFA$	=	Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.

~~-~~*delete* ~~*and replace -*~~ **C405.2.3.1 Daylight-responsive control function**~~.~~ *and replace with* **C405.2.4.1 Daylight-responsive control function**

Where required, *daylight-responsive controls* shall be provided within each space for control of lights in that space and shall comply with all of the following:

1. Lights in *toplit daylight zones* in accordance with Section C405.2.~~3~~4.3 shall be controlled independently of lights in sidelit daylight zones in accordance with Section C405.2.~~3~~4.2.

~~2~~2. Lights in the primary sidelit daylight zone shall be controlled independently of lights in the secondary sidelit daylight zone.

3. *Daylight responsive controls* within each space shall be configured so that they can be calibrated from within that space by authorized personnel.

~~3~~4. Calibration mechanisms shall be in a location with *ready access*.

~~4. Where located in offices, classrooms, laboratories and library reading rooms,~~ 5. D*aylight responsive controls* shall dim lights continuously from full light output to 15 percent of full light output or lower.

~~5~~6. *Daylight responsive controls* shall be configured to completely shut off all controlled lights.

~~6~~7. When occupant sensor controls have reduced the lighting power to an unoccupied setpoint in accordance with Sections C405.2.1.2 through C405.2.1.4, daylight responsive controls shall continue to adjust electric light levels in response to available daylight, but shall be configured to not increase the lighting power above the specified unoccupied setpoint.

8. Lights in *sidelit daylight zones* in accordance with Section C405.2.~~3~~4.2 facing different cardinal orientations [within 45 degrees (0.79 rad) of due north, east, south, west] shall be controlled independently of each other.

~~7. Incorporate time-delay circuits to prevent cycling of light level changes of less than three minutes.~~

~~8. The maximum area a single daylight responsive control device serves shall not exceed 2,500 square feet (232 m2).~~

~~9. Occupant permanent override capability of daylight dimming controls is not permitted, other than a reduction of light output from the level established by the daylighting controls. Occupant temporary override capability is allowed as long as the lighting control automatically resets to the original setting within twelve hours.~~

~~Exception:~~Exceptions:

1. Within each space, up to 150 watts of lighting within the primary sidelit daylight zone is permitted to be controlled together with lighting in a primary sidelit daylight zone facing a different cardinal orientation.

2. Within each space, up to 150 watts of lighting ~~in each space~~ within the secondary sidelit daylight zone is permitted to be controlled together with lighting in a secondary sidelit daylight zone facing a different cardinal orientation.

~~***- add -***~~*delete* **C405.2.3.1.1 Dimming.**
~~*Daylight responsive controls* shall be configured to automatically reduce the power of *general lighting* in the *daylight zone* in response to available~~

delete **C405.2.3.2 Sidelit daylight**~~, while maintaining *uniform illumination* in the space through one of the following methods:~~

> ~~1. Continuous dimming using dimming ballasts/dimming drivers and **zone**~~ *and replace with* **C405.2.4.2 Sidelit daylight**~~-sensing automatic controls. The system shall reduce lighting power continuously to less than 15 percent of rated power at maximum light output.~~
>
> ~~2. Stepped dimming using multi-level switching and **zone**~~
> The sidelit daylight~~-sensing controls. The system shall provide a minimum of two steps of uniform illumination between 0 and 100 percent of rated power at maximum light output. Each step shall be in equal increments of power, plus or minus 10 percent. General lighting within daylight zones in offices, classrooms, laboratories and library reading rooms shall use the continuous dimming method. Stepped dimming is not allowed as a method of daylight zone control in these spaces.~~

~~- *delete and replace* - **C405.2.3.2 Sidelit zone.**~~
~~The sidelit~~ zone is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Where the fenestration is located in a wall, the sidelit daylight zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to ~~2 feet (610 mm),~~0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.~~3~~4.2~~.~~(1).

~~2~~2. Where the fenestration is located in a rooftop monitor, the sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.4.2(2) and C405.2.4.2(3).

3. The secondary sidelit daylight zone is directly adjacent to the primary sidelit daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the fenestration or to the nearest full height wall, whichever is less, and longitudinally from the edge of the fenestration to the nearest full height wall, or up to 2 feet, whichever is less, as indicated in Figure C405.2.4.2(1). The area of secondary sidelit zones shall not be considered in the calculation of the daylight zones in Section C402.4.1.1.

4. The area of the fenestration is not less than 24 square feet (2.23 m^2).

~~3~~5. The distance from the fenestration to any building or geological formation that would block *access* to daylight is greater than the height from the bottom of the fenestration to the top of the building or geologic formation.

~~4~~6. The visible transmittance of the fenestration is not less than 0.20.

~~5. Where *clerestory* fenestration is located in a wall, the sidelight daylight zone includes a lateral area twice the depth of the clerestory fenestration height, projected upon the floor at a 45-degree angle from the center of the clerestory fenestration. The longitudinal width of the daylight zone is calculated the same as for fenestration located in a wall. Where the 45-degree angle is interrupted by an obstruction greater than 0.7 times the ceiling height, the daylight zone shall remain the same lateral area but be located between the clerestory and the obstruction, as indicated in Figure C405.2.3.3(4).~~

~~6.~~ 7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection that is shading the fenestration is not greater than 1.0 for fenestration oriented 45 degrees or less from true north and not greater than 1.5 for all other orientations.

8. If the rough opening area of a vertical fenestration assembly is less than 10 percent of the calculated primary daylight zone area for this fenestration, it does not qualify as a daylight zone.

~~7.~~ 9. Where located in existing buildings, the visible transmittance of the fenestration is no less than 0.20.

~~8.~~ 10. In parking garages with floor area adjacent to perimeter wall openings, the daylight zone shall include the area within 20 feet of any portion of a perimeter wall that has a net opening to wall ratio of at least 40 percent.

~~*- delete and replace -*~~

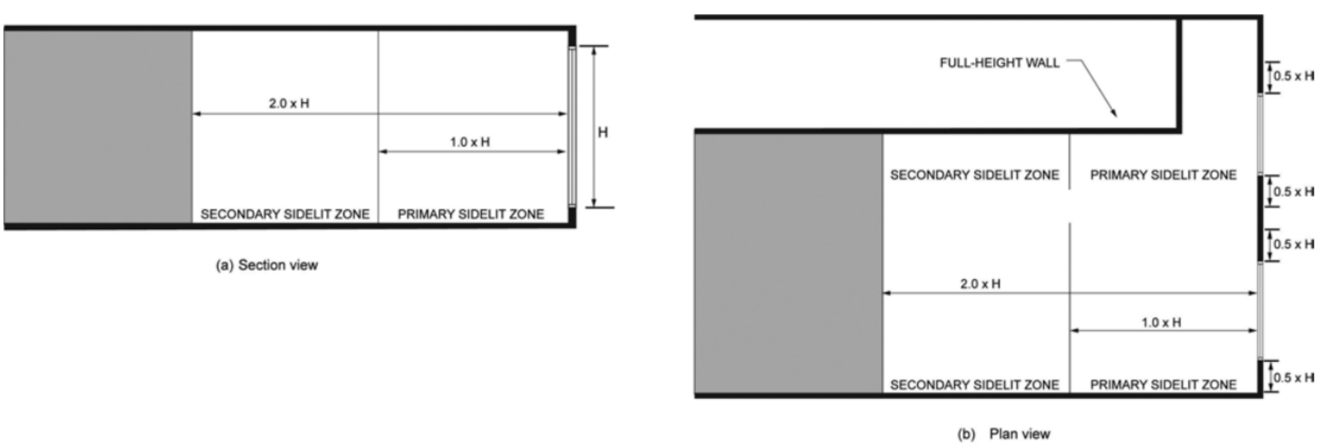


FIGURE C405.2.4.2(1)
PRIMARY AND SECONDARY SIDELIT DAYLIGHT ZONES

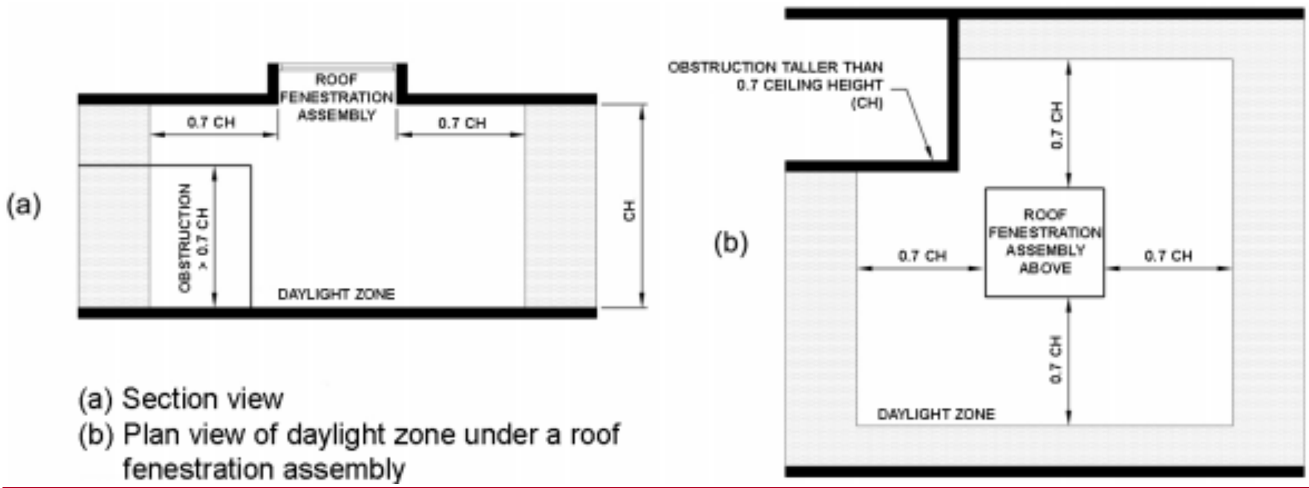


FIGURE C405.2.4.2(2)
DAYLIGHT ZONE UNDER A ROOFTOP MONITOR

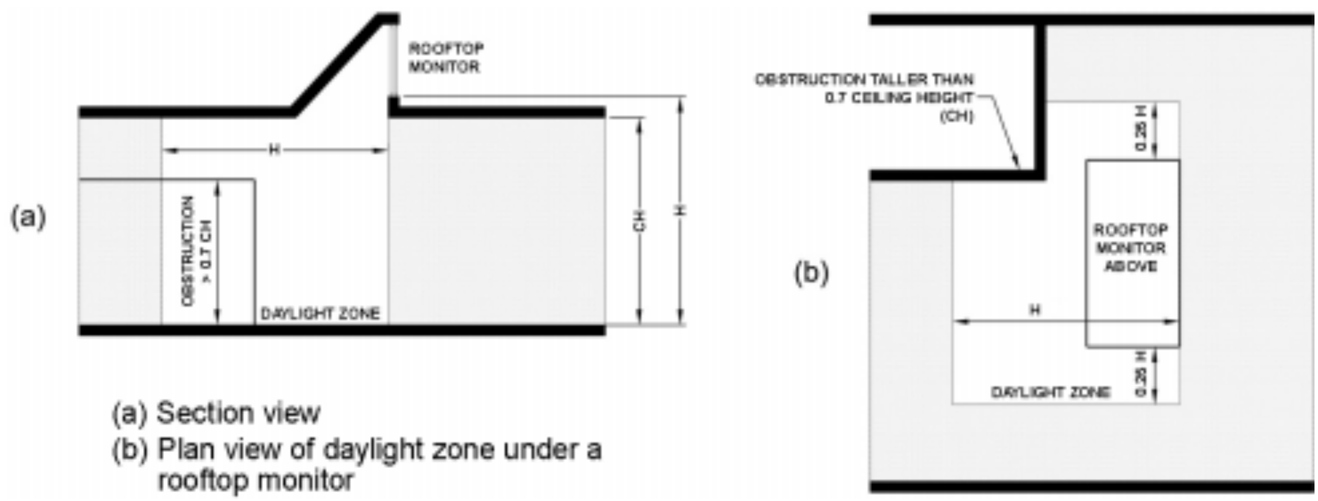


FIGURE C405.2.4.2(3)
DAYLIGHT ZONE UNDER A SLOPED ROOFTOP MONITOR

Delete C405.2.3.3 Toplit zone~~.~~ and replace with C405.2.4.3 Toplit daylight zone
The *toplit daylight zone* is the floor area underneath a roof fenestration assembly that complies with all of the following:

1. The *toplit daylight zone* shall extend laterally and longitudinally beyond the edge of the roof fenestration assembly to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.7 times the ceiling height, whichever is less, as indicated in Figure C405.2.4.3.~~3(1).~~
2. ~~Where the fenestration is located in a rooftop monitor, the toplit zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever~~

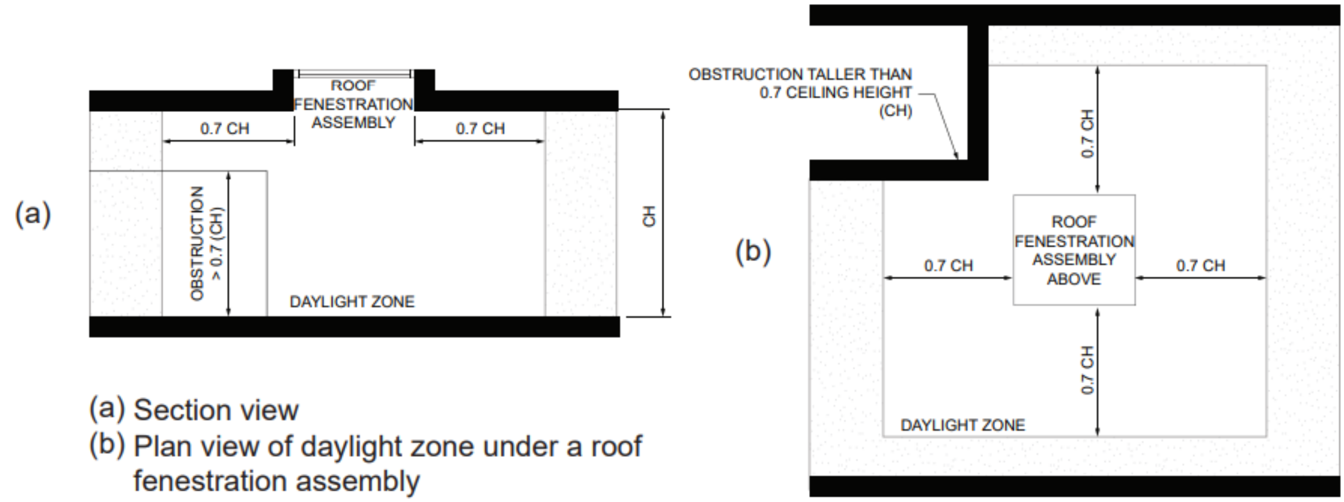
~~is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.3.3(2) and C405.2.3.3(3).~~

~~3~~
2. Direct sunlight is not blocked from hitting the roof fenestration assembly at the peak solar angle on the summer solstice by buildings or geological formations.

~~4~~3. The product of the visible transmittance of the roof fenestration assembly and the area of the rough opening of the roof fenestration assembly divided by the area of the *toplit* zone is not less than 0.008.

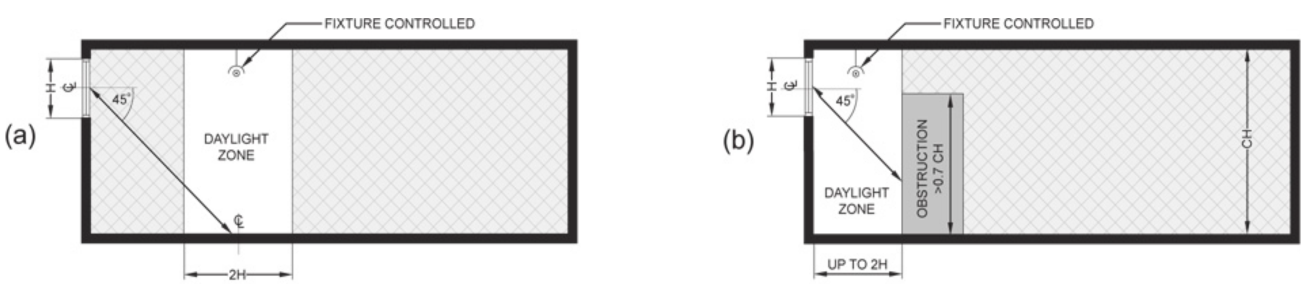
~~5.~~ 4. Where toplight daylight zones overlap with sidelight daylight zones, lights within the overlapping area shall be assigned to the toplight daylight zone.

~~- add -~~



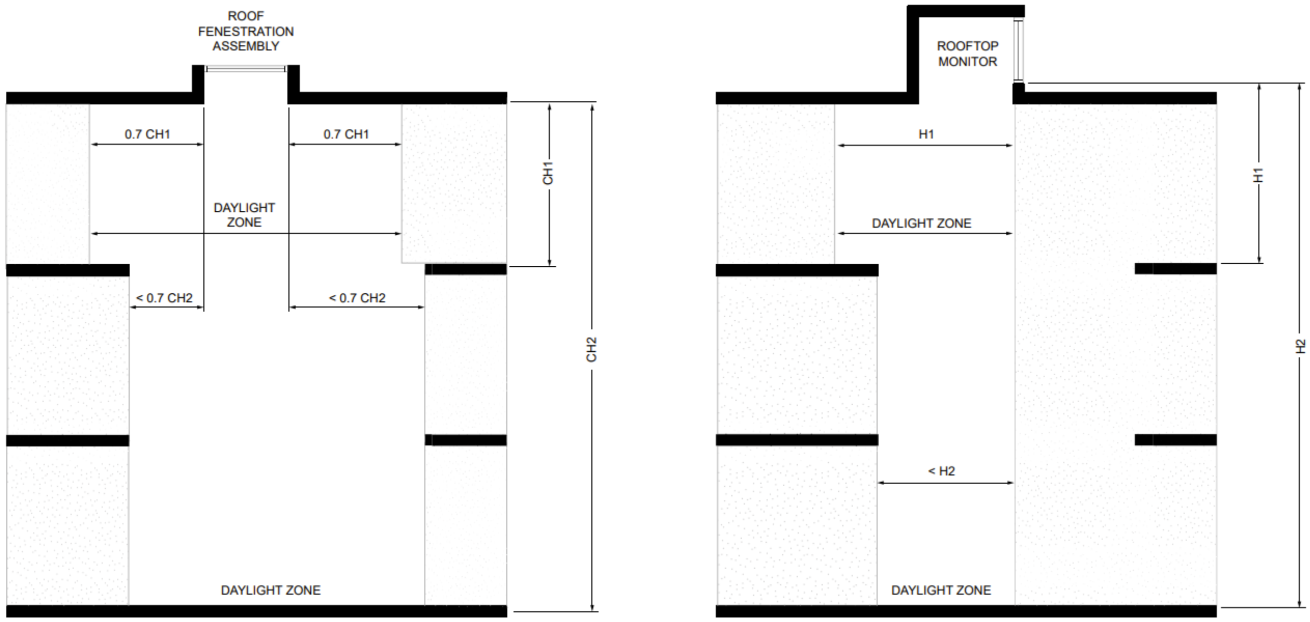
(a) Section view
(b) Plan view of daylight zone under a roof fenestration assembly

FIGURE C405.2.4.3~~.3(4)~~
TOPLIT DAYLIGHT ZONE ~~ADJACENT TO CLERESTORY FENESTRATION IN A WALL~~



(a) Section view
(b) Section view with obstruction

add **C405.2.4.4 Atriums.** Daylight zones at atrium spaces shall be established at the top floor surrounding the atrium and at the floor of the atrium space, and not on intermediate floors, as indicated in Figure C405.2.4.4.



(a) Section view of roof fenestration assembly at atrium

(b) Section view of roof monitor at atrium

FIGURE C405.2.~~3.3(~~4~~)~~.4

DAYLIGHT ~~ZONE ADJACENT TO CLERESTORY FENESTRATION IN A WALL~~ZONES AT A MULTISTORY ATRIUM

delete **C405.2.4 Specific application controls** *and replace with* **C405.2.5 Specific application controls**

Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:

   1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.

   1.2 Display and accent.

   1.3. Lighting in display cases.

   1.4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.

   1.5. Lighting equipment that is for sale or demonstration in lighting education.

1.6 Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

Exceptions:

1. Lighting and switched receptacles controlled by card key controls.

2. Spaces where patient care is directly provided.

3. Permanently installed luminaires within *dwelling units* shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.

4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.

5. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

delete **C405.2.5 Manual controls** *and replace with* **C405.2.6 Manual controls.**

delete **C405.2.6 Exterior lighting controls** *and replace with* **C405.2.7 Exterior lighting controls.**
Exterior lighting systems shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4.

Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.

2. Lighting controlled from within dwelling units.

delete **C405.2.6.1 Daylight shutoff** *and replace with* **C405.2.7.1 Daylight shutoff.**

delete **C405.2.6.2 Decorative lighting shutoff** *and replace with* **C405.2.7.2 Building façade and landscape lighting.**

delete **C405.2.6.3 Lighting setback** *and replace with* **C405.2.7.3 Lighting setback.**
Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at

one of the following times:

1.1. From not later than midnight to not earlier than 6 a.m.
1.2. From not later than one hour after business closing to not earlier than one hour before business opening.

1.3. During any time where activity has not been detected for 15 minutes or more.

2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

delete **C405.2.6.4 Exterior time-switch control function** *and replace with* **C405.2.7.4 Exterior time-switch control function.**

add **C405.2.8 Parking garage lighting control.**
Parking garage lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a *time-switch control* complying with Section C405.2.2.1. Additional lighting controls shall be provided as follows:

1. Lighting power of each luminaire shall be automatically reduced by not less than 30 percent when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be not larger than 3,600 square feet (334.5 m2).

   Exception: Lighting zones provided with less than 1.5 footcandles of illumination on the floor at the darkest point with all lights on are not required to have automatic light-reduction controls.

2. Where lighting for eye adaptation is provided at covered vehicle entrances and exits from buildings and parking structures, such lighting shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent from sunset to sunrise.

3. The power to luminaires within 20 feet (6096 mm) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

   Exceptions:
   1. Where the opening-to-wall ratio is less than 40 percent as viewed from the interior and encompassing the vertical distance from the driving surface to the lowest structural element.

   2. Where the distance from the opening to any exterior daylight blocking obstruction is less than one-half the height from the bottom of the opening or fenestration to the top of the obstruction.

3. Where openings are obstructed by permanent screens or architectural elements restricting daylight entering the interiorspace.

delete and replace **C405.3 Interior lighting power requirements ~~(Prescriptive).~~.**
A building complies with this section where its total connected interior lighting power calculated under Section C405.3.1 is not greater than the interior lighting power allowance calculated under Section C405.3.2.

~~**Exceptions:** Neither the floor area nor the wattage of lighting is counted in sections C405.3.1 and C405.3.2 for the following spaces:~~

~~1. *Dwelling units* and *sleeping units* within Group R-2 buildings (see *occupancy classification*).~~

~~2. *Dwelling units* and *sleeping units* within buildings other than Group R-2, provided that not less than 90 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 90 percent of the permanently installed lighting fixtures shall be high-efficacy fixtures or contain only high-efficacy lamps.~~

delete and replace **C405.3.1 Total connected interior lighting power.**
The total connected interior lighting power shall be determined in accordance with Equation 4-9.

TCLP = [~~*SL* +~~ *LVL* + *BLL* + *LED* + *TRK* + Other] **(Equation 4-9)**

where:

TCLP	=	Total connected lighting power (watts).
SL	=	Labeled wattage of luminaires for screw-in lamps.
~~*SL*~~	=	~~Labeled wattage of luminaries for screw-in lamps.~~
LVL	=	For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.
BLL	=	For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.
LED	=	For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.
TRK	=	For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following: 1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).

2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power. Additionally, for multiple systems installed in circadian rhythm systems, only include the maximum power that would be on at any one time.

1. Television broadcast lighting for playing areas in sports arenas.

2. Emergency lighting automatically off during normal building operation.

3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.

4. Casino gaming areas.

5. Mirror lighting in dressing rooms.

6. Task lighting for medical and dental purposes that is in addition to general lighting ~~and controlled by an independent control device~~.

7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting ~~and controlled by an independent control device~~.

8. Lighting for theatrical purposes, including performance, stage, film production and video production.

9. Lighting for photographic processes.

10. Lighting integral to equipment or instrumentation and installed by the manufacturer.

11. Task lighting for plant growth or maintenance provided it is limited to no more than ~~1.5~~75 W per square foot of Canopy Area.

12. Advertising signage or directional signage.

13. Lighting for food warming.

14. Lighting equipment that is for sale.

15. Lighting demonstration equipment in lighting education facilities.

16. Lighting approved because of safety considerations.
17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
19. Exit signs.

~~*delete and replace* ***TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD***~~

20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

delete and replace **C405.3.2 Interior lighting power allowance.**
The total interior lighting power allowance (watts) for an entire building shall be determined according to Table C405.3.2(1) using the Building Area Method, or Table C405.3.2(2) using the Space-by-Space Method. The interior lighting power allowance for projects that involve only portions of a building shall be determined according to Table C405.3.2(2) using the Space-by-Space Method. Buildings with unfinished spaces shall use the Space-by-Space Method.

delete and replace **TABLE C405.3.2(1)**

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

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	0.~~60~~56
Convention center	0.~~70~~55
Courthouse	0.~~76~~64
Dining: bar lounge/leisure	0.~~76~~64
Dining: cafeteria/fast food	0.~~67~~59
Dining: family	0.~~69~~58
~~Dormitory[c]~~ Dormitory[a,b]	0.~~47~~41
Exercise center	0.~~59~~54
Fire station[a]	0.~~48~~43
Gymnasium	0.~~64~~58
Health care clinic	0.~~69~~62
Hospital[a]	0.~~84~~74
Hotel/Motel[a, b]	0.~~65~~50
Library	0.~~78~~66
Manufacturing facility	0.~~82~~68
Motion picture theater	0.~~64~~44
Multifamily[c]	0.~~48~~38
Museum	0.~~83~~55
Office	0.~~64~~53

Parking garage	0.~~14~~13
Penitentiary	0.~~62~~54
Performing arts theater	~~1.02~~0.77
Police station	0.~~67~~55
Post office	0.~~61~~52
Religious building	0.~~77~~60
Retail	0.~~92~~73
School/university	0.~~67~~57
Sports arena	0.~~71~~61
Town hall	0.~~67~~56
Transportation	0.~~52~~42
Warehouse	0.~~43~~36
Workshop	0.~~83~~72

For SI: 1 watt per square foot = 10.76 W/m2.

a. Where sleeping units are excluded from lighting power ~~calculations when 90%~~by application of ~~the sleeping units' lamps or fixtures is high-efficacy~~Section C405.1.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

b. Where dwelling units are excluded from lighting power ~~calculations when 90%~~by application of ~~the sleeping units' lamps or fixtures is high-efficacy~~Section C405.1.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

c. Dwelling units and sleeping units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

~~-~~All permanently installed lighting serving dwelling units, excluding kitchen appliance lighting, shall contain only high-efficacy lighting sources

delete and replace ~~-~~**TABLE C405.3.2(2)** ~~*INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD*~~

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

COMMON SPACE TYPES[a]	LPD (watts/~~sq.ft~~ft^2)
Atrium	
Less than 40 feet in height	~~0.03 per foot in total height~~ 0.48
Greater than 40 feet in height	~~0.40 + 0.02 per foot in total height~~ 0.60
Audience seating area	

In an auditorium	0.~~50~~46
~~In a convention center~~	~~0.66~~
In a gymnasium	0.~~52~~23
In a motion picture theater	0.~~91~~27
In a penitentiary	0.22
In a performing arts theater	1.~~77~~16
In a religious building	~~1.22~~0.72
In a sports arena	0.~~34~~28
Otherwise	0.~~34~~28
Banking activity area	0.~~74~~56
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	~~1.07~~0.81
Otherwise	0.~~87~~65
Computer room, data center	~~1.21~~0.89
Conference/meeting/multipurpose room	0.~~92~~78
Copy/print room	0.~~51~~31
Corridor	
In a facility for the ~~elderly or~~ visually impaired (and not used primarily by the staff)[b]	0.~~92~~71
In a hospital	0.~~79~~62
~~In a manufacturing facility~~	~~0.29~~
Otherwise	0.~~66~~41
Courtroom	1.~~24~~01
Dining area	
In bar/lounge or leisure dining	0.~~80~~68
In cafeteria or fast food dining	0.~~51~~38
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.~~56~~27
In family dining	0.~~64~~51
In a penitentiary	0.~~77~~42
Otherwise	0.~~51~~39
Electrical/mechanical room	0.43
Emergency vehicle garage	0.~~38~~37
Food preparation area	0.82

Guestroom[c, d]	0.36
Laboratory	
In or as a classroom	0.89
Otherwise	1.08
Laundry/washing area	0.39
Loading dock, interior	0.42

(continued)

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

COMMON SPACE TYPES[a]	LPD (watts/sq.ft)
~~Food preparation area~~	~~0.90~~
~~Guestroom[c, d]~~	~~0.47~~
~~Laboratory~~	
~~In or as a classroom~~	~~1.05~~
~~Otherwise~~	~~1.30~~
~~Laundry/washing area~~	~~0.41~~
~~Loading dock, interior~~	~~0.42~~
Lobby	
For an elevator	0.~~53~~49
In a facility for the ~~elderly or~~ visually impaired (and not used primarily by the staff)[b]	1.54
In a hotel	0.~~85~~51
In a motion picture theater	0.~~41~~23
In a performing arts theater	1.~~47~~12
Otherwise	0.~~76~~66
Locker room	0.~~48~~41
Lounge/breakroom	
In a healthcare facility	0.~~68~~42
Otherwise	0.~~54~~47
Office	
Enclosed	0.~~81~~64
Open plan	0.~~71~~55
Parking area, interior	0.~~13~~12

Pharmacy area	1.~~20~~17
Restroom	
In a facility for the ~~elderly or~~ visually impaired (and not used primarily by the staff[b])	~~0.86~~ 1.26
Otherwise	0.~~73~~56
Sales area	~~1.11~~0.89
Seating area, general	0.~~38~~23
Stairway (see Space containing stairway)	
Stairwell	0.~~51~~41
Storage room	0.~~43~~33
Vehicular maintenance area	0.~~49~~45
Workshop	~~1.08~~0.96
BUILDING TYPE SPECIFIC SPACE TYPESa	**LPD (watts/sq.ft)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.~~88~~61
Dormitory – living quarters[c,d]	0.50
Facility for the ~~elderly or~~ visually ~~impaired~~impaired[b]	
In a chapel (and not used primarily by the staff)	~~1.06~~0.70
In a recreation room (and not used primarily by the staff)	1.~~67~~ 42
Fire Station—sleeping quarters[c]	0.~~17~~ 16
Gymnasium/fitness center	
In an exercise area	0.48
In a playing area	0.~~80~~68

~~(continued)~~

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

~~**BUILDING TYPE SPECIFIC SPACE TYPES**[a]~~	~~**LPD (watts/sq.ft)**~~
Healthcare facility	
In an exam/treatment room	1.~~34~~13

In an imaging room	~~1.02~~0.81
In a medical supply room	0.~~51~~46
In a nursery	0.~~76~~69
In a nurse's station	0.61
In an operating room	1.~~85~~69
In a patient room[c]	0.~~50~~48
In a physical therapy room	0.~~70~~66
In a recovery room	0.87
Library	
In a reading area	0.~~75~~70
In the stacks	~~1.15~~0.96

(continued)

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

BUILDING TYPE SPECIFIC SPACE TYPES[a]	LPD (watts/sq.ft)
Manufacturing facility	
In a detailed manufacturing area	0.~~88~~69
In an equipment room	0.~~55~~54
In an extra-high-bay area (greater than 50~~′~~ feet floor-to-ceiling height)	0.84
In a high-bay area (25~~-~~–50~~′~~ feet floor-to-ceiling height)	0.75
In a low-bay area (less than 25~~′~~ feet floor-to-ceiling height)	0.~~85~~71
Museum	
In a general exhibition area	0.~~84~~31
In a restoration room	0.74
Performing arts theater—dressing room	0.~~36~~32
Post office—sorting area	0.~~64~~58
Religious buildings	
In a fellowship hall	0.~~47~~42
In a worship/pulpit/choir area	~~1.22~~0.85

Retail facilities	
In a dressing/fitting room	0.~~48~~41
In a mall concourse	0.~~80~~67
Sports arena—playing area	
For a Class I facility[e]	2.~~17~~10
For a Class II facility[f]	1.~~55~~46
For a Class III facility[g]	1.~~17~~02
For a Class IV facility[h]	0.~~70~~64

~~*(continued)*~~

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

~~BUILDING TYPE SPECIFIC SPACE TYPES[a]~~	~~LPD (watts/sq.ft)~~
Transportation facility	
In a baggage/carousel area	0.~~39~~37
In an airport concourse	0.27
At a terminal ticket counter	0.~~56~~34
Warehouse—storage area	
For medium to bulky, palletized items	0.~~35~~28
For smaller, hand-carried items	0.~~65~~55

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 W/m2

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply

b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Where sleeping units are excluded from lighting power calculations ~~when 90% of the sleeping units' lamps or fixtures is high-efficacy~~by application of Section C405.1.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

d. Where dwelling units are excluded from lighting power calculations ~~when 90% of the sleeping units' lamps or fixtures is high-efficacy~~by application of Section C405.1.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

e. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

f. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high-school facilities with seating for more than 2,000 spectators.

g. Class III facilities consist of club, amateur league and high-school facilities with seating for 2,000 or fewer spectators.

h. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high-school facilities without provision for spectators.

~~- delete and replace -~~*delete and replace* **C405.3.2.1 Building Area Method.**
For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an "area" shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.

2. Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the lighting power (watts) for each building area type.

3. The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

delete and replace **C405.3.2.2 Space-by-Space Method.**
Where a building has unfinished spaces, the lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.2 watts per square foot (10.76 w/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.

2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the lighting power (watts) for each space type.

3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

delete and replace **C405.3.2.2.1 Additional interior lighting power.**
Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and ~~automatically~~ controlled ~~separately from the general lighting, to be turned off during nonbusiness hours~~in accordance with Section C405.2.5. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-10.

Additional interior lighting power allowance = 500 W + (Retail Area 1 × 0.22 W/ft^2) + (Retail Area 2 × 0.22W/ft^2) + (Retail Area 3 × 0.52 W/ft^2) + (Retail Area 4 × 0.93 W/ft^2)

For SI units:

~~Additional interior lighting power allowance~~ = ~~250~~Additional interior lighting power allowance = 500 W + (Retail Area 1 × ~~0.20~~2.4 W/~~ft~~m^2) ~~+~~ + (Retail Area 2 × ~~0.20~~2.42 W/~~ft~~m2) + (Retail Area 3 × ~~0.50~~5.5 W/~~ft~~m^2) + (Retail Area 4 × ~~0.90~~10 W/~~ft~~m^2)

~~SI units:~~

~~Additional interior lighting power allowance = 250 W + (Retail Area 1 × 2.13 W/m^2) + (Retail Area 2 × 2.15 W/m2) + (Retail Area 3 × 5.24 W/m^2) + (Retail Area 4 × 9.63 W/m^2)~~ ~~**(Equation 4-10)**~~

(Equation 4-10)

where:

Retail Area 1	=	The floor area for all products not listed in Retail Area 2, 3 or 4.
Retail Area 2	=	The floor area used for the sale of vehicles, sporting goods and small electronics.
Retail Area 3	=	The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is approved by the code official~~ or authority having jurisdiction~~.

~~2.~~

~~-~~*delete* ~~*and replace* -~~**C405.4 Exterior lighting power requirements** ~~**(Mandatory).**~~*and replace with* **C405.4 Lighting for plant growth and maintenance.**
Not less than 95 percent of the permanently installed luminaires used for plant growth and maintenance shall have a photon efficiency of not less than 1.7 μmol/J for greenhouses or 1.9 μmol/J for indoor facilities as defined in accordance with ANSI/ASABE S640.

delete and replace **C405.5 Exterior lighting power requirements.**
The total connected exterior lighting power calculated in accordance with Section C405.~~4~~5.1 shall be not greater than the exterior lighting power allowance calculated in accordance with Section C405.~~4~~5.2~~ and C405.4.3~~. Appropriate exterior lighting designs including maximum exterior illuminance levels may be required by the District Environmental Commission for Act 250 projects.

~~- *delete and replace* -~~

delete **C405.4.1 Total connected exterior building exterior lighting power** *and replace with* **C405.5.1 Total connected exterior building exterior lighting power**
The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Theatrical purposes, including performance, stage, film production and video production.

8. Athletic playing areas.

9. Temporary lighting.

10. Industrial production, material handling, transportation sites and associated storage areas.

11. Theme elements in theme/amusement parks.

12. Used to highlight features of art, public monuments, and the national flag.

13. Lighting for water features and swimming pools.

14. Lighting controlled from within dwelling units, where the lighting complies with Section C405.1.1.

delete **C405.4.2 Exterior lighting power allowance** *and replace with* **C405.5.2 Exterior lighting power allowance**

The exterior lighting power allowance (watts) is calculated as follows:

1. Determine the Lighting Zone (LZ) for the building according to Table C405.5.2(1), unless otherwise specified by the code official.
2. For each exterior area that is to be illuminated by lighting that is powered through the energy service for the building, determine the applicable area type from Table C405.5.2(2). For area types not listed, select the area type that most closely represents the proposed use of the area.
3. Determine the total area or length of each area type and multiply by the value for the area type in Table C405.5.2(2) to determine the lighting power (watts) allowed for each area type.
4. The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.5.2(2), plus the watts from each area type.

add **C405.5.2.1 Additional exterior lighting power.**

Additional exterior lighting power allowances are available for the specific lighting applications listed in Table C405.5.2(3). These additional power allowances shall be used only for the luminaires serving these specific applications and shall not be used to increase any other lighting power allowance.

delete **TABLE C405.4.2(1)** *and replace with* **TABLE C405.5.2(1)**

TABLE C405.5.2(1)
EXTERIOR LIGHTING ZONES

~~**TABLE C405.4.2(1)**~~
~~**EXTERIOR LIGHTING ZONES**~~

LIGHTING ZONE	DESCRIPTION
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed-use areas
3	All other areas not classified as lighting zone 1 or 2

~~-~~*delete* ~~-~~**TABLE C405.4.2(2)** ~~***LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS***~~

~~*- add -*~~*and replace with* **TABLE C405.~~4~~5.2(2)** ~~**INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**~~

TABLE C405.~~4~~5.2(2)
~~INDIVIDUAL~~ **LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

	LIGHTING ZONES		
	Zone 1	**Zone 2**	**Zone 3**
Base Site Allowance	~~250~~175 W	~~300~~200 W	~~375~~250 W
Uncovered Parking Areas			
Parking areas and drives	0.02 W/ft^2	0.~~03~~02 W/ft^2	0.~~05~~03 W/ft^2
Building Grounds			
Walkways less than 10 feet wide	0.~~35~~25 W/linear foot	0.~~35~~25 W/linear foot	0.~~40~~30 W/linear foot
Walkways, 10 feet wide or greater, plaza areas, special feature areas	0.~~07~~05 W/ft^2	0.~~07~~05 W/ft^2	0.~~08~~06 W/ft^2
Dining areas	0.~~50~~35 W/ft^2	0.~~50~~35 W/ft^2	0.~~60~~40 W/ft^2
Stairways	0.~~40~~30 W/ft^2	0.~~50~~35 W/ft^2	0.~~50~~35 W/ft^2
Pedestrian tunnels	0.~~08~~06 W/ft^2	0.~~08~~06 W/ft^2	0.~~10~~07 W/ft^2
Landscaping	0.02 W/ft^2	0.~~03 Wft2~~02 W/ft^2	0.~~03~~02 W/ft^2
Building Entrances and Exits			
Pedestrian and vehicular entrances and exits	~~10~~7 W/linear foot of ~~door width~~opening	~~10~~7 W/linear foot of ~~door width~~opening	~~15~~11 W/linear foot of ~~door width~~opening
Entry canopies	0.10 W/ft^2	0.12 W/ft^2	0.20 W/ft^2
Loading docks	0.~~25~~20 W/ft^2	0.~~25~~20 W/ft^2	0.~~25~~20 W/ft^2

Sales Canopies			
Free-standing and attached	0.~~30~~20 W/ft^2	0.~~30~~20 W/ft^2	0.~~40~~30 W/ft^2
Outdoor Sales			
Open areas (including vehicle sales lots)	0.~~15~~10 W/ft^2	0.~~15~~10 W/ft^2	0.~~25~~18 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	~~5~~4 W/linear foot	~~5~~4 W/linear foot
Building ~~facades~~façades	No allowance	0.~~075~~038 W/ft^2 of gross above-grade wall area	0.~~113~~057 W/ft^2 of gross above- grade wall area
Automated teller machines (ATM) and night depositories	~~135~~70 W per location plus ~~45~~25 W per additional ATM per location	~~135~~70 W per location plus ~~45~~25 W per additional ATM per location	~~135~~70 W per location plus ~~45~~25 W per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	0.~~5~~25 W/ft^2 of covered and uncovered area	0.~~5~~25 W/ft^2 of covered and uncovered area	0.~~5~~25 W/ft2 of covered and uncovered area
Loading areas for law enforcement, fire, ambulance and other ~~emergency~~emer gency service vehicles	0.~~35~~20 W/ft^2 of covered and uncovered area	0.~~35~~20 W/ft^2 of covered and uncovered area	0.~~35~~20 W/ft^2 of covered and uncovered area
Drive-up windows/doors	~~200~~100 W per drive-through	~~200~~100 W per drive-through	~~200~~100 W per drive-through
Parking near 24-hour retail entrances	~~400~~200 W per main entry	~~400~~200 W per main entry	~~400~~200 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 W/~~0.0929~~ m^2.
W = watts.

~~**- delete -**~~

add **TABLE C405.~~4~~5.2(3)**

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

~~- delete -~~ ~~**C405.4.2.1 Additional exterior lighting power.**~~

~~- add -~~

	LIGHTING ZONES		
	Zone 1	**Zone 2**	**Zone 3**
Building façades	No allowance	0.038 W/ft^2 of gross	0.057 W/ft^2 of gross

		above-grade wall area	above- grade wall area
Automated teller machines (ATM) and night depositories	70 W per location plus 25 W per additional ATM per location	70 W per location plus 25 W per additional ATM per location	70 W per location plus 25 W per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	0.25 W/ft^2 of covered and uncovered area	0.25 W/ft^2 of covered and uncovered area	0.25 W/ft2 of covered and uncovered area
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.20 W/ft^2 of covered and uncovered area	0.20 W/ft^2 of covered and uncovered area	0.20 W/ft^2 of covered and uncovered area
Drive-up windows/doors	100 W per drive-through	100 W per drive-through	100 W per drive-through
Parking near 24-hour retail entrances	200 W per main entry	200 W per main entry	200 W per main entry

For SI: 1 watt per square foot = 10.76 W/m^2.
W = watts.

delete **C405.4.3 Exterior fixtures~~.~~** *and replace with* **C405.5.3 Exterior fixtures**
Exterior lighting shall be *full cut off* fixtures, limiting the light output to less than 10~~%~~ percent at and below 10 degrees below the horizontal. Fixtures shall be independently certified by manufacturer as full cut off~~,~~ or meet the definition of a *fully shielded* light fixture.

~~- modify -~~ **~~C405~~***delete* **C404.4.3~~4~~ Gas lighting ~~(Mandatory) to~~** *and replace with* **C405.45.4 Gas lighting**
Gas-fired lighting appliances shall not be permitted.

delete **C405.5 Dwelling electrical meter** *and replace with* **C405.6 Dwelling electrical meter**
Each dwelling unit located in a *Group R*-2 building shall have a separate electrical meter.

> **Exception:** Buildings where a majority of the living units serve tenants at or below 80 percent of area median income.

delete **C405.6 Electrical transformers (Mandatory)** *and replace with* **C405.7 Electrical transformers**
Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of Table C405.7 as tested and rated in accordance with the test procedure listed in DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the transformer manufacturer.

> **Exception:** The following transformers are exempt:

1. Transformers that meet the *Energy Policy Act of 2005* exclusions based on the DOE 10 CFR 431 definition of special purpose applications.

2. Transformers that meet the *Energy Policy Act of 2005* exclusions that are not to be used in general purpose applications based on information provided in DOE 10 CFR 431.

3. Transformers that meet the *Energy Policy Act of 2005* exclusions with multiple voltage taps where the highest tap is not less than 20 percent more than the lowest tap.

4. Drive transformers.

5. Rectifier transformers.

6. Auto-transformers.

7. Uninterruptible power system transformers.

8. Impedance transformers.

9. Regulating transformers.

10. Sealed and nonventilating transformers.

11. Machine tool transformers.

12. Welding transformers.

13. Grounding transformers.

14. Testing transformers.

renumber **TABLE C405.6** *as* **TABLE C405.7**

delete **C405.7 Electric motors (Mandatory)** *and replace with* **C405.8 Electric motors.**

~~- *delete and replace* - **C405.8.1 Elevator cabs.**~~

~~For the luminaires in each elevator cab, not including signals and displays, the sum of the lumens divided by the sum of the watts shall be not less than 55 lumens per watt. Ventilation fans in elevators that do not have their own air-conditioning system shall not consume more than 0.33 watts/cfm at the maximum rated speed of the fan. Controls shall be provided that will de-energize ventilation fans and lighting systems when the elevator is stopped, unoccupied and with its doors closed for over 15 minutes.~~

~~- add - **C405.10 Electric Vehicle Charging Stations**~~

~~New parking lots serving buildings with occupancy groups listed in Table 405.11 shall provide the electrical service capacity to serve the number of Electric Vehicle Charging Parking Spaces in~~

~~Table C405.11. Electrical service capacity includes use of a listed cabinet, box or enclosure connected to a conduit linking the parking spaces with the electrical service. Parking lots serving multiple occupancy groups shall use the occupancy group with the largest square feet of finished area.~~

~~Exception:~~ Electric motors shall meet the minimum efficiency requirements of Tables C405.8(1) through C405.8(4) when tested and rated in accordance with the DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the motor manufacturer.

Exception: The standards in this section shall not apply to the following exempt electric motors:

1. Air-over electric motors.
2. Component sets of an electric motor.
3. Liquid-cooled electric motors.
4. Submersible electric motors.
5. Inverter-only electric motors.

renumber **TABLE C405.7(1)** *as* **TABLE C405.8(1)**

renumber **TABLE C405.7(2)** *as* **TABLE C405.8(2)**

renumber **TABLE C405.7(3)** *as* **TABLE C405.8(3)**

renumber **TABLE C405.7(4)** *as* **TABLE C405.8(4)**

delete **C405.8 Vertical and horizontal transportation systems and equipment** *and replace with* **C405.9 Vertical and horizontal transportation systems and equipment.**

delete **C405.8.1 Elevator cabs** *and replace with* **C405.9.1 Elevator cabs.**

delete **C405.8.2 Escalators and moving walks** *and replace with* **C405.9.2 Escalators and moving walks**
Escalators and moving walks shall comply with ASME A17.1/CSA B44 and shall have automatic controls that reduce speed as permitted in accordance with ASME A17.1/CSA B44 and applicable local code.

Exception: A variable voltage drive system that reduces operating voltage in response to light loading conditions is an alternative to the reduced speed function.

delete **C405.8.2.1 Energy recovery** *and replace with* **C405.9.2.1 Energy recovery**
Escalators shall be designed to recover electrical energy when resisting overspeed in the down direction. The escalator shall be designed to recover, on average, more power than is consumed by the power recovery feature of its motor controller system.

delete **C405.9 Voltage drop in feeder and branch circuits** *and replace with* **C405.10 Voltage drop**
The total *voltage drop* across the combination of customer-owned service conductors, feeder conductors and branch circuit conductors shall not exceed 5 percent.

add **C405.11 Automatic receptacle control.**
The following shall have automatic receptacle control complying with Section C405.11.1:

1. At least 50 percent of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms, and individual workstations, including those installed in modular partitions and module office workstation systems.

2. At least 25 percent of branch circuit feeders installed for modular furniture not shown on the construction documents.

add **C405.11.1 Automatic receptacle control function.**
Automatic receptacle controls shall comply with the following:

1. Either split controlled receptacles shall be provided with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches (304.8 mm) of each uncontrolled receptacle.

2. One of the following methods shall be used to provide control:

   2.1. A scheduled basis using a time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building of not more than 5,000 square feet (464.5 m^2) and not more than one floor. The occupant shall be able to manually override an area for not more than 2 hours. Any individual override switch shall control the receptacles of not more than 5,000 feet (1524 m).

   2.2. An occupant sensor control that shall turn off receptacles within 20 minutes of all occupants leaving a space.
   2.3. An automated signal from another control or alarm system that shall turn off receptacles within 20 minutes after determining that the area is unoccupied.

3. All controlled receptacles shall be permanently marked in accordance with NFPA 70 and be uniformly distributed throughout the space.

4. Plug-in devices shall not comply.

Exceptions: Automatic receptacle controls are not required for the following:

1. Receptacles specifically designated for equipment requiring continuous operation (24 hours per day, 365 days per year).
2. Spaces where an automatic control would endanger the safety or security of the room or building occupants.
3. Within a single modular office workstation, noncontrolled receptacles are permitted to be located more than 12 inches (304.8 mm), but not more than 72 inches (1828 mm) from the controlled receptacles serving that workstation.

add **C405.12 Energy monitoring.**

New buildings with a gross conditioned floor area of 25,000 square feet (2322 m^2) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

Exception:

R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet (464.5 m^2) of conditioned floor area.

add **C405.12.1 Electrical energy metering.**

For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

add **C405.12.2 End-use metering categories.**

Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.12.3 is provided.

TABLE C405.12.2
ENERGY USE CATEGORIES

Load Category	Description of Energy Use
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances, and equipment connected to convenience receptacle outlets.

EVSE	Electric vehicle supply equipment.
Process load	Any single load that is not included in an HVAC, lighting, plug load, or EVSE category and that exceeds 5 percent of the peak connected load of the whole building, including, but not limited to data centers, manufacturing equipment and commercial kitchens.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

add **C405.12.3 Meters.**

Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.12.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.12.4 and C405.12.5.

add **C405.12.4 Data acquisition system.**

A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.12.2.

add **C405.12.5 Graphical energy report.**

A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the energy consumption for each end-use category required by Section C405.12.2 at least every hour, day, month and year for the previous 36 months.

delete **C405.10 Electric vehicle** *and replace with* **C405.13 Electric vehicle Power Transfer Infrastructure.**

New parking facilities shall be provided with *electric vehicle* power transfer infrastructure in compliance with Sections C405.13.1 through C405.13.7.

add **C405.13.1 Quantity.**

The number of required *EVSE spaces*, *EV capable spaces* and *EV ready spaces* shall be determined in accordance with this Section and Table C405.13.1 based on the total number of *automobile parking spaces* and shall be rounded up to the nearest whole number.

1. Where more than one parking facility is provided on a building site, the number of required *automobile parking spaces* required to have *EV* power transfer infrastructure shall be calculated separately for each parking facility.

2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.

3. Each installed *EVSE* space with an *EV fast charger* shall count as four (4) *EVSE* spaces in Table C405.13.1.

4. Installed *EVSE* spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV ready spaces* and *EV capable spaces*.

5. Installed *EV ready spaces* that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV capable spaces*.

6. The quantity shall never exceed the number of *automobile parking spaces* or require more *automobile parking spaces* to be constructed.

Exceptions:

1. Parking facilities, serving occupancies other than R-2 with fewer than 10 automobile parking spaces.

2. Stand-alone retail stores with fewer than 50 spaces are exempt from the requirement to provide EVSE spaces but are still required to provide EV Ready and EV Capable spaces in Table C405.13.1 if there are 10 or more automobile parking spaces.

3. Motor liquid fuel-dispensing facilities including gas stations.

~~1.~~4. Parking spaces are not counted in Table 405.~~11~~13.1 if one of the following conditions apply:

   1. Parking spaces intended exclusively for storage of vehicles for retail sale or vehicle service.

   2. ~~2.~~ Parking spaces that are separated from the meter by a public right-of-way.

   3. Parking spaces ~~which~~that are limited to parking durations of less than an hour.

~~50% of the parking spaces indicated in Table C405.11, rounded up to the nearest whole number, is the minimum number of Electric Vehicle Supply Equipment (EVSE) or receptacles necessary to function as available electric vehicle charging upon building occupancy. The number of parking spaces indicated in Table C405.11 minus the number of installed EVSE parking spaces is the minimum number of parking spaces that are required to be pre-wired, allowing for future installations when they are needed for use by customers, employees or other users (EVSE-ready). If level 1 service is provided, the required EV Charging Parking Spaces shall also be "Level 2 ready" as defined below in this Section C405.10. Electrical service capacity includes use of a listed cabinet, box or enclosure connected to a conduit linking the parking spaces with the electrical service. For parking lots with 25 or more parking spaces, Table C405.11 can be satisfied by either Option A or B in the table.~~

~~Parking spaces~~ *delete* **TABLE C405.11** *and replace with* **TABLE C405.13.1**

TABLE C405.13.1
REQUIRED EV POWER TRANSFER INFRASTRUCTURE

COMMERCIAL BUILDING OCCUPANCY[a]	EVSE SPACES	EV READY SPACES	EV CAPABLE SPACES
Groups A, M	2%	0%	20%
Group B	6%	0%	30%
Group E	4%	0%	20%
Groups F, H, S	2%	0%	10%
Groups I, R-3, R-4	3%	0%	10%
Group R-1	8%	7%	50%
Group R-2	0%	0%	Determined in Equation 4-11

a. See *occupancy classification* in Section C202.

$$R2EVC = D/SU + 0.25 * (APS - D/SU) \qquad \textbf{(Equation 4-11)}$$

where:

R2EVC = Total requirement for EV Capable Spaces in R-2 building occupancies.

D/SU = Total number of dwelling and sleeping units in the R-2 building.

APS = Total number of *automobile parking spaces* provided.

add **C405.13.2 EV Capable Spaces.**

Each *EV capable space* used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the *EV capable space* and a suitable panelboard or other onsite electrical distribution equipment.

2. Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with C405.13.5.

3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.

4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future *electric vehicle supply equipment* (EVSE)."

5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each *EV capable space.*

   Exceptions:

   1. R-2 Occupancies with Multifamily building garage or covered parking, should provide on electrical drawings the appropriate sized pathway to the building electrical room to accommodate a future electrical upgrade for Level 2 EVSE electric vehicle charging; provide adequate wall and floor space in the building electrical room for future EV charging related electrical equipment; provide the appropriate sized pathways to exterior on-grade surface parking spaces for future Level 2 EVSE electric vehicle charging; provide a line diagram on the electrical drawings demonstrating a pathway for future Level 2 EVSE electric vehicle charging

add **C405.13.3 EV Ready Spaces.**

Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each *EV ready space* it serves.
2. Have a minimum circuit capacity in accordance with C405.13.5.
3. The panelboard or other electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

add **C405.13.4 EVSE Spaces.**

An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of Section C405.13.1, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.13.5.
2. Have a minimum charging rate in accordance with C405.13.4.1.
3. Be located within 3 feet (914 mm) of each *EVSE space* it serves.
4. Be installed in accordance with Section C405.13.6.

add **C405.13.4.1 EVSE Minimum Charging Rate.**

Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
2. When serving multiple *EVSE spaces* and controlled by an energy management system providing load management, be capable of simultaneously charging each *EVSE space* at a minimum rate of no less than 3.3 kVA.

3. When serving *EVSE spaces* allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.13.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each *ESVE space* at a minimum rate of no less than 2.1 kVA.

add **C405.13.5 Circuit Capacity.**

The capacity of electrical infrastructure serving each *EV capable space*, *EV ready space*, and *EVSE space* shall comply with one of the following:

1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each *EV ready space* or *EVSE space* it serves.
2. The requirements of C405.13.5.1.

add **C405.13.5.1 Circuit Capacity Management.**

The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.

2. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE space* for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be *EV ready spaces* or *EVSE spaces*.

3. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE spaces* for a building site when all (100%) of the *automobile parking spaces* are designed to be *EV ready* or *EVSE spaces*.

add **C405.13.6 EVSE Installation.**
EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. *EVSE* shall be accessible in accordance with International Building Code Section 1107.

add **C405.13.7 EVSE Parking Restrictions.**
Automobile parking spaces required by Table C405.13.1 to be equipped with *EVSE* shall be marked for EV use only.

~~Exception:~~

Exceptions:

1. In Group R-2 buildings the number of parking spaces with EVSE that are marked for “EV use only” need not exceed the number of EV cars driven by occupants of the building. This exception does not reduce the number of EVSE spaces, just the number that are marked for EV use only.

2. In structured parking lots ~~½~~ $^1/_2$ of parking spaces, rounded up, with EVSE shall be marked for “EV use only~~”~~,” while the remainder need not be marked for “EV use

only~~"~~." This exception does not reduce the number of EVSE spaces, just the number that are marked for EV use only.

~~Level 1 Electric Vehicle Charging Parking requires one 120V 20-amp grounded AC receptacle, NEMA 5- 20R or equivalent, within 5 feet of the centerline of each EV Charging Parking Space.~~

~~Level 2 Electric Vehicle Charging Parking requires one 208/240V 40-amp grounded connection for electric vehicle charging through dedicated Electric Vehicle Supply Equipment (EVSE) with J1772 connector or AC receptacle, NEMA 14-50, or equivalent, within 5 feet of the centerline for each EV Charging Parking Space.~~

~~DC Fast Charging, also referred to as Level 3, Electric Vehicle Charging Parking requires one, direct-current (DC) plug for electric vehicle charging through dedicated Electric Vehicle Supply Equipment (EVSE) with either a CHAdeMO or SAE Combined Charging System (CCS) format connector, within 5 feet of the centerline for each EV Charging Parking Space. Other DC Fast Charging plug standards may be accepted as they are developed.~~

~~This section does not stipulate how use of the EVSE is provided.~~

~~- add -~~ ~~**TABLE C405.11 ELECTRIC VEHICLE CHARGING PARKING SPACES**~~

~~**TABLE C405.11 ELECTRIC VEHICLE CHARGING PARKING SPACES**~~

add **C405.14 Additional electric infrastructure.** Buildings that contain *combustion equipment* and end-uses shall be required to install electric infrastructure in accordance with this section.

Exception: Buildings with R-2 *occupancy classifications*.

add **C405.14.1 Combustion space heating.** Spaces containing *combustion equipment* for space heating shall comply with either C405.14.1.1 or C405.14.1.2

add **C405.14.1.1 Low-capacity heating.** Spaces containing warm-air furnaces with a capacity less than 225,000 Btu/h and gas- and oil-fired boilers with a capacity less than 400,000 Btu/h shall be provided with a designated exterior location(s) that complies with the following:

1. Natural drainage for condensate from cooling equipment operation or a condensate drain located within 3 feet (914 mm) of the location of the space heating equipment, and
2. A dedicated branch circuit in compliance with NFPA70 Section 424.4 based on heat pump space heating equipment sized in accordance with the requirements of Section C403.1.1 and terminating within 3 feet (914 mm) of the location of the space heating equipment with no obstructions. Both ends of the branch circuit shall be labeled "For Future Heat Pump Space Heater."

Exception: Where an electrical circuit in compliance with NFPA70 Sections 440.4(B) and 440.35 exists for space cooling equipment.

add **C405.14.1.2 High-capacity heating.** Spaces containing all other space heating *equipment* shall be provided with conduit only that is continuous between a junction box located within 3 feet (914 mm) of the *equipment* and an electrical panel. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate a future branch circuit with sufficient capacity for an equivalent electric *equipment* with an equivalent equipment capacity. The electrical junction box and electrical panel shall have labels stating, “For Future Electric Space Heating Equipment”.

add **C405.14.2 Combustion water heating.** Spaces containing *combustion equipment* for water heating shall comply with either C405.14.2.1 or C405.14.2.2

add **C405.14.2.1 Low-capacity water heating.** Spaces containing water heaters with a capacity less than 300,000 Btu/h (88 kW) shall comply with the following:

1. Conduit sufficient for a 208/240-volt branch circuit with a minimum capacity of 30 amps terminating within 3 feet (914 mm) from the water heater shall be provided and be accessible to the water heater with no obstructions. Both ends of the branch circuit shall be labeled with the words "For Future Heat Pump Water Heater" and be electrically isolated,

2. A condensate drain that is no more than 2 inches (51 mm) higher than the base of the installed water heater and allows natural draining without pump assistance shall be installed within 3 feet (914 mm) of the water heater,

3. The space shall meet minimum dimensions of 3 feet (914 mm) by 3 feet (914 mm) by 7 feet (2134 mm) high, and

4. The space shall meet a minimum volume of 700 cubic feet (20,000 L) or the equivalent of one 16-inch (406 mm) by 24-inch (610 mm) grill to a heated space and one 8-inch (203 mm) duct of no more than 10 feet (3048 mm) in length for cool exhaust air.

   Exception: Where items 1 and 2 are be provided at an exterior location capable of serving an outdoor compressor for a split-system heat pump water heater and a chase that is sized to accommodate refrigerant lines is provided between the outdoor location and the space required in item 3.

add **C405.14.2.2 High-capacity water heating.** Spaces containing water heaters with a capacity greater than or equal to 300,000 Btu/h (88 kW) shall comply with the following:

1. Conduit that is continuous between a junction box located within 3 feet (914 mm) of the *equipment* and an electrical panel shall be provided. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate a branch circuit with sufficient capacity for an equivalent electric *equipment* with an equivalent equipment capacity. The electrical junction box and electrical panel shall have labels stating, “For Future Electric Water Heating Equipment”, and

2. A condensate drain that is no more than 2 inches (51 mm) higher than the base of the installed water heater and allows natural draining without pump assistance shall be installed within 3 feet (914 mm) of the water heater,

add **C405.14.3 Combustion cooking.** Spaces containing combustion equipment for cooking shall comply with either C405.14.3.1 or C405.14.3.2

add **C405.14.3.1 Commercial cooking.** Spaces containing *commercial cooking appliances* shall be provided with a dedicated branch circuit with a minimum capacity of 12 kVA per 1 kBtu of appliance input capacity. The branch circuit shall terminate within 3 feet (914 mm) of the appliance with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Cooking Equipment” and be electrically isolated.

add **C405.14.3.2 Light and medium duty cooking.** Spaces containing light- and medium duty cooking *equipment* not designated as *commercial cooking appliances* shall be provided with a dedicated branch circuit with a minimum capacity of 40 amps in compliance with NFPA 70 Section 422.10. The branch circuit shall terminate within 6 feet (1829 mm) of fossil fuel ranges, cooktops and ovens and be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Cooking Equipment” and be electrically isolated.

add **C405.14.4 Combustion clothes drying.** Spaces containing combustion equipment for clothes drying shall comply with either C405.14.4.1 or C405.14.4.2

add **C405.14.4.1 Commercial drying.** Spaces containing clothes drying *equipment*, and end-uses for commercial laundry applications shall be provided with conduit that is continuous between a junction box located within 3 feet (914 mm) of the *equipment* and an electrical panel. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate a branch circuit with sufficient capacity for an equivalent electric *equipment* with an equivalent equipment capacity. The electrical junction box and electrical panel shall have labels stating, “For Future Electric Clothes Drying Equipment”, and

add **C405.14.4.2 Residential drying.** Spaces containing clothes drying *equipment, appliances,* and end-uses serving multiple *dwelling units* or sleeping areas with a capacity less than or equal to 9.2 cubic feet shall be provided with a conduit sufficient for a dedicated 240-volt branch circuit with a minimum capacity of 30 amps shall terminate within 6 feet (1829 mm) of fossil fuel clothes dryers and shall be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Clothes Drying Equipment” and be electrically isolated.

delete **SECTION C406 ADDITIONAL PACKAGES** *in its entirety and replace with* **SECTION C406 ADDITIONAL EFFICIENCY, RENEWABLE, AND LOAD MANAGEMENT REQUIREMENTS**

SECTION C406
ADDITIONAL EFFICIENCY, RENEWABLE, AND LOAD MANAGEMENT REQUIREMENTS

C406.1 Compliance.

Buildings shall comply as follows:

1. Buildings with greater than 1000 square feet (190 m2) of floor area shall comply with Section C406.1.1.
2. Buildings with greater than 2500 square feet (465 m2) of conditioned floor area shall comply with Sections C406.1.1 and C406.1.2.
3. Build-out construction greater than 500 square feet (93 m2) of conditioned floor area that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.3.

Exception: Core and shell buildings where no less than 20 percent of the net floor area is without final lighting or final HVAC shall comply with all of the following:

1. Buildings with greater than 2500 square feet (465 m2) of conditioned floor area shall comply with Section C406.1.2
2. Portions of the building where the net floor area is without final lighting or final HVAC shall comply with Section C406.1.3
3. Portions of the building where the net floor area has final lighting and final HVAC systems shall comply with C406.1.1.

C406.1.1 Additional energy efficiency credit requirements.

Buildings shall comply with measures from C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1 based on building occupancy group. Where a project contains multiple occupancies, credits in Table C406.1.1 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 purposes of Section C406.

Exceptions:

1. Unconditioned parking garages that achieve 50% of the credits required for use groups S-1 and S-2 in Table C406.1.1.
2. Portions of buildings devoted to manufacturing or industrial use.

TABLE C406.1.1
ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

~~Commercial Building Occupancy[a]~~	~~**Minimum Number of EVSE and EVSE-ready Parking Spaces[b]**~~ ~~Whole numbers represent actual number of required spaces. Fractional percentages shall be rounded up to nearest whole number.~~**Building Occupancy Group**

	~~<25 Parking Spaces in Lot~~		~~≥25 Parking Spaces in Lot Option A~~		~~≥25 Parking Spaces in Lot Option B~~	
	~~Level 1~~	~~Level 2 or DC Fast Charge~~	~~Level 1~~	~~Level 2 or DC Fast Charge~~	~~Level 1~~	~~Level 2 or DC Fast Charge~~
~~Groups A & M[c]~~	~~0~~	~~0~~	~~0%~~	~~4%~~	~~0%~~	~~10~~
~~Groups B, E, F, & H~~	~~1~~	~~1~~	~~3%~~	~~3%~~	~~2%~~	~~5~~

	~~Groups I-1, I-~~**R-2**, ~~I-3, &~~ **R-4, and I-1**	~~1~~**I-2**	**R-1**	**B**	**A-2**~~%~~	~~4%~~**M**	**E**	**S-1**~~%~~ **and S-2**	~~10~~**All Other**
~~Group R-1~~Energy Credit Requirements	~~0~~79	~~1~~46	~~0%~~83	~~2%~~30	~~1%~~60	~~10~~75	90	65	36

~~Group R-2~~	~~1~~	~~0~~	~~8%~~	~~0%~~	~~3%~~	~~5~~

~~a. See *occupancy classification* in section C202. If more than one occupancy type, use the occupancy type with the most square feet of finished building area.~~
~~b. 50% of the parking spaces, rounded up to the nearest whole number, shall have EVSE or receptacles necessary to function as available electric vehicle charging upon building occupancy. The remainder shall be EVSE-ready.~~
~~c. Motor liquid fuel-dispensing facilities (gas stations) are exempt from the requirement to provide electric vehicle charging parking spaces.~~
~~d. Stand-alone retail stores with fewer than 50 spaces are exempt from the requirement to provide electric vehicle charging parking spaces.~~

~~If the design intent is to only provide level 2 and/or DC Fact Charge charging stations, then the level 1 and level 2 requirements should be added together.~~

~~SECTION~~ C406
~~ADDITIONAL EFFICIENCY PACKAGE OPTIONS~~

~~- *delete* - **C406.1 Requirements.**~~

~~- add -~~ ~~C406.1~~ .1.2 Additional ~~Energy Efficiency Credit Requirements.~~ **renewable and load management credit requirements.**

~~New~~ Buildings shall comply with ~~sufficient packages~~measures from ~~Table~~ C406.~~1~~3 to achieve ~~a minimum~~ not less than the number of ~~6~~required renewable and load management credits~~. Building with more than one commercial~~ from Table C406.1.2 based on building occupancy ~~type shall use the "All Other Groups" column~~group. Where a project contains multiple occupancies, credits in Table ~~406.1, unless 65% or more of the finished square footage is one commercial~~C406.1.2 from each building occupancy ~~type, in which case~~shall be weighted by the gross floor area to determine the ~~dominant commercial~~weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406.

Exceptions:

1. Where a building ~~occupancy type will be used~~achieves an additional 70% of the required points from Table C406.1.1, only 50% (round up to nearest whole number) of points from Table C406.1.2 are required.

~~*add*~~ Where a building achieves an additional 120% of the required points from Table C406.1~~-~~
~~**Efficiency Package Credits**~~

2. .1, 0 points from Table C406.1.2 are required.

~~**Efficiency Package Credits**~~

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

~~Code Section~~	~~Commercial~~ **Building Occupancy Group**								
	~~Group~~ **R-2, R-4, and I-1**	~~Group~~ ~~R~~**I-2**	**R-1**	~~Group~~ **B**	~~Group~~ ~~E~~**A-2**	~~Group~~ **M**	**E**	**S-1 and S-2**	**All Other~~-~~ ~~Groups~~**

	~~Additional Efficiency Credits~~					
~~1. More efficient HVAC performance in accordance with Section C406.2.~~	~~2~~	~~2~~	~~5~~	~~2~~	~~6~~	~~3~~
~~2.1 Reduced lighting power: Option 1 in accordance with Section C406.3.1.~~	~~1~~	~~1~~	~~3~~	~~3~~	~~3~~	~~2~~
~~2.2 Reduced lighting power: Option 2 in accordance with Section C406.3.2.~~	~~2~~	~~2~~	~~5~~	~~5~~	~~5~~	~~4~~
~~3. Enhanced lighting controls in accordance with C406.4.~~	~~N/A~~	~~N/A~~	~~2~~	~~1~~	~~2~~	~~1~~
~~4. On-site supply of renewable energy in accordance with C406.5.~~	~~3~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~
~~5. Dedicated outdoor air system in accordance with C406.6[1].~~	~~3~~	~~1~~	~~2~~	~~3~~	~~4~~	~~3~~
~~6.1 High-efficiency service water heating in accordance with Section C406.7.1 and C406.7.2.~~	~~5~~	~~6~~	~~N/A~~	~~N/A~~	~~N/A~~	~~3 (Group I only)~~
~~6.2 High-efficiency service water heating equipment in accordance with Section C406.7.1 and C406.7.3.~~	~~3~~	~~3~~	~~N/A~~	~~N/A~~	~~N/A~~	~~2 (Group I only)~~

~~6.3. Heat pump water heating~~	~~5~~16	~~5~~11	~~N/A~~14	~~N/A~~24	~~N/A~~4	~~2 (Group~~	22	20	17

~~equipment in accordance with Sections C406.7.1 and C406.7.4.~~Renewable and Load Management Credit Requirements						~~I- only)~~25			

~~7. Enhanced envelope performance in accordance with Section C406.8.~~	~~3~~	~~4~~	~~2~~	~~2~~	~~2~~	~~3~~
~~8. Reduced air infiltration in accordance with Section C406.9.~~	~~3~~	~~5~~	~~2~~	~~3~~	~~4~~	~~3~~
~~9. Efficient kitchen appliances in accordance with C406.10.[2]~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5 (Group A-2 only)~~
~~10. Controlled Receptacles in accordance with C406.11~~	~~N/A~~	~~N/A~~	~~6~~	~~2~~	~~N/A~~	~~N/A~~
~~1. This option is only available to building equipped with operable commercial kitchens serving a minimum of 5 meals per week. See C406.10~~						

~~**- delete and replace-**~~ **C406.1.**~~1 Tenant spaces.~~

~~**Tenant spaces**~~ **3 Core and Shell Buildings and Build-Out Construction.**

Where separate permits are issued for core and shell buildings and build-out construction, compliance shall be in accordance with the following requirements.

1. Core and shell buildings or portions of buildings shall comply with ~~sufficient packages from~~ one of the following:

   1.1. Where the permit includes a central HVAC system or service water heating system with chillers, heat pumps, boilers, service water heating equipment, or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required in Table C406.1 ~~to achieve a minimum number of 3 credits from Sections~~ .1 in accordance with Section C406.2~~,~~.

   1.2. Alternatively, the project shall achieve not less than 33 percent of the energy credits required in Table C406.~~3, C406.4, C406.6 or C406.7 where applicable. Where an~~ 1.1.

2. For core and shell buildings or portions of buildings the energy credits achieved shall be subject to the following adjustments:

   2.1. Lighting measure credits shall be determined only for areas with final lighting installed.

   2.2. Where HVAC or service water heating systems are designed to serve the entire building ~~complies with Section C406.5, C406.8 or C406.9, tenant spaces within the building~~ , full HVAC or service water heating measure credits shall be achieved

   2.3. Where HVAC or service water heating systems are designed to serve individual areas, HVAC or service water heating measure credits achieved shall be reduced in proportion to the floor area with final HVAC systems or final service water heating systems installed

3. Build-out construction shall be deemed to comply with Section C406.1 where either

3.1. Where heating and cooling generation are provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required in Table C406.1.1

3.2. Where heating and cooling generation are provided by an HVAC system installed in the build out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required in Table C406.1.

3.3. Where the core and shell building was approved in accordance with C408.

C406.2 Additional Energy Efficiency Credits Achieved.

Each energy efficiency credit measure used to meet credit requirements for the project shall have efficiency that is greater than the requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the base credits listed for the measure and occupancy type in Table C406.2.1 or, where calculations required by Sections C406.2.1 through C406.2.6 create or modify the table credits, the credits achieved shall be based upon the calculations. Energy credits achieved for measures shall be determined by one of the following, as applicable:

1. The measure's energy credit shall be the base energy credit for the measure where no adjustment factor or calculation is included in the description of the measure in Section C406.2.

2. The measure's energy credit shall be the base energy credit for the measure adjusted by a factor or equation as stated in the description of the measure in Section C406.2. Where adjustments are applied, each measure's energy credit shall be rounded to the nearest whole number.

3. The measure's energy credit shall be by calculation as stated in the measure's description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

Energy credits achieved for the project shall be the sum of the individual measure's energy credits. Credits are available for the measures listed in this Section. Where a project contains multiple building occupancy groups:

1. Credits achieved for each occupancy group shall be summed and then weighted by the floor area of each occupancy group to determine the weighted average project energy credits achieved.

2. Credits for improved envelope efficiency and lighting reduction (L06) shall be determined for the building or permitted floor area as a whole. Credits for other measures shall be taken from applicable tables or calculations weighted by the building occupancy group floor area.

TABLE C406.2.1
ENERGY EFFICIENCY MEASURES AND CREDITS BY OCCUPANCY GROUP [a,b]

ID	Energy Credit Measure	Building Occupancy Group								
		R-2, R-4, and I-1	I-2	R-1	B	A-2	M	E	S-1 and S-2	All Other
E01	Envelope Performance	Determined in accordance with Section C406.2.1.1								
E02	UA Reduction	19	5	13	20	33	28	25	37	28

E03	Envelope Leak Reduction	13	9	28	6	42	13	8	68	41
E04	Add Roof Insulation	7	2	3	3	2	24	23	10	9
E05	Add Wall Insulation	13	3	5	8	2	16	7	7	9
E06	Improve Fenestration	42	6	13	21	4	10	34	6	17
H01	HVAC Performance	6	6	6	6	x	9	8	x	8
H02	Heating Efficiency	14	11	6	9	19	29	15	44	18
H03	Cooling Efficiency	3	x	x	1	x	7	4	x	x
H04	Residential HVAC Control	21	x	x	x	x	x	x	x	x
H05	Energy Recovery	46	65	41	114	84	242	43	180	90
W01	SHW Preheat Recovery	93	6	36	12	34	13	13	3	26
W02	Heat Pump Water Heater	81	3	30	5	25	4	10	1	20
W04	SHW Pipe Insulation	6	1	4	4	2	4	4	1	3
W05	Point of Use Water Heaters	x	x	x	18	x	x	4	x	11
W06	Thermostatic Balance Valves	3	0	2	1	1	1	1	1	1
W07	SHW Heat Trace System	11	1	7	5	3	5	5	2	5
W08	SHW Submeters	17	x	x	x	x	x	x	x	17
W09	SHW Distribution Sizing	68	x	26	x	x	x	x	x	47
W10	Shower Heat Recovery	25	1	9	x	x	x	3	x	10
P01	Energy Monitoring	3	3	2	3	2	5	3	5	3
L01	Lighting Performance	x	x	x	x	x	x	x	x	x
L02	Enhanced Digital Lighting Controls	1	4	1	4	1	5	4	3	3
L03	Increase Occupancy Sensors	1	4	2	4	1	6	3	4	3
L04	Increase Daylight Area	2	5	3	6	1	8	5	4	4
L05	Residential Light Control	3	x	x	x	x	x	x	x	x
L06	Reduced Lighting Power	1	5	1	5	1	6	5	4	4
Q01	Efficient Elevator Equipment	4	2	2	4	0	3	4	5	3
Q02	Commercial Kitchen Equipment	x	x	x	x	21	x	x	x	x
Q03	Residential Kitchen Equipment	13	x	10	x	x	x	x	x	x
Q04	Fault Detection	3	3	2	3	3	3	4	6	4

[a]. "x" indicates credit is not available for that measure

[b]. Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

C406.2.1 More Efficient Building Envelope.

A project shall achieve credits for improved envelope performance by complying with of one of the following measures:

1. Section C406.2.1.1: E01
2. Section C406.2.1.2: E02
3. Section C406.2.1.3: E03

4. Both EO2 and E03

5. Any combination of:

   5.1 Section C406.2.1.3: E03

   5.2 Section C406.2.1.4: E04

   5.3 Section C406.2.1.5: E05

   5.4 Section C406.2.1.6: E06

C406.2.1.1 E01 Improved envelope performance 90.1 Appendix C.

Building envelope measures shall be installed to improve the energy performance of the project. The achieved energy credits shall be determined using Equation 4-13.

$$EC_{env} = 1000 \times (EPF_B - EPF_P)/EPF_B \qquad \text{(Equation 4-13)}$$

where:

EC_{ENV}	=	E01 energy credits
EPF_B	=	base envelope performance factor calculated in accordance with ASHRAE 90.1 Appendix C.
EPF_P	=	proposed envelope performance factor calculated in accordance with ASHRAE 90.1-Appendix C.

C406.2.1.2 E02 Total UA envelope reduction.

Energy credits shall be achieved where the total UA of the building thermal envelope as designed is not less than 15 percent below the total UA of the building thermal envelope in accordance with Section C402.1.3.

C406.2.1.3 E03 Reduced air leakage.

Energy credits shall be achieved where tested building air leakage is less than 0.15 cfm/ft2 provided the building is tested in accordance with the applicable method in Section C402.4.1.1.

C406.2.1.4 E04 Add Roof Insulation.

Energy credits shall be achieved in conditioned spaces for insulation that is in addition to the required insulation in Table C402.1(2). All roof areas in the project shall have additional R-10 continuous insulation included in the roof assembly. For attics this is permitted to be achieved with fill or batt insulation rated at R-10 that is continuous and not interrupted by ceiling or roof joists. Where interrupted by joists, the added insulation shall be not less than R-13. Alternatively, one-half of the base credits shall be achieved where the added R-value is one-half of the additional R-value required by this section.

~~**Exception:** Previously occupied tenant spaces that comply with this code in accordance with Section C501.~~

~~*- delete –* **C406.2 More efficient HVAC equipment performance.**~~

~~***- add -*** C406~~**C406.2.1.5 E05 Added Wall Insulation.**

Energy credits shall be achieved in conditioned spaces for insulation applied to not less than 90 percent of all opaque wall area in the project that is in addition to the required insulation in Table C402.1(2).

Opaque walls shall have additional R-5 continuous insulation included in the wall assembly. Alternatively, one-half of the base credits shall be achieved where the added R-value is R-2.5.

C406.2.1.6 E06 Improve Fenestration

Energy credits shall be achieved for improved energy characteristics of all vertical fenestration in the project meeting this requirement. The area-weighted average U-factor of all vertical fenestration shall be equal to or less than U-0.22.

C406.2.2 More Efficient HVAC Equipment ~~and fan performance.~~
~~**Buildings shall comply with Sections C406.2.1 through C406.2.3.**~~ **Performance.**

~~*- add -* **C406.2.1 HVAC system selection.** No less than 90 percent of the total HVAC capacity serving the building shall be provided by equipment that is~~ All heating and cooling systems shall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to minimum efficiencies listed in Tables ~~C403.3.2(1) through~~referenced by Section C403.3.2~~(12).~~

~~**Exception:** Air-to-water heat pumps or heat recovery chillers~~ . Where multiple efficiency requirements are ~~also permitted to be utilized for Option C406.2.~~

~~*- add -* **C406.2.2 Minimum equipment efficiency.**~~listed, equipment shall ~~exceed~~meet the ~~minimum~~seasonal or part-load efficiencies including SEER, EER/integrated energy efficiency ~~requirements listed in Tables C403.3.2(1) through C403.3.2(12) by 15 percent, in addition to the requirements of Section C403. Where multiple performance requirements are provided, the equipment shall exceed all requirements by 15 percent.~~

~~**Exception:**~~ratio (IEER), integrated part load value (IPLV), or AFUE. Equipment that is larger than the maximum capacity range indicated in Tables referenced by Section C403.3.2~~(1) through C403.3.2(12)~~ shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted average improvement based on individual system capacity.

~~*- add -* **C406.2.3 Minimum fan efficiency.** Stand-alone supply, return and exhaust fans designed for operating with motors over 750 watts (1 hp) shall have a fan efficiency grade of not less than FEG 71 as defined in AMCA 205. The total efficiency of the fan at the design point of operation shall be within 10 percentage points of either the maximum total efficiency of the fan or the static efficiency of the fan.~~

~~- delete and replace- **C406.3 Reduced lighting power.**~~
~~Buildings shall comply with Sections C406.3.1 or C406.3.2. Dwelling units and sleeping units within the building shall comply with C406.3.3.~~

~~*- add -* **C406.3.1 Reduced lighting power option 1.** The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be 90 percent or less of the total interior lighting power value calculated in accordance with Section C405.3.2.1, or by using 90 percent of the total interior lighting power allowance calculated in accordance with Section C405.3.2.2.~~

~~*- add -* **C406.3.2 Reduced lighting power option 2.** The total connected interior lighting power calculated~~Systems are permitted to achieve HVAC energy credits by meeting the requirements of either:

1. C406.2.2.1 H01
2. C406.2.2.2 H02
3. C406.2.2.3 H03
4. C406.2.2.4 H04
5. C406.2.2.5 H05
6. Any combination of H02, H03, H04 and H05
7. The combination of H01 and H04

C406.2.2.1 H01 HVAC Performance (TSPR).

H01 energy credits shall be achieved for systems allowed to use Section C403.1.3, HVAC total system performance ratio, where the proposed TSPR exceeds the minimum TSPR requirement by 5 percent. If improvement is greater, base energy credits from Table C406.2.1 are permitted to be prorated up to a 20 percent improvement using Equation 4-15. Energy credits for H01 may not be combined with energy credits from HVAC measures H02, H03 and H05.

H01 energy credit = H01 base energy credit x $TSPR_s$ / 0.05 (Equation 4-15)

where:

$TSPR_s$ = the lessor of 0.20 and (1 – ($TSPR_p$ / $TSPR_t$))

where:

$TSPR_t$	=	$TSPR_r$ / MPF
$TSPR_p$	=	HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.
$TSPR_r$	=	HVAC TSPR of the reference building design calculated in accordance with Sections C409.4, C409.5 and C409.6.
MPF	=	Mechanical Performance Factor from Table C409.4 based on climate zone and building use type. Where a building has multiple building use types, MPF shall be area weighted in accordance with Section C409.4

C406.2.2.2 H02 More efficient HVAC equipment heating performance.

No less than 90 percent of the total HVAC capacity serving the total conditioned floor area of the entire building, or tenant space in accordance with Section ~~C405.3~~C406.1.1, shall ~~be 80 percent or less~~comply with the requirements of ~~the total interior lighting power value calculated~~this Section.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2. Electric resistance heating capacity shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating.
2. Equipment shall exceed the minimum heating efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5

percent, energy efficiency credits for heating shall be determined using Equation 4-16 rounded to the nearest whole number.

$$EEC_{HEH} = EEC_{H5} \times (HEI / 0.05) \qquad \text{(Equation 4-16)}$$

where:

EEC_{HEH} = energy efficiency credits for heating efficiency improvement

EEC_{H5} = C406.2.2.2 credits from Table C406.2.1

HEI = the lesser of: the improvement (as a fraction) above minimum heating efficiency requirements, or 20 percent (0.20). Where heating equipment with different minimum efficiencies are included in the building, a heating capacity weighted average improvement shall be used. Where electric resistance primary heating or reheat is included in the building it shall be included in the weighted average improvement with an HEI of 0. Supplemental gas and electric heat for heat pump systems shall be excluded from the weighted HEI. For heat pumps rated at multiple ambient temperatures, the efficiency at 47 F (8.3 C) shall be used.
For metrics that increase as efficiency increases, HEI shall be calculated as follows:
$HEI = (HM_{DES}/HM_{MIN}) - 1$
Where:
HM_{DES} = Design heating efficiency metric, part-load or annualized where available
HM_{MIN} = Minimum required heating efficiency metric, part-load or annualized where available from Section C403.3.2

C406.2.2.3 H03 More efficient HVAC cooling equipment and fan performance.

No less than 90 percent of the total HVAC cooling capacity serving the total conditioned floor area of the entire building or tenant space in accordance with Section ~~C405.3.2.1, or by using 80 percent of the total interior lighting power allowance calculated in accordance with Section C405.3.2.2~~C406.1.1, shall comply with all of the requirements of this section.

1. ~~*- add -* **C406.3.3 Lamp fraction.** Not~~Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2.

2. Equipment shall exceed the minimum cooling efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. For water-cooled chiller plants, heat rejection equipment efficiency shall also be increased by at least the chiller efficiency improvement. Where equipment exceeds the minimum annual cooling efficiency and heat rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using Equation 4-17, rounded to the nearest whole number.

3. Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fan power or horsepower shall be less than 95 percent of the ~~lamps in permanently installed lighting fixtures shall be high-efficacy lamps or~~ allowed fan power in Section C403.8.1.

$EEC_{HEC} = EEC_5 \times (CEI / 0.05)$ (Equation 4-17)

where:

EEC_{HEC}	=	energy efficiency credits for cooling efficiency improvement
EEC_5	=	C406.2.2.3 base energy credits from Table C406.2.1
CEI	=	the lesser of: the improvement above minimum cooling and heat rejection efficiency requirements expressed as a fraction, or 0.20 (20 percent). Where cooling equipment with different minimum efficiencies are included in the building, a cooling capacity weighted average improvement shall be used. Where multiple cooling performance requirements are provided, the equipment shall exceed the annualized energy or part-load requirement. Meeting both part-load and full-load efficiencies is not required.

For metrics that increase as efficiency increases, CEI shall be calculated as follows:

$CEI = (CM_{DES} / CM_{MIN}) - 1$

For metrics that decrease as efficiency increases, CEI shall be calculated as follows:

$CEI = (CM_{MIN} / CM_{DES}) - 1$

Where:

CM_{DES}	=	Design cooling efficiency metric, part-load or annualized where available
CM_{MIN}	=	Minimum required cooling efficiency metric, part-load or annualized where available from Section C403.3.2

For Data Centers using Standard 90.4, CEI shall be calculated as follows:

$CEI = (AMLC_{MAX} / AMLC_{DES}) - 1$

Where:

$AMLC_{DES}$	=	As-Designed Annualized Mechanical Load Component calculated in accordance with Standard 90.4, Section 6.5
$AMLC_{MAX}$	=	Maximum Annualized Mechanical Load Component from Standard 90.4, Table 6.5

C406.2.2.4 H04 Residential HVAC control.

HVAC systems serving dwelling units or sleeping units shall be controlled to automatically activate a setback at least 5°F (3°C) for both heating and cooling. The temperature controller shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall be configured to operate in conjunction with one of the following:

1. A manual main control device by each dwelling unit main entrance that initiates setback and non-ventilation mode for all HVAC units in the dwelling unit and is clearly identified as “Heating/Cooling Master Setback.”
2. Occupancy sensors in each room of the dwelling unit combined with a door switch to initiate setback and non-ventilation mode for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately after a door switch

operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is configured to provide setback shall meet this requirement.

3. An advanced learning thermostat or controller that recognizes occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.

4. An automated control and sensing system that uses geographic fencing connected to the dwelling unit occupants' cell phones and initiates the setback condition when all occupants are away from the building.

C406.2.2.5 H05 Energy Recovery.

Credits for this measure are only allowed where single zone HVAC units are not required to have multi-speed or variable-speed fan control in accordance with Section C403.8.6.1. HVAC controls and ventilation systems shall include all of the following:

1. The ventilation system shall have energy recovery with an enthalpy recovery ratio of 75 percent or more at heating design conditions . Energy recovery shall include latent recovery. Where no humidification is provided, heating energy recovery effectiveness is permitted to be based on sensible energy recovery ratio. Where energy recovery effectiveness is less than the 75 percent required for full credit, adjust the credits from Section C406.2 by the factors in Table C406.2.2.5.

2. Where the ventilation system serves multiple zones and the system is not in a latent recovery outside air dehumidification mode. partial economizer cooling through an outdoor air bypass or wheel speed control shall automatically do one of the following:

    a. Set the energy recovery leaving-air temperature 55°F (13°C) or 100 percent outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).

    b. The HVAC ventilation system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.

3. Ventilation systems providing mechanical dehumidification shall use recovered energy for reheat. This shall not limit the use of latent energy recovery for dehumidification.

Where only a portion of the building is permitted to be served by constant air volume units or the enthalpy recovery ratio or sensible energy recovery ratio is less than 65 percent, the base energy credits shown in Section C406.2 shall be prorated as follows:

$$EC_{DOAS} = EC_{base} \times FLOOR_{CAV} \times ERE_{adj} \quad \text{(Equation 4-18)}$$

where:

EC_{DOAS} = Energy credits achieved for H06

EC_{base} = H06 base energy credits in Section C406.2

$Floor_{CAV}$ = Fraction of whole project gross conditioned floor area not required to have variable speed or multi-speed fan airflow control in

		accordance with Section C403.8.6.
ERE_{adj}	=	The energy recovery adjustment from Table C406.2.2.5 based on the lower of actual cooling or heating enthalpy recovery ratio or sensible energy recovery ratio where required for the climate zone. Where recovery ratios vary, use a weighted average by supply airflow.

TABLE C406.2.2.5 – DOAS Energy Recovery Adjustments

ERE_{adj} based on lower of actual heating or cooling energy recovery effectiveness where required		
Cooling ERR is ≥	Heating *enthalpy recovery ratio* or *sensible energy recovery ratio* is ≥	Energy Recovery Effectiveness Adjustment (ERE_{adj})
65%	65%	1.00
60%	60%	0.67
55%	55% [a]	0.33
50%	50% [a]	0.25

[a]In climate zones where heating recovery is required for this measure, for dwelling units a heating recovery effectiveness below 60 percent is not allowed.

C406.2.3 Reduced Energy Use In-service Water Heating.

Projects with service water-heating equipment that serves the whole building, a building addition or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of either:

1. C406.2.3.1 by selecting one allowed measure W01, or W02
2. C406.2.3.2 W03
3. C406.2.3.3 by selecting one allowed measure of W04, W05, or W06
4. C406.2.3.4 W07
5. C406.2.3.5 W08
6. C406.2.3.6 W09
7. Any combination of measures in C402.2.3.1 through C402.2.3.6 as long as no more than one allowed measure from C406.2.3.1 and C406.2.3.3 are selected.

C406.2.3.1 Service water-heating system efficiency.

A project is allowed to achieve energy credits from only one of Sections C406.2.3.1.1 through C406.2.3.1.3.

C406.2.3.1.1 W01 Recovered or renewable water heating.

The building service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the building's annual hot water requirements, or sized to provide not less than 70 percent of the building's annual hot water requirements if the building is required to comply with Section C403.10.5:

1. Waste heat recovery from SHW, heat recovery chillers, building equipment, or process equipment.
2. A water-to-water heat pump that precools chilled water return for building cooling.
3. On-site renewable energy water-heating systems.

C406.2.3.1.2 W02 Heat pump water heater.

Air-source heat pump water heaters shall be installed according to manufacturer's instructions and at least 30 percent of design end use service water heating requirements shall be met using only heat pump heating at an ambient condition of 67.5 F, db without supplemental electric resistance or fossil fuel heating. For a heat pump water heater with supplemental electric resistance heating, the heat pump only capacity shall be deemed at 40 percent of first hour draw. Where the heat pump only capacity exceeds 50 percent of the design end use load excluding recirculating system losses, the credits from the Section C406.2 tables shall be prorated as follows:

$EC_{HPWH} = (EC_{base} / 0.5) \times \{Cap_{HPWH}/EndLoad \text{ [not greater than 2]}\}$ (Equation 4-19)

where:

EC_{HPWH}	=	Energy credits achieved for W02
EC_{base}	=	W02 base energy credits from Table C406.1.1
EndLoad	=	End use peak hot water load, excluding load for heat trace or recirculation, Btu/hr or kW
Cap_{HPWH}	=	the heat pump only capacity at 50°F (10°C) entering air and 70°F (21°C) entering potable water without supplemental electric resistance or fossil fuel heat, Btu/hr or Kw

The heat pump service water heating system shall comply with the following requirements:

1. For systems with an installed total output capacity of more than 100,000 Btu/hr (30 kW) at an ambient condition of 67.5°F (19.7°C), db a preheat storage tank with greater than or equal 0.75 gallons per 1000 Btu/hr (≥9.7 L/kW) of design end use service water heating requirements shall be heated only with heat pump heating when the ambient temperature is greater than 45°F (7.2°C)
2. For systems with piping temperature maintenance, either a heat trace system or a separate water heater in series for recirculating system and final heating shall be installed.
3. Heat pump water heater efficiency shall meet or exceed one of the following:
   a. Output-capacity-weighted-average UEF of 3.0 in accordance with 10 CFR 430 Appendix E.
   b. Output-capacity-weighted-average COP of not less than 4.0 tested at 50°F (10°C) entering air and 70°F (21°C) entering potable water in accordance with AHRI standard 1300.

Where the heat pump capacity at 50°F (10°C) entering air and 70°F (21°C) entering water exceeds 50 percent of the design end-use load excluding recirculating system losses, the base credits from Section C406.2 shall be prorated based on Equation 4-20.

W02 credit = base W02 table credit × (HPLF / 50%) (Equation 4-20)

where:

HPLF = Heat pump capacity as a fraction of the design end-use SHW requirements excluding recirculating system losses, not to exceed 80 percent.

C406.2.3.1.3 Combination service water heating systems

Shall achieve credits using the measure combination as follows:

1. (W01 + W02) Where service water heating employs both energy recovery and heat pump water heating, W01 may be combined with W02 and receive the sum of both credits.

C406.2.3.3 Water-heating distribution temperature maintenance.

A project is allowed to achieve energy credits from only one of the following SHW distribution temperature maintenance measures.

C406.2.3.3.1 W03: Service Hot Water Piping Insulation Increase.

Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hot water source to the fixture shutoff. Where no more than 50% of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.

C406.2.3.3.2 W04 Point of use water heaters.

Credits are available for Group B or E buildings larger than 10,000 ft2 (930 m2). Fixtures requiring hot water shall be supplied from a localized source of hot water with no recirculating system or heat trace piping. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C403.12.3 without exception. The volume from the water heater to the termination of the fixture supply pipe shall be limited as follows:

1. Non-residential lavatories: not more than 2 oz (60 mL)
2. All other plumbing fixtures or appliances: not more than 0.25 gallons (0.95 ~~percent of the permanently installed lighting~~L)

Exception: Where all remotely located hot water uses meet the requirements for measure W04, separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping.

C406.2.3.3.3 W05 Thermostatic balancing valves.

Credits are available where service water heating is provided centrally and distributed throughout the building and has a recirculating system. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 120°F (49°C).

C406.2.3.3.4 W06 Heat trace system.

Credits are available for projects with gross floor area greater than 10,000 square feet (930 m2) and a central water-heating system. The energy credits achieved shall be from Table C406.2.1. This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

C406.2.3.4 W07 Water-heating system submeters.

Each individual dwelling unit in a Group R-2 occupancy served by a central service water-heating system shall be provided with a service hot water meter connected to a reporting system that provides individual dwelling unit reporting of actual domestic hot water use. Preheated water serving the cold water inlet to showers need not be metered.

C406.2.3.5 W08 Service hot water flow reduction.

Dwelling unit, sleeping unit, and guest room plumbing fixtures ~~shall be high-efficacy fixtures or contain only high-efficacy lamps.~~ that are connected to the service water-heating system shall have a flow or consumption rating less than or equal to the values shown in Table C406.2.3.5.

~~- delete and replace-~~Table C406.2.3.5

Maximum Flow Rating for Residential Plumbing Fixtures with Heated Water

Plumbing Fixture	Maximum Flow Rate
Faucet for private lavatory,[a] hand sinks, or bar sinks	1.2 gpm at 60 psi (0.095 L/s at 410 kPa)
Faucet for residential kitchen sink [a,b, c]	1.5 gpm at 60 psi 0.11 L/s at 410 kPa)
Shower head (including hand-held shower spray) a, b, d	1.5 gpm at 80 psi (0.13 L/s at 550 kPa)

a. Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)- (p).

b. Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.

c. Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (0.14 L/s at 410 kPa) and must default to the maximum flow rate listed.

d. When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.

C406.2.3.6 W9 Shower drain heat recovery.

Cold water serving building showers shall be preheated by shower drain heat recovery units that comply with Section C404.7. The efficiency of drain heat recovery units shall be 54 percent or greater measured in accordance with CSA B55.1. Full credits are applicable to the following building uses: I-2, I-4, R-1, R-2 and also group E where there are more than eight showers. Partial credits are applicable to buildings where all but ground floor showers are served where the base energy credit from Section C406.2 is adjusted by

Equation 4-21.

W10 credit = W10 base energy credit × (showers with drain heat recovery)/(total showers in building) (Equation 4-21)

C406.2.4 P01 Energy Monitoring.

A project not required to comply with C405.12 can achieve energy credits for installing an energy monitoring system that complies with all the requirements of C405.12.1 through C405.12.5.

C406.2.5 Energy Savings in Lighting Systems.

Projects are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of either:

1. C406.2.5.2 L02
2. C406.2.5.3 L03
3. C406.2.5.4 L04
4. C406.2.5.5 L05
5. C406.2.5.6 L06
6. Any combination of L03, L04, L05 and L06
7. Any combination of L02, L03 and L04

C406.2.5.1 L01 Lighting system performance (reserved).

Reserved for future use

C406.2.5.2 L02 Enhanced digital lighting controls.

Measure credits shall be achieved where no less than 50 percent of the gross floor area within the project shall comply with the requirements of this section.

1. Lighting controls function. Interior general lighting shall be located, scheduled and operated in accordance with Section C405.2 and ~~no less than 90 percent of the total installed interior lighting power~~ shall be configured with the following enhanced control functions~~.~~:

    a. ~~1.~~ Luminaires shall be configured for continuous dimming.

    b. ~~Luminaires~~Each luminaire shall be ~~addressed~~ individually~~.~~ addressed.

    Exceptions:

    1. ~~1.~~ Multiple luminaires mounted on no more than 12 linear feet of a single lighting track and addressed as a single luminaire.
    2. ~~2.~~ Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet.

ii. ~~3.~~ ~~Not~~No more than eight luminaires within a daylight zone are permitted to be controlled by a single daylight responsive control.

b. ~~4.~~ Luminaires shall be controlled ~~through~~by a digital control system configured with the following capabilities:

i. ~~4.1.~~ Scheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.

ii. ~~4.2.~~ Load shedding.

~~4.3. In open and enclosed offices, the illumination level of overhead general illumination luminaires are configured to be individually adjusted by occupants.~~

iii. ~~4.4.~~ Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.

c. ~~5.~~ Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.

~~- delete and replace-~~ ~~**C406.5 On-site renewable energy.**~~

d. ~~Buildings~~High-end trim. Luminaires shall be ~~provided~~initially configured with ~~on-site renewable energy systems with a total system rating per square foot of conditioned floor area of~~ the ~~building~~following:

i. High-end trim, setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of ~~not~~ a space or area, shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by at least 15 percent from full output. The average maximum light output or power of the controlled lighting shall be documented without high-end trim and with high-end trim to verify reduction of light output or power by at least 15 percent when tuned.

ii. Where lumen maintenance control is used, controls shall be configured to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power draw and lumen maintenance controls shall be limited to increasing lighting power by 1 percent per year.

iii. High-end trim and lumen maintenance controls shall be accessible only to authorized personnel.

Where general lighting in more than ~~the value specified in Table~~50 percent of the gross lighted floor area receives high-end trim, the base credits from Section C406.2 shall be prorated as follows:

[Tuned lighted floor area,%] × [Base energy credits for C406.~~5.~~2.5.2] / 50% (Equation 4-22)

~~- add - **TABLE C406.5 ON-SITE RENEWABLE ENERGY SYSTEM RATING**~~

~~**TABLE C406.5**~~
~~**ON-SITE RENEWABLE ENERGY SYSTEM RATING**~~

C406.2.5.3 L03 Increase occupancy sensor.

Lighting controls shall comply with C406.2.5.3.1, C406.2.5.3.2 and C406.2.5.3.3.

C406.2.5.3.1 Occupant Sensor Controls.

Occupant sensor controls shall be installed to control lights in the following space types:

a. Courtroom
b. Electrical / mechanical room
c. Food preparation area
d. Laboratory
e. Elevator lobby
f. Pharmacy Area
g. Vehicular Maintenance Area
h. Workshop
i. Chapel in a facility for the visually impaired
j. Recreation room in a facility for the visually impaired
k. Exercise area in a fitness center
l. Playing area in a fitness center
m. Exam / treatment room in a healthcare facility
n. Imaging room in a healthcare facility
o. Physical therapy room in a healthcare facility
p. Library reading area
q. Library stacks
r. Detailed manufacturing area
s. Equipment room in a manufacturing facility
t. Low-bay area in a manufacturing facility
u. Post office sorting area
v. Religious fellowship hall

w. Religious worship / pulpit / choir area

x. Hair salon

y. Nail salon

a. Banking activity area

b. Computer room, data center

c. Laundry / washing area

d. Medical supply room in a healthcare facility

e. Telemedicine room in a healthcare facility

f. Museum restoration room

C406.2.5.3.2 Occupant Sensor Control Function.

Occupant sensor controls shall automatically turn lights off within 10 minutes after all occupants have left the space. A manual control complying with C405.2.6 shall allow occupants to turn off lights. Time-switch controls are not required.
Exception: In spaces where an automatic shutoff could endanger occupant safety or security occupant sensor controls shall uniformly reduce lighting power to not more than 20 percent of full power within 10 minutes after all occupants have left the space. Time-switch controls complying with C405.2.2.1 shall automatically turn lights off.

C406.2.5.3.3 Occupant Sensor Time Function.

Occupant sensor controls installed in accordance with Sections C405.2.1.1, C405.2.1.2, C405.2.1.3, and C405.2.1.4 shall automatically turn lights off or reduce lighting power within 10 minutes after all occupants have left the space. Where lighting power is reduced, the unoccupied setpoint shall be 20 percent of full power or in egress areas to the power level required to meet egress light levels.

C406.2.5.4 L04 Increase daylight area.

The total daylight area of the project (DLA_{BLDG}) with continuous daylight dimming meeting the requirements of C405.2.4 shall be at least 5 percent greater than the typical daylit area (DLA_{TYP}).
Credits for measure L04 shall be determined based on Equation 4-23:

$$EC_{DL} = EC_{DL5} \times 20 \times [(DLA_{BLDG}/GLFA) - DLA_{TYP}] \qquad \text{(Equation 4-23)}$$

where:

~~(PER SQUARE FOOT) Building Area Type~~ EC_{DL}	~~kBTU per year~~ =	~~kWh per year~~ C406.2.5.4 L04 measure base energy credits
~~Assembly~~	~~1.8~~	~~0.53~~
~~Dining~~	~~10.7~~	~~3.14~~
~~Hospital~~	~~3.6~~	~~1.06~~
~~Hotel/Motel~~ DLA_{BLDG}	~~2.0~~ =	~~0.59~~ The lesser of actual area of daylight zones in the building with continuous daylight dimming, ft2 or m2 and (GLFA x DLA_{max}) see Table C406.2.5.4. Daylight zones shall meet

		the criteria in Sections C405.2.4.2 and C405.2.4.3 for primary sidelit daylight zones, secondary sidelit daylight zones, and toplit daylight zones.
~~Multi-family residential~~ GLFA	~~0.50~~ =	~~0.15~~ Project gross lighted floor area, ft2 or m2
~~Office~~	~~0.82~~	~~0.24~~
~~Other~~ DLA_{TYP}	~~2.02~~ =	~~0.59~~ Typical percentage of building area with daylight control (as a fraction) from Table C406.2.5.4
~~Retail~~	~~1.31~~	~~0.38~~
~~School/University~~	~~1.17~~	~~0.34~~
~~Supermarket~~ EC_{DL5}	~~5.0~~ =	~~1.47~~ C406.2.5.4 L04 base energy credits from Section C406.2
~~Warehouse~~	~~0.43~~	~~0.13~~

~~- delete and replace- **C406.6 Dedicated outdoor air system.**~~
~~Not less than 90% of the building conditioned floor area, excluding floor area of unoccupied spaces that do not require ventilation per ASHRAE Standard 62.1, shall be served by DOAS. Buildings containing equipment or systems regulated by Section C403.3.4, C403.4.3, C403.4.4, C403.4.5, C403.6, C403.8.4, C403.8.5, C403.8.5.1, C403.9.1, C403.9.2, C403.9.3 or C403.9.4 shall be equipped with an independent ventilation system designed to provide not less than the minimum 100-percent outdoor air to each individual occupied space, as specified by ASHRAE Standard 62.1. The ventilation system shall be capable of total energy recovery. The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.~~

~~- delete and replace- **C406.7 Reduced energy use in service water heating.**~~
~~Buildings shall comply with Sections C406.7.1 and either C406.7.2, C406.7.3 or C406.7.4.~~

~~- add - **C406.7.1 Building type.** To qualify for this credit, not less than 90 percent of the building conditioned floor area shall be of the following types:~~

~~1. *Group R*-1: Boarding houses, hotels or motels.~~

~~2. Group I-2: Hospitals, psychiatric hospitals and nursing homes.~~

~~**3. Group A-2: Restaurants and banquet halls or**~~ **TABLE C406.2.5.4 ADDED DAYLIGHTING PARAMETERS**

Building use type	**DLA_{TYP}**	**DLA_{max}**
Group B; Office ≤ 5000 ft2 (460 m2)	10%	20%
Group B; Office > 5000 ft2 (460 m2)	21%	31%
Group M; Retail with ≤ 1000 ft2 (900 m2) roof area	0%	20%
Group M; Retail with > 1000 ft2 (900 m2) roof area	60%	80%
Group E; Education	42%	52%
Groups S-1 and S-2; Warehouse	50%	70%
Group I-2, R, and other; Medical, hotel, multifamily,	NA	NA

dormitory, and other		

C406.2.5.5 L05 Residential light control.

In buildings ~~containing food preparation areas.~~

~~4. Group F: Laundries.~~

~~5.~~ with Group R-2~~.~~ occupancy spaces, interior lighting systems shall comply with the following:

~~6. Group A-3: Health clubs and spas.~~

~~- delete – **C406.7.1 Load fraction.**~~

~~- add – **C406.7.2 Load fraction.**~~

~~Not less than 60 percent of the annual building service hot water energy use, or not less than 100 percent of the annual building service hot water heating energy use in buildings subject to~~ Common area Restrooms, laundry rooms, storage rooms, and utility rooms shall have automatic full OFF occupancy sensor controls that comply with the requirements of ~~Section C403.9.5, shall be provided by one or more of the following:~~

~~1. Waste heat recovery from service hot water, heat-recovery chillers, building equipment, process equipment, or other *approved* system.~~

~~2. *On-site renewable energy* water-heating systems.~~

~~- add – **C406.7.3 High Performance Water Heating Equipment.** The combined input-capacity-weighted-average equipment rating of all water heating equipment in the building shall be not less than 95% Et or 0.95 EF.~~

~~- add – **C406.7.4 Heat pump water heater**. All Service hot water system delivering heating requirements shall be met using heat pump technology with a minimum COP of 3.0. Air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior.~~

~~- delete and replace- **C406.8 Enhanced envelope performance.**~~

~~The total UA of the building thermal envelope as designed shall be not less than 15 percent below the total UA of the building thermal envelope for a building of identical configuration and fenestration area in accordance with Section C402.1.3.~~

~~If using Section C402.1.4 Building above-grade performance alternative for compliance, UA-Total / Area ≤ 0.030 needs to be met as well as total UA of below-grade walls shall be not less than 15 percent below the total UA of the below-grade thermal envelope in accordance with Section C402.1.3.~~

~~- add – **C406.10 Efficient Kitchen Appliances.**~~

~~Buildings shall comply with Sections C406.10.1 through C406.10.2 in order to qualify for~~ C405.2.1.1. Each additional ~~efficiency credits.~~

~~- add – **C406.10.1 Building Requirements.** The building shall contain an operable commercial kitchen that serves a minimum of 5 meals per week.~~

~~- add – **C406.10.2 Equipment Type.** The following pieces of equipment that fall within the scope of the applicable Energy Star program shall comply with the equivalent criteria required to achieve the Energy Star label if installed prior to the issuance of the Certificate of Occupancy:~~

1. ~~Commercial Fryers~~
2. ~~Commercial Hot Food Holding Cabinets~~
3. ~~Commercial Steam Cookers~~
4. ~~Commercial Dishwashers~~
5. ~~Commercial Griddles~~
6. ~~Commercial Ovens~~

~~- add – **C406.11 Controlled receptacles.**~~

~~At least 50 percent of all 125 volt 15- and 20-ampere receptacles installed in private offices, open offices, conference rooms, rooms used primarily for printing and/or copying functions, break rooms, individual workstations and classrooms, including those installed in modular partitions and modular office workstation systems, shall be controlled as required by this section. Either split receptacles shall be provided, with the top receptacle(s) controlled, or a controlled receptacle shall be located within 12 inches (0.30 m) of each uncontrolled receptacle. Controlled receptacles shall be visibly differentiated from standard receptacles and shall be controlled by one of the following automatic control devices:~~

1. ~~An occupant sensor that turns receptacle power off when no occupants have been detected for a maximum of 20 minutes.~~

1. ~~A time-of-day operated~~ control device ~~that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building not to exceed~~ shall control no more than 5,000 ~~square feet (465 m2) and not to exceed one full floor. The device shall be capable of being overridden for periods of up to two hours by a timer accessible to occupants~~sq.ft.

~~Any individual override switch~~Each dwelling unit shall have a main control by the ~~controlled~~main entrance that turns off all the lights and all switched receptacles ~~for a maximum area of 5,000 square feet (465 m2). Override switches for controlled~~in the dwelling unit. Two switched receptacles ~~are permitted to control the lighting within the same area.~~

~~Exception:~~

1. ~~Receptacles designated for specific equipment requiring 24-hour operation, for building maintenance functions,~~shall be provided in living and sleeping rooms or ~~for specific safety or security equipment are not required to be controlled by an automatic control device and are not required to~~areas and clearly identified. All switched receptacles shall be located within 12 inches (~~0.~~30 ~~m~~cm) of ~~a~~

~~controlled~~an unswitched receptacle.

~~2. Within a single modular office workstation, non-controlled receptacles are~~ The main control shall be permitted to ~~be located not more than 72 inches, from the controlled~~have two controls, one for permanently wired lighting and one for switched receptacles ~~serving that workstation.~~

~~***- delete -*** SECTION C407 TOTAL BUILDING PERFORMANCE **in its entirety (sections C407.1 through C407.6 and all subsections)**~~

~~*- modify -* **SECTION C408 MAINTENANCE INFORMATION AND SYSTEM COMMISSIONING to SECTION C407 MAINTENANCE INFORMATION AND SYSTEM COMMISSIONING**~~

~~SECTION C407~~
~~MAINTENANCE INFORMATION~~
~~AND SYSTEM COMMISSIONING~~

~~*- modify -* **C408.1 General to C407.1 General.**~~

~~*- add -* **C407.1.1 Qualifications.**~~

~~The scope shall be completed by the project commissioning authority.~~. The ~~commissioning authority shall:~~

~~1. Have experience~~main controls should be clearly identified as ~~a commissioning authority on at least (3) previous projects each at least 20,000 square feet or greater, and~~

~~2. Be an independent third-party entity. The commissioning authority shall not be an employee of the design team, construction team, owner or developer~~

2. ~~*- modify -* **C408.1.1 Building operations and maintenance information to C407.1.2 Building operations**~~"lights master off" and ~~**maintenance information**~~"switched outlets master off."

~~*- delete -* **C408.2 Mechanical systems and service water-heating systems commissioning and completion requirements.**~~

~~*- add -* **C407.2 Mechanical systems and service water-heating systems commissioning and completion requirements.**~~

~~Prior to the final mechanical and plumbing inspections, the *design professional/ agency* shall provide evidence of mechanical systems *commissioning* and completion in accordance with the provisions of this section.~~

~~*Construction document* notes shall clearly indicate provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner or owner's authorized agent and made available to the *code official or other authority having jurisdiction*, upon request in accordance with Sections C407.2.4 and C407.2.5.~~

~~**Exceptions:** The following systems are exempt:~~

1. ~~Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.~~

2. ~~Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units.*~~

~~- *delete* – **C408.2.1 Commissioning plan.**~~

~~- *add* – **C407.2.1 Commissioning plan.**~~
~~A *commissioning plan* shall be developed by a *design professional*/*agency* and shall include the following items:~~

1. ~~A narrative description of the activities that will be accomplished during each phase of *commissioning,* including the personnel intended to accomplish each of the activities.~~

2. ~~A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.~~

3. ~~Functions to be tested including, but not limited to, calibrations and economizer controls.~~

4. ~~Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions.~~

5. ~~Measurable criteria for performance.~~

~~- modify - **C408.2.2 Systems adjusting and balancing to C407.2.2 Systems adjusting and balancing**~~

~~- delete – **C408.2.2.1 Air systems balancing.**~~

~~- add - **C407.2.2.1 Air systems balancing.**~~
~~Each supply air outlet and *zone* terminal device shall be equipped with means for air balancing. Discharge dampers used for air-system balancing are prohibited on constant-volume fans and variable-volume fans with motors 10 hp (18.6 kW) and larger. Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp (0.746 kW), fan speed shall be adjusted to meet design flow conditions.~~

~~**Exception:** Fans with fan motors of 1 hp (0.74 kW) or less are not required to be provided with a means for air balancing.~~

~~- delete – **C408.2.2.2 Hydronic systems balancing.**~~

~~- add – **C407.2.2.2 Hydronic systems balancing.**~~
~~Individual hydronic heating and cooling coils shall be equipped with means for balancing~~

~~and measuring flow. Hydronic pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have either the capability to measure pressure across the pump, or test ports at each side of each pump.~~

~~- delete – **C408.2.3 Functional performance testing.**~~

~~- add – **C407.2.3 Functional performance testing.**~~
~~Functional performance testing specified in Sections C407.2.3.1 through C407.2.3.3 shall be conducted.~~

~~- modify – **C408.2.3.1 Equipment** to **C407.2.3.1 Equipment**~~

~~- modify – **C408.2.3.2 Controls** to **C407.2.3.2 Controls**~~

~~- modify – **C408.2.3.3 Economizers** to **C407.2.3.3 Economizers**~~

~~- delete – **C408.2.4 Preliminary commissioning report.**~~

~~- add – **C407.2.4 Preliminary commissioning report.**~~
~~A preliminary report of *commissioning* test procedures and results shall be completed and certified by the *design professional/agency* and provided to the building owner or owner's authorized agent. The report shall be organized with mechanical and service hot water findings in separate sections to allow independent review. The report shall be identified as "Preliminary Commissioning Report," shall include the completed Commissioning Compliance Checklist, Figure C407.2.4, and shall identify:~~

1. ~~Itemization of deficiencies found during testing required by this section that have not been corrected at the time of report preparation.~~

2. ~~Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.~~

3. ~~Climatic conditions required for performance of the deferred tests.~~

4. ~~Results of functional performance tests.~~

5. ~~Functional performance test procedures used during the commissioning process, including measurable criteria for test acceptance.~~

Project Information: ______________________________ Project Name:____________________________________

Project Address: ____

Commissioning Authority: ____

Commissioning Plan (Section C408.2.1)

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

☐ Systems Adjusting and Balancing has been completed.

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

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

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

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

☐ Service Water Heating System Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on:____________________________

☐ Manual, record documents and training have been completed or scheduled

☐ Preliminary Commissioning Report submitted to owner and includes all items required by Section C408.2.4

I hereby certify that the commissioning provider has provided me with evidence of mechanical, service water heating and lighting systems commissioning in accordance with the 2018 IECC.

Signature of Building Owner or Owner's Representative ____________________________ Date______________

~~- modify – **FIGURE C408.2.4 COMMISSIONING COMPLIANCE CHECKLIST** to **FIGURE C407.2.4 COMMISSIONING COMPLIANCE CHECKLIST**~~

~~- *delete* – **C408.2.4.1 Acceptance of report.**~~

~~- *delete* – **C408.2.4.2 Copy of report.**~~

~~- *modify* – **C408.2.5 Documentation requirements** to **C407.2.5 Documentation requirements.**~~

~~- *delete* – **C408.2.5.1 System balancing report.**~~

~~- *add* – **C407.2.5.1 System balancing report.**~~
~~A written report describing the activities and measurements completed in accordance with Section C407.2.2.~~

~~- *modify* – **C408.2.5.2 Final commissioning report** to **C407.2.5.2 Final commissioning report.**~~

~~***- modify –*** C408.3 Functional testing of~~**C406.2.5.6 L06 Reduced lighting** ~~controls **to** C407.3 Functional testing of~~**power.**

Interior lighting ~~**controls**~~
within the whole building shall comply with all the requirements of this section. The net connected interior lighting power (LPn) shall be 95 percent or less than the net interior lighting power allowance (LPAn) determined in accordance with Section C405.3.2.2. In R-1 and R-2 occupancies the credit is calculated for all common areas other than dwelling units and sleeping units. All of the permanently installed light fixtures in dwelling units and sleeping units, excluding kitchen appliance lighting, shall be provided by high efficacy lamps with a minimum efficacy of 90 lumens per watt or high efficacy luminaires that have a minimum efficacy of 80 lumens per watt. Energy credits shall not be greater than four times the L06 base credit from Section C406.2 and shall be determined using Equation 4-24:

~~- *delete* – **C408.3.1 Functional testing.**~~

~~- *add* – **C407.3.1 Functional testing.**~~
~~Prior to passing final inspection, the *design professional/agency* shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the *construction documents* and manufacturer's instructions. Functional testing shall be in accordance with Sections C407.3.1.1 through C407.3.1.3 for the applicable control type.~~

~~- *modify* – **C408.3.1.1 Occupant sensor controls** to **C407.3.1.1 Occupant sensor controls.**~~

~~- *modify* – **C408.3.1.2 Time-switch**~~ $EC_{LPA} = EC_5 \times 20 \times (LPA_n - LP_n) / LPA_n$ (Equation 4-24)

where:

EC_{LPA}	=	additional energy credit for lighting power reduction
LP_n	=	net connected interior lighting power calculated in accordance with Section C405.3.1, watts, excluding any additional lighting power allowed in Section C405.3.2.2.1
LPA_n	=	interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2.2, watts, less any additional interior lighting power allowed in Section C405.3.2.2.1
EC_5	=	L06 base credit from Section C406.2

C406.2.6 Efficient Equipment Credits.

Projects are permitted to achieve energy credits using any combination of Efficient Equipment Credits Q01 through Q04.

C406.2.6.1 Q01 Efficient Elevator Equipment.

Qualifying elevators in the building shall be Energy efficiency class A per ISO 25745-2, Table 7. Only buildings 3 or more floors above grade are permitted to use this credit. Credits shall be prorated based on Equation 4-25, rounded to the nearest whole credit. Projects with a compliance ratio below 0.5 do not qualify for this credit.

$EC_e = EC_t \times CR_e$ (Equation 4-25)

where:

EC_e	=	Elevator energy credit achieved for the building
EC_t	=	C406.2.7.1 Table energy credit
CR_e	=	Compliance Ratio = (FA / FB)
F_A	=	Sum of floors served by class A elevators
F_B	=	Sum of floors served by all building elevators and escalators

C406.2.6.2 Q02 Efficient Commercial Kitchen Equipment.

For buildings and spaces designated as Group A-2, or facilities whose primary business type involves the use of a commercial kitchen where at least one gas or electric fryer is installed before the issuance of the Certificate of Occupancy all fryers, dishwashers, steam cookers and ovens installed before the issuance of the Certificate of Occupancy shall comply with all of the following:

a. Comply with the efficiency levels outlined in the Vermont Appliance Efficiency Standards

b. Achieve performance levels for select equipment that exceed the requirements in the Vermont Appliance Efficiency Standards, as outlined in Tables C406.2.7.2 (1) through C406.2.7.2 (4) when rated in accordance with the applicable test procedure.

c. Have associated performance levels listed on the construction documents submitted for permitting.

TABLE C406.2.7.2(1)
Minimum Efficiency Requirements: Commercial Fryers

	Heavy-Load Cooking Energy Efficiency	Idle Energy Rate	Test Procedure
Standard Open Deep-Fat Electric Fryers	≥ 83%	≤ 800 watts	ASTM F1361

TABLE C406.2.7.2(3)
MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS

Machine Type	High Temperature Efficiency Requirements			Low Temperature Efficiency Requirements			Test Procedure
	Idle Energy Rate[a]	Washing Energy	Water Consumption[b]	Idle Energy Rate[a]	Washing Energy	Water Consumption[b]	
Under Counter	≤ 0.30 kW	≤ 0.35 kWh/rack	≤ 0.86 GPR (≤ 3.3 LPR)	≤ 0.25 kW	≤ 0.15 kWh/rack	≤ 1.19 GPR ≤ 4.5 LPR	ASTM F1696

Stationary Single Tank Door	≤ 0.55 kW	≤ 0.35 kWh/rack	≤ 0.89 GPR (≤ 3.4 LPR)	≤ 0.30 kW	≤ 0.15 kWh/rack	≤ 1.18 GPR ≤ 4.47 LPR	ASTM F1920
Pot, Pan, and Utensil	≤ 0.90 kW	kWh/rack ≤ 0.55 + 0.05 × SF_{rack}^{c} (≤ 0.55 + 0.0046 × SM_{rack}^{c})	≤ 0.58 GPSF (≤ 2.2 LPSM)	N/A	N/A	N/A	
Single Tank Conveyor	≤ 1.20 kW	≤ 0.36 kWh/rack	≤ 0.70 GPR (≤ 2.6 LPR	≤ 0.85 kW	≤ 0.16 kWh/rack	≤ 0.79 GPR ≤ 3.0 LPR	
Multiple Tank Conveyor	≤ 1.85 kW	≤ 0.36 kWh/rack	≤ 0.54 GPR (≤ 2.0 LPR)	≤ 1.00 kW	≤ 0.22 kWh/rack	≤ 0.54 GPR ≤ 2.0 LPR	

a. Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heaters and controls. The most energy consumptive configuration in the product family shall be selected to test the idle energy rate. Booster heater (internal or external) energy consumption shall be measured and reported separately, if possible, per ASTM F1696 and ASTM F1920 Sections 10.8 and 10.9, respectively. However, if booster energy cannot be measured separately it will be included in the idle energy rate measurements.
b. GPR = gallons per rack, LPR = Liters per rack, GPSF = gallons per square foot of rack, LPSM = liters per square fmeter of rack, GPH = gallons per hour, c = [maximum conveyor belt speed (feet/minute)] × [conveyor belt width (feet)], LPH = liters per hour, d = [maximum conveyor belt speed (m/minute)] × [conveyor belt width (m)]
c. PPU Washing Energy is still in format kWh/rack when evaluated; SF_{rack} (SM_{rack}) is Square Feet of rack area (square meters of rack area), same as in PPU water consumption metric.

Table C406.2.7.2(4)
Minimum Efficiency Requirements: Commercial Ovens

Fuel Type	**Classification**	**Idle Rate**	**Cooking Energy Efficiency, %**	**Test Procedure**
		Convection Ovens		
Gas	Full-Size	≤ 12,000 Btu/h (3.5 kW)	≥ 46	ASTM F1496
Electric	Half-Size	≤ 1.0 kW	≥ 71	
	Full-Size	≤ 1.60 kW		
		Combination Ovens		
Gas	Steam Mode	≤ 200 P^a + 6,511 Btu/h (≤ 0.059 P^a + 1.9 kW)	≥ 41	ASTM F2861
	Convection Mode	≤ 150 P^a + 5,425 Btu/h (≤ 0.044 P^a + 1.6 kW)	≥ 56	
Electric	Steam Mode	≤ 0.133 P^a + 0.6400 kW	≥ 55	
	Convection Mode	≤ 0.080 P^a + 0.4989 kW	≥ 76	
		Rack Ovens		
Gas	Single	≤ 25,000 Btu/h (7.3 kW)	≥ 48	ASTM F2093
	Double	≤ 30,000 Btu/h (8.8 kW)	≥ 52	

[a] *P* = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495

C406.2.6.3 Q03 Efficient Residential Kitchen Equipment.

For projects with Group R-1 and R-2 occupancies, energy credits shall be achieved where all dishwashers, refrigerators, and freezers comply with all of the following:

a. Achieve the Energy Star Most Efficient 2021 label in accordance with the specifications current as of:
    i. Refrigerators and freezers 5.0, 9/15/2014
    ii. Dishwashers 6.0, 1/29/2016
b. Be installed before the issuance of the certificate of occupancy.

For Group R-1 where only some guest rooms are equipped with both refrigerators and dishwashers, the table credits shall be prorated as follows:

[Section C406.2 base credits]× (floor area of guest rooms with kitchens)/(total guest room floor area) (Equation 4-26)

C406.2.6.4 Q04 Fault detection and diagnostics system.

A project not required to comply with C403.2.3 can achieve energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with items 1 through 6 in Section C403.2.3.

C406.3 Renewable and Load Management Credits Achieved.

Renewable energy and load management measures installed in the building that comply with Sections C406.3.1 through C406.3.8 shall achieve the credits listed for the occupancy group in Table C406.3.1 or where calculations are required in Sections C406.3 to determine credits or modify the table credits, the credits achieved shall be based upon the Section C406.3 calculations. Measure credits achieved shall be determined in one of two ways, depending on the measure:

1. The measure credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the description of the measure in Section C406.3.
2. The measure credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the description of the measure in Section C406.3. Where adjustments are applied, each energy credit shall be rounded to the nearest whole number.

Load management and renewable credits achieved for the project shall be the sum of credits for individual measures included in the project. Credits are available for the measures listed in this Section. Where a project contains multiple building use groups credits achieved for each building use group shall be summed and then weighted by the gross floor area of each building use group to determine the weighted average project energy credits achieved.

The load management measures in Sections C406.3.2 (G01) through C406.3.7 (G06) require load management control sequences that are capable of automatically providing the load management operation specified based on indication of a peak period related to high short-term electric prices, grid condition, or peak building load.

TABLE C406.3.1
Renewable and Load Management Credit Requirements by Building Occupancy Group

ID	Renewable and Load Management Credit	Building Occupancy Group								
		R-2, R-4, and I-1	I-2	R-1	B	A-2	M	E	S-1 and S-2	All Other
R01	On-Site Renewable Energy	9	6	8	14	2	9	13	24	11
G01	Lighting Load Management	5	14	9	10	4	18	16	36	14
G02	HVAC Load Management	10	12	x	8	16	14	18	14	13
G03	Automated Shading	1	x	1	5	x	8	14	x	5
G04	Electric Energy Storage	14	13	13	16	4	11	20	24	14
G05	Cooling Energy Storage	7	11	12	12	2	9	16	1	9

G06	SHW Energy Storage	18	4	26	6	15	4	7	2	10
G07	Building Thermal Mass	27	26	26	8	6	13	31	20	20
C01	Insulation Embodied Carbon	5	3	4	8	1	8	7	6	5
E01	Additional Electric Infrastructure	16	x	x	x	x	x	x	x	x

C406.3.1 R01 Renewable Energy.

Projects installing on-site renewable energy systems with a capacity of at least 0.1 watts per gross square foot (1.08 W/m2) of building area or securing off-site renewable energy shall achieve energy credits for this measure calculated as follows:

$EC_R = EC_{0.1} \times R_t / (0.1 \times PGFA)$ (Equation 4-27)

where:

EC_R = C406.3.1 R01 energy credits achieved for this project
R_t = actual total rating of on-site renewable energy systems (W)
PGFA = Project gross floor area, ft2
$EC_{0.1}$ = C406.3.1 R01 base credits from Tables C406.3(1) through C406.3(9)

C406.3.2 G01 Lighting Load Management.

Luminaires shall have dimming capability and automatic load management controls that are capable of gradually reduce general lighting power during peak periods. The load management controls shall be capable of reducing lighting power in 75 percent of the building area by at least 20 percent with continuous dimming over a period no longer than 15 minutes. Where less than 75 percent, but at least 50 percent of the project general lighting is controlled, the credits from Tables C406.3 shall be prorated as follows:

[building area with lighting load management, %] x [table credits for C406.3.2] / 75% (Equation 4-28)

Exception: Warehouse or retail storage building areas shall be permitted to achieve this credit by switching off at least 25 percent of lighting power in 75 percent of the building area without dimming, or as adjusted by Equation 4-28.

C406.3.3 G02 HVAC Load Management.

Automatic load management controls ~~to **C407.3.1.2 Time-switch**~~ shall be capable of:

1. Where electric cooling is in use gradually increase the cooling setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective cooling capacity to 60% of installed capacity during the peak period.

2. Where electric heating is in use gradually decrease the heating setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective heating capacity to 60% of installed capacity during the peak period.

~~1.~~3. Where HVAC systems are serving multiple zones and have less than 70 percent outdoor air required, include controls~~.~~
that are capable of providing excess outdoor air preceding the peak period and reduce

outdoor air by at least 30 percent during the peak period, in accordance with ASHRAE Standard 62.1 Section 6.2.5.2 Short Term Conditions.

C406.3.4 G03 Automated Shading Load Management.

Where fenestration on east, south, and west exposures exceeds 20 percent of wall area, load management credits shall be achieved as follows:

1. Automatic exterior shading devices or dynamic glazing that are capable of reducing solar gain (SHGC) through sunlit fenestration by at least 50 percent when fully closed shall receive the full credits in Table C406.3.1. The exterior shades shall have fully open and fully closed SHGC determined in accordance with AERC 1.
2. Automatic interior shading devices with a minimum solar reflectance of 0.50 for the surface facing the fenestration shall receive 40 percent of the credits in Table C406.3.1.
3. All shading devices, dynamic glazing, or shading attachments shall:
    a. provide at least 90 percent coverage of the total fenestration on east, south, and west exposures in the building
    b. be automatically controlled and shall modulate in multiple steps or continuously the amount of solar gain and light transmitted into the space in response to peak periods and either daylight levels or solar intensity
    c. include a manual override located in the same enclosed space as the shaded vertical fenestration that shall override operation of automatic controls no longer than four hours. Such override shall be locked out during peak periods.

For this section, directional east, south, or west exposures shall exclude fenestration that is plus or minus 45 degrees of facing true north in the northern hemisphere. In the southern hemisphere, where the south exposure is referred to, it shall be replaced by the north exposure and the referenced south exposure shall be replaced by the north exposure.

C406.3.5 G04 Electric Energy Storage.

Electric storage devices shall be capable of charging and discharging by automatic load management controls to store energy during non-peak periods and use stored energy during peak periods to reduce building demand. Electric storage devices shall have a minimum capacity of 1.5 Wh/ft2 (87 Wh/m2) of gross building area. Base credits in Tables C406.3-1 through C406.3-8 are based on installed electric storage of 5 Wh/ft2 (54 Wh/m2) and shall be prorated for actual installed storage capacity between 1.5 and 15 Wh/ft2 (16 to 160 Wh/m2), as follows:

(electric storage capacity, Wh/ft2 (Wh/m2))/(5 (54)) × [C406.3.5 Credits from C406.3 Tables] (Equation 4-29)

Larger energy storage shall be permitted; however, credits are limited to the range of 1.5 to 15 Wh/ft2 (16 to 160 Wh/m2).

C403.3.6 G05 Cooling Energy Storage.

Automatic load management controls shall be capable of activating ice or chilled water storage equipment to reduce demand during summer peak periods. Storage tank standby loss shall be demonstrated through analysis to be no more than 2 percent of storage capacity over a 24 hour period for the cooling design day.

Base credits in Section C406.3 are based on storage capacity of the design peak hour cooling load with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 4.0 times the design day peak hour cooling load, rounded to the nearest whole credit. Larger storage shall be permitted but the associated credits are limited to the range above. Energy credits shall be determined as follows:

$$EC_s = EC_{1.0} \times (1.44 \times SR + 0.71) / 2.15 \qquad \text{(Equation 4-30)}$$

where:

ECs = Cooling Storage credit achieved for Project

EC1.0 = G05 base energy credit for building use type and climate zone based on 1.0 ton-hours storage per design day ton (kWh/kW) of cooling load

SR = Storage ratio in Btu storage per peak design day Btu/hr cooling load (kWh/kW) where 0.5 ≤ SR ≤ 4.0

C406.3.7 G06 SWH Energy Storage.

Where SHW is heated by electricity, automatic load management controls that comply with ANSI/CTA-2045-B shall be capable of preheating stored SHW before the peak period and suspend electric water heating during the peak period. Storage capacity shall be provided by either:

1. Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water-heating capacity. Tempering valves shall be provided at the water heater delivery location.
2. Providing additional heated water tank storage capacity above peak SHW demand with equivalent peak storage capacity to item 1. Where heat pump water heating is used, the credits achieved shall be 1/3 of the credits in Tables C406.3.1.

C406.3.8 G07 Building Thermal Mass.

The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80 percent of gross floor area unoccupied between midnight and 6:00 a.m. The project shall meet the following requirements:

1. Interior to the building envelope insulation, provide 10 lb/ft2 (50 kg/m2) of project conditioned floor area of passive thermal mass in the building interior wall, the inside of the exterior wall, or interior floor construction. Mass construction shall have mass surfaces directly contacting the air in conditioned spaces with directly attached gypsum panels allowed. Mass with carpet or furred gypsum panels or exterior wall mass that is on the exterior of the insulation layer (e.g., the portion of CMU block on the exterior of insulation filled cell cavities) shall not be included toward the building mass required.
2. HVAC units for 80 percent or more of the supply airflow in the project shall be equipped with outdoor air economizers and fans that have variable or low speed capable of operating at 66 percent or lower airflow and be included in the night flush control sequence.
3. Night flush controls shall be capable of being configured with the following sequence or another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating, and is approved by the authority having jurisdiction.
    a. Summer mode shall be activated when outdoor air temperature exceeds 70 F (21 C) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45 F (7 C). During summer mode, the occupied cooling set

point shall be set 1 F (0.6 C) higher than normal and the occupied heating set point shall be reset 2 F (1.1 C) lower than normal.

b. When all the following conditions exist, night flush shall be activated:

i. Summer mode is active in accordance with item 3.1

ii. Outdoor air temperature is 5 F (2.8 C) or more below indoor average zone temperature

iii. Indoor average zone temperature is greater than morning occupied heating set point

iv. In climate zones 0A through 3A, outdoor dewpoint is below 50 F (10 C) or outdoor air enthalpy is less than indoor air enthalpy

v. Local time is between 10:00 pm and 6:00 am.

c. When night flush is active, automatic night flush controls shall operate outdoor air economizers at low fan speed not exceeding 66 percent during the unoccupied period with mechanical cooling and heating locked out.

4. The project shall demonstrate a contractual obligation for post-occupancy commissioning and control tuning in the spring or fall season to tune the summer mode activation setpoints and occupied heating setpoint or other algorithms to achieve minimal morning heating due to night flush activation while maintaining comfort conditions. Commissioning shall include monitoring of time series space temperature, heating, and cooling operation to demonstrate both night cooling and minimization of morning heating along with monitoring of post-tuning operation to verify tuned parameters. Operating manuals shall include recommendations for tuned parameters and narrative training for operating staff on night flush automated settings. Reporting shall be in compliance with C408.

C406.3.9 C01 Insulation Embodied Carbon

Complete calculation in Table C406.3.9(1) to summarize estimated embodied emissions from insulation materials used in the project. The output metric for this measure shall be global warming potential (GWP) intensity, capturing insulation GWP per square foot of conditioned floor area. To complete the basic calculation, project teams shall provide the following information for foundation, wall, and roof insulation materials:

1. Insulation material type
2. Product R-value
3. Total surface area covered by the insulation product (sf)
4. Default, industry-average GWP value, from Table C406.3.9(2) or GWP values from *Type III Product-specific Environmental Product Declaration (EPD)*
5. Total project area (conditioned square feet)

Projects may substitute product-specific data for the default GWP value if the specified product has a lower reported GWP than the default value. Product-specific data shall be substituted in Column G of the calculation Table C406.3.9(1). Substitution of default GWP values is only allowed when type III product-specific EPDs are sourced and noted in Column G. Projects shall use GWP values that include A1-A3 lifecycle stages, as documented in product-specific EPDs, with the exception of SPF and XPS products. For these products, the A5 and B1 values shall be included in the documented GWP value to account for the on-site and off-gassing impact of blowing agents. Projects shall provide the EPDs declaration number in Column G.

TABLE C406.3.9(1)
INSULATION GLOBAL WARMING POTENTIAL CALCULATION

Table 1 - Insulation Global Warming Potential Calculation

A	B		C		D		E		F	G (Optional)	G (Optional)		H		I
Assembly	Material *List insulation material type from Table 2*		Product R-Value		Surface Area (gross square feet)		Framing Factor ("1.0" for continuous, "0.8" for cavity)		Default Global Warming Potential (kg CO2e /sq.m. RSI-1) *Use Default GWP values from Table 2. Leave blank for products where product specific data will be provided.*	Project has sourced Type III - Product-specific Environmental Product Declaration (EPD) *EPD Declaration Number*	Product Specific Global Warming Potential (kg CO2e /sq.m. RSI-1) *Leave blank unless EPDs have been sourced. Use GWP values from product-specific EPDs.*		Conversion Factor		GWP Result (kg CO2e)
Slab edge				X		X	1.0	X				X	0.0164	=	
Under slab				X		X	1.0	X				X	0.0164	=	
Basement walls				X		X	1.0	X				X	0.0164	=	
Above grade walls, cavity				X		X	0.8	X				X	0.0164	=	
Above grade walls, continuous				X		X	1.0	X				X	0.0164	=	
Roof, flat				X		X	1.0	X				X	0.0164	=	
Roof, sloped, cavity				X		X	0.8	X				X	0.0164	=	
Roof, sloped, continuous				X		X	1.0	X				X	0.0164	=	

(blue)	Input for basic calculation
(green)	Inputs for product-specific data
(yellow)	Calculation outputs

Summary Metrics		
Summary Metrics	Total Insulation GWP (kg CO2e)	
	Conditioned Floor Area (sf)	
	OUTPUT: Insulation GWP Intensity (kg CO2e/sf)	

TABLE C406.3.9(2)
DEFAULT INSULATION GLOBAL WARMING POTENTIAL VALUES.

All values are from Building Emissions Accounting for Materials (BEAM)[a], unless noted.

Material	**Default Global Warming Potential (kg CO2e /sq.m. RSI-1)**
Cellular glass - Aggregate	3.93[b]
Cellulose - Densepack	-2.10
Cellulose - Blown/loosefill	-1.10
Cork - Board	-6.80
EPS/graphite - Board, unfaced, Type II - 15psi	2.80
EPS/graphite - Board, unfaced, Type IX - 25psi, graphite	3.40
EPS - Board, unfaced, Type I - 10psi	2.80
EPS - Board, unfaced, Type II- 15psi	3.80
EPS - Board, unfaced, Type IX- 25psi	4.80
Fiberglass - Batt, unfaced	0.70
Fiberglass - Blown/loosefill	1.00
Fiberglass - Blown/spray	1.93[c]
Hemp - Batt	-0.50
HempCrete	-3.00
Mineral wool - Batt, unfaced	1.70
Mineral wool - Blown	1.60
Mineral wool - Board, unfaced, "light" density	3.30
Mineral wool - Board, unfaced, "heavy" density	8.10
Phenolic foam - Board	1.54[d]
Polyiso - Wall Board	4.10
Polyiso - Roof Board	2.90
SPF – Spray, open cell	1.40
SPF – Spray, closed cell HFO	4.20
SPF – Spray, high density HFO	4.90
SPF – Spray, closed cell HFC	13.10
SPF – Spray, high density HFC	17.00
Straw – Panel	-6.50
Vacuum Insulated Panel	7.40
Wood fiber – Board, unfaced, European	-6.50
Wood fiber – Board, unfaced, North America	-10.30
Wood fiber – Batt, unfaced	-2.40
Wool (Sheep) – Batt	1.00
Wool (Sheep) – Loosefill	0.80
XPS – Board, 25psi HFC	55.50
XPS – Board, 25psi “Low GWP” (HFO/HFC)	4.90

[a] https://www.buildersforclimateaction.org/beam-estimator.html~~ modify – C408.3.1.3 Daylight responsive controls~~ to ~~C407.3.1.3 Daylight responsive controls.~~

~~modify – C408.3.2 Documentation~~

[b] EPD Declaration Number NEPD-2012-889-EN

[c] EPD Declaration Number 4788647002.102.1

[d] EPD Declaration Number EPD-KSI-20190072-IBC1-EN

Points shall be calculated via Table C406.3.9(3) below.

TABLE C406.3.9(3)
POINTS OPTIONS FOR INSULATION EMBODIED CARBON

COMPONENT		DESCRIPTION	POINTS
Insulation Embodied Carbon	Basic	Report the global warming potential (GWP) impact of project insulation materials as described in Section C406.3.9. Use calculation Table C406.3.9(1) to summarize insulation GWP intensity (kg CO2e/ ft2) for the project. Default global warming potential (GWP) values for common insulation products are provided in Table C406.3.9(2). The calculation may utilize Type III, product-specific environmental product declaration (EPD) in lieu of default values for insulation products. If EPD values are used for a given insulation product, include the sum of lifecycle stages A1-A3 from the sourced EPD instead of default GWP value when completing the calculation. Include A5 and B1 GWP values for SPF and XPS products.	As listed in Table C406.3.1
	Advanced	Demonstrate a calculated insulation GWP intensity (kg CO2e/sf) less than 0.5. Product-specific EPDs may be used in place of default values, subject to requirements in C406.3.9	1.5 x points listed in Table C406.3.1
	Stretch	Demonstrate a calculated insulation GWP intensity (kg CO2e/sf) less than 0. Product-specific EPDs may be used in place of default values, subject to requirements in C406.3.9.	2.0 x points listed in Table C406.3.1

C406.3.10 E01 Additional Electric Infrastructure

For R-2 occupancy only, comply with the requirements of Section C405.14 Additional electric infrastructure.

SECTION C407
MAINTENANCE INFORMATION
AND SYSTEM COMMISSIONING

delete and replace **C407.2.3.1 Equipment.**
Equipment functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed. Testing shall include all modes and *sequence of operation*, including under full-load, part-load and the following emergency conditions:

1. All modes as described in the *sequence* of *operation*.

2. Redundant or *automatic* back-up mode.

3. Performance of alarms.

4. Mode of operation upon a loss of power and restoration of power.

Exception: Unitary or packaged HVAC equipment listed in the tables in Section C403.3.2 that do not require supply air economizers.

Add **Section 408**

SECTION C408
CALCULATION OF HVAC TOTAL SYSTEM PERFORMANCE RATIO

C408.1 Purpose. Section 4089 establishes criteria for demonstrating compliance with the requirements ~~to **C407.3.2 Documentation**~~of C403.1.1, HVAC total system performance ratio (HVAC TSPR)

C408.2 Scope. Section C408 applies to new HVAC systems that serve buildings in Section C403.1.3.1 and are not excluded from using HVAC TSPR by Section C403.1.3.

All applicable HVAC systems shall comply with Section C408.

C408.3 Core & Shell / Initial Build-Out, and Future System Construction Analysis. Where the building permit applies to only a portion of the HVAC system in a building and the remaining components will be designed under a future building permit or were previously installed, the future or previously installed components shall be modeled as follows:

1. Where the HVAC zones that do not include HVAC systems in the current permit will be or are served by independent systems, then the block including those zones shall not be included in the model.

2. Where the HVAC zones that do not include complete HVAC systems in the permit are intended to receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not

exceed, the requirements~~.~~
of C403.

3. Where the zone equipment in the permit receives HVAC services from previously installed systems that are not in the permit, the previously installed systems shall be modeled with equipment matching the certified value of what is installed or equipment that meets the requirements of C403.

4. Where the central plant heating and cooling equipment is completely replaced and HVAC zones with existing systems receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.

C408.4 HVAC TSPR Compliance. Systems allowed to use HVAC TSPR in accordance with C403.1.3 shall comply with all of the following:

1. Systems shall meet the applicable provisions of Section C403.1.3.3 and Sections within Section C403 that are listed in Table C407.2

2. The HVAC TSPR of the proposed design shall be greater than or equal to the HVAC TSPR of the standard reference design divided by the mechanical performance factor (MPF)using Equation 4-16.

TSPRp > TSPRr / MPF (Equation 4-16)

where:

TSPRp = HVAC TSPR of the proposed design calculated in accordance with Sections C408.4, C408.5 and C408.6.

TSPRr = HVAC TSPR of the reference building design calculated in accordance with Sections C408.4, C408.5 and C408.6.

MPF = Mechanical Performance Factor from Table C408.4 based on climate zone and building use type Where a building has multiple building use types, MPF shall be area weighted using Equation 4-17

MPF = (A1*MPF1 + A2* MPF2+...+An*MPFn)/(A1+A2+...+An) (Equation 4-17) where:

MPF1, MPF2 through MPFn = Mechanical Performance Factors from Table C408.4 based on climate zone and building use types 1,2, through n

A1, A2through An = Conditioned floor areas for building use types 1, 2, through n

Table C408.4 Mechanical Performance Factors

Building Type	**Occupancy Group**	**Performance Factor**
Office (small and medium)[a]	B	0.865
Office (Large)[a]	B	0.73
Retail	M	0.5
Hotel/Motel	R-1	0.35
Multi-Family/ Dormitory	R-2	0.55
School/ Education and Libraries	E (A-3)	0.89

a Large office (gross conditioned floor area >150,000 ft2 (14,000 m2) or > 5 floors); all other offices are small or medium

C408.4.1 HVAC TSPR. HVAC TSPR is calculated according to Equation 4-18 .

HVAC TSPR = heating and cooling load / building HVAC system energy (Equation 4-18)

where:

building HVAC system energy = sum of the annual site energy consumption for heating, cooling, fans, energy recovery, pumps, and heat rejection in thousands of Btus heating and cooling load = sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btus

C408.5 General. Projects shall comply with the requirements of this Section when calculating compliance using HVAC Total System Performance Ratio.

C408.5.1 Simulation Program. Simulation tools used to calculate HVAC TSPR of the Standard Reference Design shall comply with the following:

1. The simulation program shall calculate the HVACTSPR based only on the input for the proposed design and the requirements of Section 409. The calculation procedure shall not allow the user to directly modify the building component characteristics of the standard reference design.

2. Performance analysis tools meeting the applicable subsections of Section 409 and tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140, shall be permitted to be approved. The required tests shall include building thermal envelope and fabric load tests (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verification tests (Section 5.2.4), space- cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC equipment analytical verification tests (Section 5.5), along with the associated reporting (Section 6). Tools are permitted to be approved based on meeting a specified threshold for a jurisdiction. The code official shall be permitted to approve tools for a specified application or limited scope.

3. The test results and modeler reports shall be posted on a publicly available website and shall include the test results of the simulation program and input files used for generating the results along with the results of the other simulation programs included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.

4. The simulation program shall have the ability to explicitly model part-load performance curves or other part-load adjustment methods based on manufacturer's part-load performance data for mechanical equipment.

C408.5.2 Climatic Data. The simulation program shall perform the simulation using hourly values of climatic data, such as temperature and humidity, using TMY3 data for the site as specified here:

https://energycode.pnl.gov/HVACSystemPerformance/resources~~- *modify* – **C408.3.2.1 Drawings** to **C407.3.2.1 Drawings.**~~

~~- *modify* – **C407.3.2.2 Manuals** to **C407.3.2.2 Manuals.**~~

~~- *modify* – **C408.3.2.3 Report** to **C407.3.2.3 Report.**~~

C408.5.3 Documentation. Documentation conforming to the provisions of this section shall be provided to the code official.

C408.5.3.1 Compliance Report. Building permit submittals shall include:

1. A report produced by the simulation software that includes the following:
    1. Address of the building.
    2. Name of individual completing the compliance report.
    3. Name and version of the compliance software tool.
    4. The dimensions, floor heights and number of floors for each block.
    5. By block, the U-factor, C-factor, or F-factor for each simulated opaque envelope component and the U-factor and SHGC for each fenestration component.
    6. By block or by surface for each block, the fenestration area.
    7. By block, a list of the HVAC equipment simulated in the proposed design including the equipment type, fuel type, equipment efficiencies and system controls.
    8. Annual site HVAC energy use by end use for the proposed and baseline building
    9. Annual sum of heating and cooling loads for the baseline building.
    10. The HVAC total system performance ratio for both the standard reference design and the proposed design.
2. A mapping of the actual building HVAC component characteristics and those simulated in the proposed design showing how individual pieces of HVAC equipment identified above have been combined into average inputs as required by Section C408.6.1.10 including:
    1. Fans

2. Hydronic pumps

3. Air handlers

4. Packaged cooling equipment

5. Furnaces

6. Heat pumps

7. Boilers

8. Chillers

9. Heat rejection equipment (open and closed circuit cooling towers; dry coolers)

10. Electric resistance coils

11. Condensing units

12. Motors for fans and pumps

13. Energy recovery devices

3. For each piece of equipment identified above include the following as applicable:

    1. Equipment name or tag consistent with that found on the design documents.

    2. Rated Efficiency level.

    3. Rated Capacity.

    4. Where not provided by the simulation program report in item a, documentation of the calculation of any weighted equipment efficiencies input into the program

    5. Electrical input power for fans and pumps (before any speed or frequency control device) at design condition and calculation of input value (W/cfm or W/gpm)

4. Floor plan of the building identifying:

    1. How portions of the buildings are assigned to the simulated blocks

    2. Areas of the building that are not covered under the requirements of SectionC403.1.1.

C408.6 Calculation Procedures. Except as specified by this Section, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques

C408.6.1 Simulation of the proposed building design. The proposed design shall be configured and analyzed as specified in this section.

C408.6.1.1 Block Geometry. The geometry of buildings shall be configured using one or more blocks. Each block shall define attributes including block dimensions, number of floors, floor to floor height and floor to ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent blocks. Where actual building shape does not match these pre-defined shapes, simplifications are permitted providing the following requirements are met:

1. The conditioned floor area and volume of each block shall match the proposed design within 10 percent.
2. The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.
3. The area of vertical fenestration and skylights is accounted for within 10 percent of the actual design.
4. The orientation of each component in 2 and 3 above is accounted for within 45 degrees of the actual design.

The creation of additional blocks may be necessary to meet these requirements. A more complex zoning of the building shall be allowed where all thermal zones in the reference and proposed model are the same and rules related to block geometry and HVAC system assignment to blocks are met with appropriate assignment to thermal zones.

Exception: Portions of the building that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.

C408.6.1.1.1 Number of Blocks. One or more blocks may be required per building based on the following restrictions:

1. Each block can have only one occupancy type (multifamily dwelling unit, multifamily common area, office, library, education, hotel/motel or retail). Therefore, at least one single block shall be created for each unique use type.

2. Each block can be served by only one type of HVAC system. Therefore, a single block shall be created for each unique HVAC system and use type combination. Multiple HVAC units of the same type may be represented in one block. Table D601.10.2 provides directions for combining multiple HVAC units or components of the same type into a single block.

3. Each block can have a single definition of floor to floor or floor to ceiling heights. Where floor heights differ by more than two feet, unique

4. blocks should be created for the floors with varying heights.

5. Each block can include either above grade or below grade floors. For buildings with both above grade and below grade floors, separate blocks should be created for each. For buildings with floors partially above grade and partially below grade, if the total wall area of the floor(s) in consideration is greater than or equal to 50 percent above grade, then it should be simulated as a completely above grade block, otherwise it should be simulated as a below grade block.

6. Each wall on a façade of a block shall have similar vertical fenestration. The product of the proposed design U-factor times the area of windows (UA) on each façade of a given floor cannot differ by more than 15 percent of the average UA for that façade in each block. The product of the proposed design SHGC times the area of windows (SHGCA) on each façade of a given floor cannot differ by more than 15 percent of the average SHGCA for that façade in each block. If either of these conditions are not met, additional blocks shall be created consisting of floors with similar fenestration.

7. For a building model with multiple blocks, the blocks should be configured together to have the same adjacencies as the actual building design.

C408.6.1.2 Thermal Zoning. Each floor in a block shall be modeled as a single thermal zone or as five thermal zones consisting of four perimeter zones and a core zone. Below grade floors shall be modeled as a single thermal block. If any façade in the block is less than 45 feet in length, there shall only be a single thermal zone per floor. Otherwise each floor shall be modeled with five thermal zones. A perimeter zone shall be created extending from each façade to a depth of 15 feet. Where facades intersect, the zone boundary shall be formed by a 45 degree angle with the two facades. The remaining area or each floor shall be modeled as a core zone with no exterior walls.

C408.6.1.3 Occupancy. Building occupancies modeled in the standard reference design and the proposed design shall comply with the following requirements.

C408.6.1.3.1 Occupancy Type. The occupancy type for each block shall be consistent with the building area type as determined in accordance with C405.4.2.1. Portions of the building that are building area types other than multifamily dwelling unit, multifamily common area, office, school (education), library, or retail shall not be included in the simulation. Surfaces adjacent to such building portions shall be modeled as adiabatic in the simulation program.

C408.6.1.3.2 Occupancy schedule, density, and heat gain. The occupant density, heat gain, and schedule shall be for multifamily, office, retail, library, hotel/motel or school as specified by ASHRAE Standard 90.1 Normative Appendix C.

C408.6.1.4 Envelope Components. Building envelope components modeled in the standard reference design and the proposed design shall comply with the requirements of this Section.

C408.6.1.4.1 Roofs. Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single block, an area weighted U-factor shall be used. Roof solar absorptance shall be modeled at 0.70 and emittance at 0.90.

C408.6.1.4.2 Above grade walls. Walls will be modeled as steel frame construction. The U-factor and area of above grade walls shall be modeled as in the proposed design. If different wall constructions exist on the façade of a block an area-weighted U-factor shall be used.

C408.6.1.4.3 Below grade walls. The C-factor and area of below grade walls shall be modeled as in the proposed design. If different slab on grade floor constructions exist in a block, an area-weighted C- factor shall be used.

C408.6.1.4.4 Above grade exterior floors. Exterior floors shall be modeled as steel frame. The U-factor and area of floors shall be modeled as in the proposed design. If different wall constructions exist in the block an area-weighted U-factor shall be used.

C408.6.1.4.5 Slab on grade floors. The F-factor and area of slab on grade floors shall be modeled as in the proposed design. If different below grade wall constructions exist in a block, an area-weighted F-factor shall be used.

C408.6.1.4.6 Vertical Fenestration. The window area and area weighted U-factor and SHGC shall be modeled for each façade based the proposed design. Each exterior surface in a block must comply with Section C408.6.1.1.1 item 5. Windows will be combined into a single window centered on each façade based on the area and sill height input by the user. When different U values, SHGC or sill heights exist on a single facade, area weighted average for each shall be input by the user.

C408.6.1.4.7 Skylights. The skylight area and area weighted U-factor and SHGC shall be modeled for each floor based the proposed design. Skylights will be combined into a single skylight centered on the roof of each zone based on the area input by the user

C408.6.1.4.8 Exterior Shading. Permanent window overhangs shall be modeled. When windows with and without overhangs or windows with different overhang projection factors exist on a façade, window width weighted projection factors shall be input by the user as follows.

C408.6.1.5 Lighting. Interior lighting power density shall be equal to the allowance in Table C405.4.2(1) for multifamily, office, retail, library, or school. The lighting schedule shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls shall be modeled. Exterior lighting shall not be modeled.

C408.6.1.6 Miscellaneous equipment. The miscellaneous equipment schedule and power shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of miscellaneous equipment controls is assumed to be captured by the equipment schedule and no explicit controls shall be modeled.

Exceptions:

1. Multifamily dwelling units shall have a miscellaneous load density of 0.42 W/ft2

2. Multifamily common areas shall have a miscellaneous load density of 0 W/ft2

C408.6.1.7 Elevators. Elevators shall not be modeled.

C408.6.1.8 Service water heating equipment. Service water heating shall not be modeled.

C408.6.1.9 On-site renewable energy systems. On-site Renewable Energy Systems shall not be modeled.

C408.6.1.10 HVAC Equipment. HVAC systems shall meet the requirements of Section C403 Mechanical Systems.

C408.6.1.10.1 Supported HVAC systems. At a minimum, the HVAC systems shown in Table C408.6.1.10.1 shall be supported by the simulation program.

Table C408.6.1.10.1 PROPOSED BUILDING HVAC SYSTEMS SUPPORTED BY HVAC TSPR SIMULATION SOFTWARE

System No.	System Name	System Abbreviation
1	Packaged Terminal Air Conditioner	PTAC
2	Packaged Terminal Air Heat Pump	PTHP
3	Packaged Single Zone Gas Furnace	PSZGF
4	Packaged Single Zone Heat Pump (air to air only)	PSZHP
5	Variable Refrigerant Flow (air cooled only)	VRF
6	Four Pipe Fan Coil	FPFC
7	Water Source Heat Pump	WSHP
8	Ground Source Heat Pump	GSHP
9	Packaged Variable Air Volume (DX cooling)	PVAV

10	Variable Air Volume (hydronic cooling)	VAV
11	Variable Air Volume with Fan Powered Terminal Units	VAVFPTU
12	Dedicated Outdoor Air System (in conjunction with systems 1-8)	DOAS

C408.6.1.10.2 Proposed building HVAC system simulation. The HVAC systems shall be modeled as in the proposed design at design conditions unless otherwise stated with clarifications and simplifications as described in Tables C408.6.1.10.2(1) and C408.6.1.10.2(2). System parameters not described in the following sections shall be simulated to meet the minimum requirements of Section C403. All zones within a block shall be served by the same HVAC system type as described in Section C408.6.1.1.1 item 2. Heat loss from ducts and pipes shall not be modeled. Table C408.6.1.10.1 proposed building HVAC parameter requirements are based on input of full-load equipment efficiencies with adjustment using part-load curves integrated in the simulation program. Where other approaches to part-load adjustment are used, it is permitted for specific input parameters to vary.

The simulation program shall model part-load HVAC equipment performance using either:

1. full-load efficiency adjusted for fan power input that is modeled separately and typical part- load performance adjustments for the proposed equipment,
2. part-load adjustments based on input of both full- load and part- load metrics, or
3. equipment- specific adjustments based on performance data provided by the equipment manufacturer for the proposed equipment.

For packaged single-zone air conditioners (cooling only), water-loop heat pumps, ground-source heat pumps and packaged rooftop heat pumps, heating COP and cooling COP, exclusive of fan power, shall be determined using the following equations:

For Systems 4, 7, and 8 heating efficiency

$$COP_{nfheating} = 1.48E\text{-}7 \times COP47 \times Q + 1.062 \times COP47$$

For System 3 heating efficiency

$$COP_{nfheating} = -0.0296 \times HSPF2 + 0.7134 \times HSPF$$

For System 4, 7, 8, and 9 cooling efficiency

$$COP_{nfcooling} = 7.84E\text{-}8 \times EER \times Q + 0.338 \times EER$$

For System 1 and 2 cooling efficiency

$$COP_{nfcooling} = -0.0076 \times SEER2 + 0.3796 \times SEER$$

For System 1 and 2 cooling efficiency

$$COP_{nfcooling} = 0.3322 \times EER - 0.2145$$

For System 2 heating efficiency

$$COP_{nfheating} = 1.1329 \times COP - 0.214$$

Where:

EER, SEER, COP and HSPF shall be at AHRI full load test conditions

Q = AHRI rated cooling capacity in BTU/h. If Q > 760,000BTU/h use 760,000 in the calculation

Where multiple system components serve a block, average values weighed by the appropriate metric as described in this section shall be used.

1. Where multiple fan systems serve a single block, fan power shall be based on weighted average using the design supply air cfm

2. Where multiple cooling systems serve a single block, COP shall be based on a weighted average using cooling capacity. DX coils shall be entered as multi-stage if more than 50% of coil capacity serving the block is multi-stage with staged controls.

3. Where multiple heating systems serve a single block, thermal efficiency or heating COP shall be based on a weighted average using heating capacity.

4. Where multiple boilers or chillers serve a heating water or chilled water loop, efficiency shall be based on a weighted average for using heating or cooling capacity.

5. When multiple cooling towers serving a condenser water loop are combined, the cooling tower efficiency, cooling tower design approach and design range are based on a weighted average of the design water flow rate through each cooling tower.

6. Where multiple pumps serve a heating water, chilled water or condenser water loop, pump power shall be based on a weighted average for using design water flow rate.

7. When multiple system types with and without economizers are combined, the economizer maximum outside air fraction of the combined system shall be based on weighted average of 100% supply air for systems with economizers and design outdoor air for systems without economizers.

8. Multiple systems with and without ERVs cannot be combined.

9. Systems with and without supply air temperature reset cannot be combined.

10. Systems with different fan control (constant volume, multi-speed or VAV) for supply fans cannot be combined.

TABLE C408.6.1.10.2(1) PROPOSED BUILDING SYSTEM PARAMETERS

Category	**Parameter**	**Fixed or User Defined**	**Required**	**Applicable Systems**
HVAC System Type	System Type	User Defined	Selected from Table CD105.2.10.1	All
System Sizing	Design Day Information	Fixed	99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design	All
	Zone Coil Capacity	Fixed	Sizing factors used are 1.25 for heating equipment and 1.15 for cooling equipment	All
	Supply Airflow	Fixed	Based on a supply-air-to-room-air temperature *set-point* difference of 20°F or	1-11
		Fixed	Equal to required outdoor air ventilation	12
Outdoor Ventilation Air	Portion of supply air with proposed Filter ≥MERV 13	User-defined	Percentage of supply air flow subject to higher filtration (Adjusts baseline Fan Power higher. Prorated)	All
	Outdoor Ventilation Air Flow Rate	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed DCV control	All
	Outdoor *Ventilation* Supply Air Flow Rate Adjustments	Fixed	Based on ASHRAE Standard 62.1 Section 6.2.4.3 System Ventilation Efficiency (Evs) is 0.75	9-11
		Fixed	System Ventilation Efficiency (Evs) is 1.0	1-8, 12
		Fixed	Basis is 1.0 Zone Air Distribution Effectiveness	All

System Operation	Space temperature Set points	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, except multifamily which shall use 68 deg. F heating and 76 deg. F cooling setpoints	1-11
	Fan Operation – Occupied	User Defined	Runs continuously during occupied hours or cycles to meet load. Multispeed fans reduce airflow related to thermal loads.	1-11
	Fan Operation – Occupied	Fixed	Fan runs continuously during occupied hours	12
	Fan Operation – Night Cycle	Fixed	Fan cycles on to meet setback temperatures	1-11
Packaged Equipment Efficiency	DX Cooling Efficiency	User Defined	Cooling COP without fan energy calculated in accordance with Section CD105.2.10.2	1, 2, 3, 4, 5,7, 8, 9, 11,12
	DX Coil Number of Stages	User-defined	Single Stage or Multistage	3, 4, 9
	Heat Pump Efficiency	User Defined	Heating COP without fan energy calculated in accordance with Section CD105.2.10.2	2, 4, 5, 7, 8
	Furnace Efficiency	User Defined	Furnace thermal efficiencyc	3, 11
Heat Pump Supplemental Heat	Control	Fixed	Supplemental electric heat locked out above 40°F. Runs In conjunction with compressor between 40°F and 0°F.	2, 4
Category	Parameter	Fixed or User Defined	Required	Applicable Systems
System Fan Power and Controls	Part-load Fan Controls	User-defined	Constant volume or two speed	1-8
	Part-load Fan Controls[a]	User-defined	Constant volume or variable air volume	12
	Part-load Fan Controls[a]	Fixed	Variable air volume. VFD with static pressure reset	9-11
	Design Fan Power (W/cfm)	User Defined	Input electric power for all fans in required to operate at fan system design conditions divided by the supply airflow rate This is a “wire to air” value including all drive, motor efficiency and other losses.	All
	Low-speed fan power	User Defined	Low speed input electric power for all fans required to operate at low speed conditions divided by the low speed supply airflow rate. This is a “wire to air”	1-8

			value including all drive, motor efficiency and other losses.	
Variable Air Volume Systems	Supply Air Temperature (SAT) Controls	User defined	If not SAT reset then constant at 55°F. Options for reset based on outside air temperature (OAT) or warmest zone. If warmest zone, then the user can specify the minimum and maximum temperatures. If OAT reset, SAT is reset higher to 60°F at outdoor low of 50°F. SAT is 55°F at outdoor high of 70°F.	9, 10, 11
	Minimum Terminal Unit airflow percentage	User Defined	Average minimum terminal unit airflow percentage for block weighted by cfm or minimum required for outdoor air ventilation, whichever is higher.	9, 10, 11
	Terminal Unit Heating Source	User Defined	Electric or hydronic	9, 10, 11
	Dual set point minimum VAV damper position	User-defined	Heating maximum airflow fraction	9,10.
	Fan Powered Terminal Unit (FPTU) Type	User Defined	Series or parallel FPTU	11
	Parallel FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
	Series FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
Economizer	Economizer Presence	User Defined	Yes or No	3, 4, 9, 10,11
	Economizer Control Type	Fixed	Differential dry-bulb	3, 4, 9, 10,11
Energy Recovery	Sensible Effectiveness	User Defined	Heat exchanger sensible effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Latent Effectiveness	User Defined	Heat exchanger latent effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Economizer Bypass	User Defined	If ERV is bypassed during economizer conditions	3, 4, 9, 10, 11, 12
	Bypass SAT Setpoint	User Defined	If bypass, target supply air temperature	3, 4, 9, 10,

				11, 12
	Fan Power Reduction during Bypass (W/cfm)	User Defined	If ERV system include bypass, static pressure set point and variable speed fan, fan power can be reduced during economizer conditions	3, 4, 9, 10, 11, 12
Demand Controlled Ventilation	DCV Application	User Defined	Percent of block floor area under DCV control	3, 4, 9, 10, 11, 12
DOAS	DOAS Fan Power W/cfm	User Defined	Fan electrical input power in W/cfm of supply airflow[a]	12
	DOAS Supplemental Heating and Cooling	User Defined	Heating source, cooling source	12
	Maximum SAT Set point (Cooling)	User-defined	SAT set point if DOAS includes supplemental cooling	12
	Minimum SAT Set point (Heating)	User-defined	SAT set point if DOAS includes supplemental heating	12
Heating Plant	Boiler Efficiency[d]	User Defined	Boiler thermal efficiency	1, 6, 7, 9, 10, 11, 12
	Heating Water loop Configuration[a]	User-defined	Constant flow primary only; Variable flow primary only; Constant flow primary – variable flow secondary	1, 6, 7, 9, 10, 11, 12
	Heating Water Primary Pump Power (W/gpm)	User-defined	Heating water primary pump input W/gpm heating water flow	1, 6, 7, 9, 10, 11, 12
	Heating Water Secondary Pump Power (W/gpm)	User-defined	Heating water secondary pump input W/gpm heating water flow (if primary/secondary)	1, 6, 7, 9, 10, 11, 12
	Heating Water Loop Temperature	Fixed	180°F supply, 130°F return	1, 6, 9, 10,11
	Boiler Type	Fixed	Non-condensing boiler where input thermal efficiency is less than 86%; Condensing boiler otherwise	1, 6, 7, 9, 10, 11, 12
Chilled Water Plant	Chiller Compressor Type	User Defined	Screw/Scroll, Centrifugal or Reciprocating	6,1 0, 11, 12
	Chiller Condenser Type	User Defined	Air cooled or water cooled	6, 10, 11, 12

	Chiller Full Load Efficiencyd	User Defined	Chiller COP	6, 10, 11, 12
	Chilled Water loop Configurationa	User Defined	Variable flow primary only, constant flow primary – variable flow secondary	6, 10, 11, 12
	Chilled Water Primary Pump Power (W/gpm)	User-defined	Primary pump input W/gpm chilled water flow	6, 10, 11,12
	Chilled Water Secondary Pump Power (W/gpm)	User-defined	Secondary Pump input W/gpm chilled water flow (if primary/secondary)	6, 10, 11,12
	Chilled Water Temperature Reset Included	User Defined	Yes/No	6, 10, 11,12
	Chilled Water Temperature Reset Schedule (if included)	Fixed	Outdoor air reset: CHW supply temperature of 44°F at 80°F outdoor air dry bulb and above, CHW supply temperature of 54°F at 60°F outdoor air dry bulb temperature and below, ramped linearly between	6, 10, 11,12
	Condenser Water Pump Power (W/gpm)	User Defined	Pump input W/gpm condenser water flow	6, 7, 8, ,10, 11, 12
	Condenser Water Pump Control	User Defined	Constant speed or variable speed	6, 7, 8, 10, 11,12
	Cooling Tower Efficiency	User Defined	gpm/hp tower fan	6, 7, 10, 11,12
	Cooling Tower Fan Control	User Defined	Constant or variable speed	6, 7, 10, 11,12
	Cooling Tower Approach and Range	User Defined	Design cooling tower approach and range temperature	6, 7, 10, 11,12
Heat Pump Loop Flow Control	Loop flow and Heat Pump Control Valve	Fixed	Two position Valve with VFD on Pump. Loop flow at 3 gpm/ton	7, 8
Heat Pump Loop Temperature Control	-	Fixed	Set to maintain temperature between 50°F and 70°F	7
GLHP Well Field	-	Fixed	Bore depth = 250’ Bore length 200’/ton for greater of cooling or heating load Bore spacing = 15’ Bore diameter = 5”	8

			¾" Polyethylene pipe Ground and grout conductivity = 4.8 Btu-in/h-ft2-0F	

a. Part load fan power and pump power modified in accordance with Table C408.6.1.10.2(2)

TABLE C408.6.1.10.2(2) FAN AND PUMP Power CURVE COEFFICIENTS

Equation Term	**Fan Power Coefficients**	**Pump Power Coefficients**	
	VSD + SP reset	**Ride Pump Curve**	**VSD + DP/valve reset**
b	0.0408	0	0
x	0.088	3.2485	0.0205
x2	-0.0729	-4.7443	0.4101
x3	0.9437	2.5295	0.5753

C408.6.1.10.3 Demand Control Ventilation. Demand Controlled Ventilation (DCV) shall be modeled using a simplified approach that adjusts the design outdoor supply air flow rate based on the floor area of the building that is covered by DCV. The simplified method shall accommodate both variable DCV and on/off DCV, giving on/off DCV one third the effective floor control area of variable DCV. Outdoor air reduction coefficients shall be as stated in Table C408.6.1.10.3.

Exception: On/off DCV shall receive full effective area adjustment for R-1 and R-2 occupancies.

Table C408.6.1.10.3 DCV Outdoor Air Reduction Curve Coefficients

Equation Term	***DCV* OSA reduction (y) as a function of effective *DCV* control floor area (x)**			
	Office	**School**	**Hotel; Motel; Multi-Family; Dormitory**	**Retail**
b	0	0	0	0
x	0.4053	0.2676	0.5882	0.4623
x_2	-0.8489	0.7753	-1.0712	-0.848
x_3	1.0092	-1.5165	1.3565	1.1925

x_4	-0.4168	0.7136	-0.6379	-0.5895

C408.6.2 Simulation of the standard reference design. The standard reference design shall be configured and analyzed as specified in this section.

C408.6.2.1 Utility Rates. Same as proposed design.

C408.6.2.2 Blocks. Same as proposed design.

C408.6.2.3 Thermal zoning. Same as proposed design.

C408.6.2.4 Occupancy type, schedule, density, and heat gain. Same as proposed design.

C408.6.2.5 Envelope components. Same as proposed design.

C408.6.2.6 Lighting. Same as proposed design.

C408.6.2.7 Miscellaneous equipment. Same as proposed design.

C408.6.2.8 Elevators. Not modeled. Same as proposed design.

C408.6.2.9 Service water heating equipment. Not modeled. Same as proposed design.

C408.6.2.10 On-site renewable energy systems. Not modeled. Same as proposed design.

C408.6.2.11 HVAC equipment. The reference building design HVAC equipment consists of separate space conditioning systems as described in Table C408.6.2.11(1) through Table C408.6.2.11(3) for the appropriate building use types.

Table C408.6.2.11(1) Reference Building Design HVAC Complex Systems

Building Type Parameter	**Large Office**	**School**
System Type	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*
Fan control	VSD (No SP Reset)	VSD (No SP Reset)
Main fan power (W/CFM (W·s/L) Proposed ≥ MERV13	1.165 (2.468)	1.165 (2.468)
Main fan power (W/CFM (W·s/L) proposed < MERV13	1.066 (2.259)	1.066 (2.259)
Zonal fan power (W/CFM (W·s/L))	NA	NA
Minimum zone airflow fraction	1.5* Voz	1.2 * Voz
Heat/cool sizing factor	1.25/1.15	1.25/1.15
Outdoor air economizer	Yes except 4A	Yes except 4A
Occupied OSA (= proposed)	Sum(Voz)/0.75	Sum(Voz)/0.65
Energy recovery ventilator *efficiency* ERR (Enthalpy Recovery Ratio) ERV bypass SAT *set point*	NA	50% 60°F
DCV	No	No
Cooling Source	(2) Water- cooled Centrifugal Chillers	(2) Water- Cooled Screw Chillers
Cooling *COP* (net of fan)	Path B for profile	Path B for profile
Heating source (reheat)	Gas *Boiler*	Gas *Boiler*
Furnace or *boiler efficiency*	75% Et	80% Et
Condenser heat rejection	Cooling tower	Cooling tower

Cooling tower *efficiency* (gpm/fan-hp)	38.2	38.2
Tower turndown (> 300 ton (1060 *kW*))	50%	50%
Pump (constant flow/variable flow)	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range
Tower Approach	25.72 – (0.24 x WB), where WB is the 0.4% evaporation design wet-bulb temperature (°F)	
Cooling condenser *pump* power (W/gpm)	19	19
Cooling primary *pump* power (W/gpm)	9	9
Cooling secondary *pump* power (W/gpm)	13	13
Cooling coil chilled water delta- T, °F	12	12
Design chilled water supply temperature, °F	44	44
Chilled water supply temperature (CHWST) reset *set point* vs OAT, °F (°C)	CHWST/OAT :44-54/ 80-60 (6.7-12.2/26.7-15.6)	CHWST/OAT :44-54/ 80-60 (6.7-12.2/26.7-15.6)
CHW cooling loop pumping control	2-way Valves & pump VSD	2-way Valves & pump VSD
Heating pump power (W/gpm)	16.1	19
Heating oil HW dT. °F	50	50
Design Hot Water Supply Temperature (HWST). °F	180	180
HWST reset set point vs OAT, °F	HWST: 180-150/ OAT 20- 50 (82-65.6/ -6.7-10)	HWST: 180-150/ OAT 20- 50 (82-65.6/ -6.7-10)
Heat loop pumping control	2-way Valves & pump VSD	2-way Valves & pump VSD

Table C408.6.2.11(3) TSPR Reference Building Design HVAC Simple Systems

Building Type Parameter	**Hotel**	**Multifamily**
System type	*PTAC*	*PTAC*

Fan control	Constant Volume	Constant Volume
Main fan power (W/CFM (W·s/L))	0.300 (0.636)	0.300 (0.636)
Heat/cool sizing factor	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA
Outdoor air economizer	No	No
Occupied OSA source	Packaged unit, occupied damper	Packaged unit, occupied damper
Energy recovery ventilator	No	No
DCV	No	No
Cooling source	DX, 1 stage	DX, 1 stage
Cooling *COP* (net of fan)	3.20	3.20
Heating source	(2) Hydronic *Boiler*	(2) Hydronic *Boiler*
Heating *COP* (net of fan) / furnace or *boiler efficiency*	75% E_t	75% E_t
Heating *pump* power (W/gpm (W·s/L))	19 (300)	19 (300)
Heating coil heating water delta-T, °F (°C)	50 (27.8)	50 (27.8)
Design HWST, °F (°C)	180 (82.2)	180 (82.2)
HWST reset *set point* vs OAT, °F (°C)	HWST: 180-150/ OAT 20-50 (82-65.6/ -6.7-10)	HWST: 180-150 / OAT 20-50 (82-65.6/ -6.7-10)
Heat loop *pump*ing control	2-way Valves & ride *pump* curve	2-way Valves & ride *pump* curve

CHAPTER 5 [CE]
EXISTING BUILDINGS

SECTION C501
GENERAL

~~–~~*delete* **C501.2 Existing buildings** *and replace* ~~–~~*with* **C501.~~4~~1.1 Existing buildings.**

add **C501.2 Compliance.**
Additions, *alterations, repairs,* ~~*additions*~~ and changes of occupancy to, or relocation of, existing *buildings* and structures shall comply with Sections C502, C503, C504 and C505 of this code, as applicable, and with the provisions for *alterations, repairs, additions* and changes of occupancy or relocation, respectively, in ~~this code and in~~ the *International Building Code, International Existing Building Code, International Fire Code, International Fuel Gas Code,* ~~,~~ *International Plumbing Code, International Property Maintenance Code, International Private Sewage Disposal Code*, ANSI/SMACNA 006 ~~-~~*HVAC Duct Construction Standards*, ASHRAE Standard 62.1, and NFPA 70. Changes where unconditioned space is changed to conditioned space shall comply with Section C502.

~~*- delete and replace –* **C501.6 Historic buildings.**~~
~~Provisions of this code relating to the construction, *repair, alteration*, restoration and movement of structures, and *change of occupancy* shall not be mandatory for *historic buildings* provided that a "Historic Building Exemption Report" obtained from the State Historic Preservation Office, has been submitted to the State Historic Preservation Office and signed by the owner, an owners agent, a *registered design professional*, a representative of the State Historic Preservation Office or the historic preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the *building*. The State Historic Preservation Office, upon receipt of the report, will review and validate the exemption request. Upon request, a copy of the report shall be provided to the *code official or other authority having jurisdiction*.~~
Exception: Additions, alterations, repairs or changes of occupancy complying with ANSI/ASHRAE/IESNA 90.1.
delete **C501.4 Compliance.**

renumber **C501.5 New and replacement materials** *as* **C501.4 New and replacement materials.**

renumber **C501.6 Historic buildings** *as* **C501.5 Historic buildings.**

SECTION C502
ADDITIONS

~~–~~*add* **C502.2 Change in space conditioning.**
Any nonconditioned or low-energy space that is altered to become conditioned space shall be required to comply with Section C502.

Exceptions:

1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.

2. Where the total building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.

delete **C502.2 Prescriptive compliance** *and replace* –*with* **C502.3 Compliance.**

delete **C502.2.1 Vertical fenestration**~~.~~
and replace with **C502.3.1 Vertical fenestration**
Additions shall comply with the following:

1. Where an addition has a new *vertical fenestration* area that results in a total building *fenestration* area less than or equal to that ~~specified in Section C402.3.1 shall comply with~~permitted by Section C402.~~1.3 or~~3.1, the addition shall comply with Section C402.~~3~~1.3~~. *Additions*~~ or C402.3.3.
2. *Where an addition* with *vertical fenestration* that ~~result~~results in a total building *fenestration* area greater than Section C402.3.1 or *additions* that exceed the fenestration area greater than that permitted by Section C402.3.1, the fenestration shall comply with Section C402.3.1.1 for the *addition* only~~. *Additions* that result in a total building vertical fenestration area exceeding that specified in Section C402.3.1.1 shall comply with Section C402.1.3~~.

~~–~~3. Where an addition has vertical fenestration that results in a total building vertical fenestration area exceeding that permitted by Section C402.3.1.1, the addition shall comply with Section C402.1.3.

delete ~~*and replace –*~~ **C502.2.2 Skylight area**~~.~~
and replace with **C502.3.2 Skylight area**
Skylights shall comply with the following:
1. Where an addition has a new *skylight* area that results in a total building *fenestration* area less than or equal to that ~~specified in~~permitted by Section C402.3.1, the addition shall comply with shall comply with Section C402.1.3. ~~*Additions* with~~
2. Where an addition has a new *skylight* area that ~~result~~results in a total building *skylight* area greater than C402.3.1 or additions ~~that exceed the~~ have skylight area ~~shall comply with~~ greater than that permitted by Section C402.3.1.2 for the *addition* only. ~~*Additions* that result~~
3. Where an addition has skylight area that results in a total building skylight area exceeding that ~~specified in~~permitted by Section C402.3.1.2, the addition shall comply with Section C402.1.3.

delete **C502.2.3 Building mechanical systems** *and replace with* **C502.3.3 Building mechanical systems**
New mechanical systems and equipment that are part of the *addition* and serve the building heating, cooling and ventilation needs shall comply with Section C403 and C407.

delete **C502.2.4 Service water-heating systems** *and replace with* **C502.3.4 Service water-heating systems.**

delete **C502.2.5 Pools and inground permanently installed spas** *and replace with* **C502.3.5 Pools and inground permanently installed spas**

delete **C502.3.6 Lighting power and systems** *and replace with* **C502.3.6 Lighting power and systems.**
New lighting systems that are installed as part of the addition shall comply with Section C405 and C407.

delete **C502.2.6.1 Interior lighting power** *and replace with* **C502.3.6.1 Interior lighting power.**

delete **C502.2.6.2 Exterior lighting power** *and replace with* **C502.3.6.2 Exterior lighting power.**

SECTION C503
ALTERATIONS

~~-~~*Delete and replace*~~—~~ **C503.1 General.**
Alterations to any *building* or structure shall comply with the requirements of Section C503~~ and the code for new construction~~. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the *existing building* or structure was prior to the *alteration. Alterations* to an existing *building, building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Alterations complying with ANSI/ASHRAE/IESNA 90.1. need not comply with Sections C402, C403, C404 and C405.

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

1. Storm windows installed over existing *fenestration*.

2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.

3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.

4. Construction where the existing roof, wall or floor cavity is not exposed.

5. Replacement of existing electrical resistance unit.

6. *Roof recover*.

7. *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.

~~*- delete and replace –* **C503.2 Change in space conditioning.**~~
~~Any nonconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.~~

~~**Exception:** Where the component performance alternative in Section C402.1.3 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.~~

~~*- delete and replace –* **C503.3 Building envelope.**~~
~~New building envelope assemblies that are part of the *alteration* shall comply with Sections C402.1 through C402.4.~~

~~**Exception:** Where the existing building exceeds the fenestration area limitations of Section C402.3.1 prior to alteration, the building is exempt from Section C402.3.1 provided that there is not an increase in fenestration area.~~

~~*- delete and replace –*~~
Delete and replace **C503.3.1 Roof replacement.**
Roof replacements shall comply with Section C402.1.1, C402.1.2 or C402.1.3 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. In no case shall the R-value of the roof insulation be reduced or the U-factor of the roof assembly be increased as part of the roof replacement.

~~*- delete and replace –*~~*add* **C503.3.2 ~~Vertical~~.1 Application to replacement fenestration~~.~~**
~~The addition~~ **products.**
Where some or all of ~~*vertical*~~an existing fenestration ~~that results in a total~~ unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and SHGC in Table C402.4.

Exception: An area-weighted average of the U-factor of replacement fenestration products being installed in the building ~~*fenestration* area less than or equal to~~ for each fenestration product category listed in Table C402.4 shall be permitted to satisfy the U-factor requirements for each fenestration product category listed in Table C402.4. Individual fenestration products from different product categories listed in Table C402.4 shall not be combined in calculating the area-weighted average U-factor.

delete and replace **C503.4 Heating and cooling systems.**
New heating, cooling and duct systems that are part of the *alteration* shall comply with Sections C403 and C407.

delete and replace **C503.5 Service hot water systems.**
New service hot water systems that ~~specified in~~are part of the *alteration* shall comply with Section ~~C402.3.1~~C404 and C407.

delete and replace **C503.6 Lighting systems.**
New lighting systems that are part of the *alteration* shall comply with Section ~~C402.1.3 or C402.3.3. The addition of *vertical fenestration* that results~~C405 and C407.

> **Exception:** *Alterations* that replace less than 10 percent of the luminaires in a ~~total building *fenestration* area greater than Section C402.3.1 shall comply with Section C402.3.1.1 for the~~ space ~~adjacent to the new fenestration only. *Alterations* that result in a total building *vertical fenestration* area exceeding that specified in Section C402.3.1.1 shall comply with Section C402.1.3.~~ , provided that such *alterations* do not increase the installed interior lighting power.

~~– *delete and replace* – **C503.3.3 Skylight area.**~~
~~New *skylight* area that results in a total building *skylight* area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.1.3 or C402.3. The addition of *skylight* area that results in a total building skylight area greater than Section C402.3.1 shall comply with Section C402.3.1.2 for the space adjacent to the new skylights. *Alterations* that result in a total building skylight area exceeding that specified in Section C402.3.1.2 shall comply with Section C402.1.3.~~

~~SECTION C505~~
~~CHANGE OF OCCUPANCY OR USE~~

~~– *delete and replace* – **C505.1 General.**~~
~~Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code. Where the use in a space changes from one use in Table C405.3.2(1) or C405.3.2(2) to another use in Table C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section C405.3. Where the space undergoing a change in occupancy or use is in a building with a fenestration area that exceeds the limitations of Section C402.3.1, the space is exempt from Section C402.3.1 provided that there is not an increase in fenestration area.~~

> ~~**Exception:** Where the component performance alternative in Section C402.1.3 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.~~

Delete and replace Chapter 6 in its entirety

CHAPTER 6 [CE]
REFERENCED STANDARDS

AAMA

American Architectural Manufacturers Association
1827 Walden Office Square
Suite 550
Schaumburg, IL 60173-4268

AAMA/WDMA/CSA 101/I.S.2/A C440—17: North American Fenestration Standard/Specifications for Windows, Doors and Unit Skylights

Table C402.5.2

AHAM

Association of Home Appliance Manufacturers
1111 19th Street NW, Suite 402
Washington, DC 20036

ANSI/AHAM RAC-1—2015: Room Air Conditioners

Table C403.3.2(3)

AHAM HRF-1—2016: Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers

Table C403.10.1

AHRI

Air-Conditioning, Heating, & Refrigeration Institute
2111 Wilson Blvd, Suite 500
Arlington, VA 22201

ISO/AHRI/ASHRAE 13256-1 (2012): Water-to-Air and Brine-to-Air Heat Pumps—Testing and Rating for Performance

Table C403.3.2(2)

ISO/AHRI/ASHRAE 13256-2 (1998 RA2014): Water-to-Water and Brine-to-Water Heat Pumps —Testing and Rating for Performance

Table C403.3.2(2)

210/240—2017 and 2023: Performance Rating of Unitary Air-conditioning and Air-source Heat Pump Equipment

Table C403.3.2(1), Table C403.3.2(2)

310/380—2017 (CSA-C744-17): Standard for Packaged Terminal Air Conditioners and Heat Pumps

Table C403.3.2(3)

340/360—2019: Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment

Table C403.3.2(1), Table C403.3.2(2)

365(I-P)—2009: Commercial and Industrial Unitary Air-conditioning Condensing Units

Table C403.3.2(1), Table C403.3.2(6)

390 (I-P)—2003: Performance Rating of Single Package Vertical Air-conditioners and Heat Pumps

Table C403.3.2(3)

400 (I-P)—2015: Performance Rating of Liquid to Liquid Heat Exchangers

Table C403.3.2(10)

440—2008: Performance Rating of Room Fan Coils—with Addendum 1

C403.11.3

460—2005: Performance Rating of Remote Mechanical-draft Air-cooled Refrigerant Condensers

Table C403.3.2(8)

550/590 (I-P)—2018: Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle

C403.3.2.1, Table C403.3.2(7)

560—2018: Absorption Water Chilling and Water Heating Packages

Table C403.3.2(7)

910—2014: Performance Rating of Indoor Pool Dehumidifiers

Table C403.3.2(11)

920—2015: Performance Rating of DX-Dedicated Outdoor Air System Units

Table C403.3.2(12), Table C403.3.2(13)

1160 (I-P) —2014: Performance Rating of Heat Pump Pool Heaters (with Addendum 1)

Table C404.2

1200 (I-P)—2013: Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets

C403.10, Table C403.10.1(1), Table C403.10.1(2)

1230—2014: Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air Conditioning and Heat Pump Equipment (with Addendum 1)

Table C403.3.2(9)

1250 (I-P)—2014: Standard for Performance Rating in Walk-in Coolers and Freezers

Table C403.11.2.1(3)

1360—2017: Performance Rating of Computer and Data Processing Room Air Conditioners

Table C403.3.2(10), Table C403.3.2(16)

AMCA

Air Movement and Control Association International
30 West University Drive
Arlington Heights, IL 60004-1806

208—18: Calculation of the Fan Energy Index

C403.8.3

220—19: Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating
C402.5.6

500D—18: Laboratory Methods for Testing Dampers for Rating
C403.7.7

230—15: Laboratory Methods of Testing Air Circulating Fans for Rating and Certification
C403.9

ANSI

American National Standards Institute
25 West 43rd Street, 4th Floor
New York, NY 10036

Z21.10.3/CSA 4.3—17: Gas Water Heaters, Volume III—Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating Tank and Instantaneous
Table C404.2

Z21.47/CSA 2.3—16: Gas-fired Central Furnaces
Table C403.3.2(4)

Z83.8/CSA 2.6—16: Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-fired Duct Furnaces
Table C403.3.2(4)

APSP

The Association of Pool & Spa Professionals
2111 Eisenhower Avenue, Suite 580
Alexandria, VA 22314

~~- delete and replace -~~

14—~~2014~~2019: American National Standard for Portable Electric Spa Energy Efficiency
C404.10

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085

S640—2017: Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)
C405.4

ASHRAE

ASHRAE
1791 Tullie Circle NE
Atlanta, GA 30329

~~- add -~~

ANSI/ASHRAE/ACCA Standard 183—2007 (RA2017): Peak Cooling and Heating Load Calculations in Buildings, Except Low-rise

Residential Buildings
C403.1.1

ANSI/ASHRAE Standard 62.1—2016: Ventilation for Acceptable Indoor Air Quality
~~ANSI/ASHRAE Standard 62.1-2016 Ventilation for Acceptable Indoor Air Quality~~
C201.3, C403.2.2, C403.6.1, C403.7.1, C403.7.4, C403.7.7, C403.8.5.1, C406.6, C501.4

ASHRAE—2020: ASHRAE HVAC Systems and Equipment Handbook—2020
C403.1.1

ISO/AHRI/ASHRAE 13256-1 (1998 RA2014): Water-to-Air and Brine-to-Air Heat Pumps—Testing and Rating for Performance
Table C403.3.2(2)

ISO/AHRI/ASHRAE 13256-2 (1998 RA2014): Water-to-Water and Brine-to-Water Heat Pumps—Testing and Rating for Performance
Table C403.3.2(2)

55—2017: Thermal Environmental Conditions for Human Occupancy
Table C407.5.1

90.1—2019: Energy Standard for Buildings Except Low-rise Residential Buildings
C401.2, Table C402.1.3, Table C402.1.4, C406.2, Table C407.6.1, C502.1, C503.1, C504.1

90.4—2016: Energy Standard for Data Centers
C403.1.2, C405.2.4

140—2014: Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs
C407.6.1

146—2011: Testing and Rating Pool Heaters
Table C404.2

ASME

American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990

ASME A17.1—2019/CSA B44—19: Safety Code for Elevators and Escalators
C405.8.2

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700

West Conshohocken, PA
19428-2959

C90—2016A: Specification for Load-bearing Concrete Masonry Units
Table C401.3

C1363—11: Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
C303.1.4.1, Table C402.1.4, 402.2.7

C1371—15: Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
Table C402.3

C1549—2016: Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
Table C402.3

D1003—13: Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
C402.4.2.2

D8052/D8052M—2017: Standard Test Method for Quantification of Air Leakage in Low-Sloped Membrane Roof Assemblies
C402.5.1.4

E283—2004(2012): Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
C402.5.1.2.2, Table C402.5.2, C402.5.7

E408—13: Test Methods for Total Normal Emittance of Surfaces Using Inspection-meter Techniques
Table C402.3

E779—10(2018): Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
C402.5

E903—2012: Standard Test Method Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)
Table C402.3

E1677—11: Specification for Air Barrier (AB) Material or Systems for Low-rise Framed Building Walls
C402.5.1.2.2

E1827—2011(2017): Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door
C402.5, C406.9, C606.4

E1918—06(2016): Standard Test Method for Measuring Solar Reflectance of Horizontal or Low-sloped Surfaces in the Field
Table C402.3

E1980—11: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces

Table C402.3, C402.3.2

E2178—13: Standard Test Method for Air Permanence of Building Materials
C402.5.1.2.1

E2357—2018: Standard Test Method for Determining Air Leakage of Air Barriers Assemblies
C402.5.1.2.2

E3158—2018: Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building
Section C402.5.3

F1281—2017: Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Pressure Pipe
Table C404.5.2.1

F1361—2017: Standard Test Method for Performance of Open Deep Fat Fryers
Table C406.12(1)

F1484—2018: Standard Test Method for Performance of Steam Cookers
Table C406.12(2)

F1495—2014a: Standard Specification for Combination Oven Electric or Gas Fired
Table C406.12(4)

F1496—2013: Standard Test Method for Performance of Convection Ovens
Table C406.12(4)

F1696—2018: Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines
Table C406.12(3)

F1920—2015: Standard Test Method for Performance of Rack Conveyor Commercial Dishwashing Machines
Table C406.12(3)

F2093—2018: Standard Test Method for Performance of Rack Ovens
Table C406.12(4)

F2144—2017: Standard Test Method for Performance of Large Open Vat Fryers
Table C406.12(1)

F2861—2017: Standard Test Method for Enhanced Performance of Combination Oven in Various Modes
Table C406.12(4)

CRRC

Cool Roof Rating Council
2435 North Lombard Street
Portland, OR 97217

ANSI/CRRC-S100—2020: Standard Test Methods for Determining Radiative Properties of Materials
Table C402.3, C402.3.1

CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights
Table C402.5.2

CSA B55.1—2015: Test Method for Measuring Efficiency and Pressure Loss of Drain Water Heat Recovery Units
C404.8

CSA B55.2—2015: Drain Water Heat Recovery Units

C404.8

CTI

Cooling Technology Institute
P. O. Box 681807
Houston, TX 77268

ATC 105—2019: Acceptance Test Code for Water Cooling Tower
Table C403.3.2(8)

ATC 105DS—2018 : Acceptance Test Code for Dry Fluid Coolers
Table C403.3.2(7)

ATC 105S—11: Acceptance Test Code for Closed Circuit Cooling Towers
Table C403.3.2(8)

ATC 106—11: Acceptance Test for Mechanical Draft Evaporative Vapor Condensers
Table C403.3.2(8)

STD 201—11: Standard for Certification of Water Cooling Towers Thermal Performances
Table C403.3.2(8)

CTI STD 201 RS(17): Performance Rating of Evaporative Heat Rejection Equipment
Table C403.3.2(8)

DASMA

Door & Access Systems
Manufacturers Association,
International
1300 Sumner Avenue
Cleveland, OH 44115-2851

105—2017: Test Method for Thermal Transmittance and Air Infiltration of Garage Doors and Rolling Doors
C303.1.3, Table C402.5.2

DOE

U.S. Department of Energy
c/o Superintendent of
Documents
1000 Independence Avenue
SW
Washington, DC 20585

10 CFR, Part 430—2015: Energy Conservation Program for Consumer Products: Test Procedures and Certification and Enforcement Requirement for Plumbing Products; and Certification and Enforcement Requirements for Residential Appliances; Final Rule
Table C403.3.2(4), Table C403.3.2(5), Table C404.2

10 CFR, Part 430, Subpart B, Appendix N—(2015): Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers
C202

10 CFR, Part 431—2015: Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and Efficiency Standards; Final Rules

Table C403.3.2(5), C405.6, Table C405.6, C405.7

10 CFR 431 Subpart B App B: Uniform Test Method for Measuring Nominal Full Load Efficiency of Electric Motors

C403.8.4, Table C405.7(1), Table C405.7(2), Table C405.7(3), C405.7(4)

NAECA 87—(88): National Appliance Energy Conservation Act 1987 [Public Law 100-12 (with Amendments of 1988-P.L. 100-357)]

Table C403.3.2(1), Table C403.3.2(2), Table C403.3.2(4)

HVI

Home Ventilating Institute
1740 Dell Range Blvd Ste H, PMB 45
Cheyenne, WY 82009

916-18 : Airflow Test Procedure

C403.8.5

ICC

International Code Council, Inc.
500 New Jersey Avenue NW
6th Floor
Washington, DC 20001

ANSI/RESNET/ICC—19: Standard for Testing Airtightness of Building, Dwelling Unit and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems

C402.5.2, C402.5.3

~~- delete -~~

~~IMC—18~~IBC—21: International ~~Mechanical~~Building Code®

~~C403.7.7, C403.2.2, C403.7.1, C403.7.2, C403.7.4, C403.7.5, C403.11.1, C403.11.2.1, C403.11.2.2, C403.6, C403.6.6, C406.6, C501.4~~

C201.3, C303.2, C402.5.3, C501.4

ICC 500—2020: Standard for the Design and Construction of Storm Shelters

C402.4.2

IFC—21: International Fire Code®

C201.3, C501.4

IFGC—21: International Fuel Gas Code®

C201.3, C501.4

IPC—21: International Plumbing Code®

C201.3, C501.4

IPMC—21: International Property Maintenance Code®
C501.4

IPSDC—21: International Private Sewage Disposal Code®
C501.4

IEEE

Institute of Electrical and Electronic Engineers
3 Park Avenue, 17th Floor
New York, NY 10016

IEEE 515.1—2012: IEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications
C404.6.2

IES

Illuminating Engineering Society
120 Wall Street, 17th Floor
New York, NY 10005-4001

ANSI/ASHRAE/IESNA 90.1—2019: Energy Standard for Buildings, Except Low-rise Residential Buildings
C401.2, Table C402.1.3, Table C402.1.4, C406.2, C502.1, C503.1, C504.1

ISO

International Organization for Standardization
Chemin de Blandonnet 8, CP 401, 1214 Vernier
Geneva, Switzerland

ISO/AHRI/ASHRAE 13256-1(2017): Water-to-Air and Brine-to-Air Heat Pumps -Testing and Rating for Performance
Table C403.3.2(2)

ISO/AHRI/ASHRAE 13256-2(2017): Water-to-Water and Brine-to-Water Heat Pumps -Testing and Rating for Performance
C403.3.2(2)

NEMA

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, VA 22209

MG1—2016: Motors and Generators
C202

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

70—20: National Electrical Code
C501.4

NFRC

National Fenestration Rating Council, Inc.
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770

100—2020: Procedure for Determining Fenestration Products *U-factors*
C303.1.3, C402.2.1.1

200—2020: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence
C303.1.3, C402.4.1.1

203—2017: Procedure for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence
C303.1.3

400—2020: Procedure for Determining Fenestration Product Air Leakage
Table C402.5.2

SMACNA

Sheet Metal and Air Conditioning Contractors' National Association, Inc.
4021 Lafayette Center Drive
Chantilly, VA 20151-1219

SMACNA—2012: HVAC Air Duct Leakage Test Manual Second Edition
C403.2.11.2.3

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

710—12: Exhaust Hoods for Commercial Cooking Equipment—with Revisions through November 2013
C403.7.5

727—18: Oil-fired Central Furnaces
Table C403.3.2(4)

731—18: Oil-fired Unit Heaters
Table C403.3.2(4)

1784—15: Air Leakage Tests of Door Assemblies—with Revisions through February 2015
C402.5.3

2202—2009: *Electric Vehicle (EV) Charging System- with revisions through February 2018*
C405.13

2594—2016: Standard for Electric Vehicle Supply Equipment
C405.13

US-FTC

United States-Federal Trade Commission
600 Pennsylvania Avenue NW
Washington, DC 20580

CFR Title 16 (2015): *R*-value Rule
C303.1.4

WDMA

Window and Door Manufacturers Association
2025 M Street NW, Suite 800
Washington, DC 20036-3309

AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights
Table C402.5.2

delete **APPENDIX CA**
~~SOLAR-READY ZONE—~~

add **APPENDIX CC**

APPENDIX CC
ZERO ENERGY COMMERCIAL BUILDING PROVISIONS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.
User note:
About this chapter: Appendix CC provides a model for applying new renewable energy generation when new buildings add electric load to the grid. This renewable energy will avoid the additional emissions that would otherwise occur from conventional power generation.

SECTION ~~CA103~~ ~~SOLAR-READY ZONE~~CC101 GENERAL

~~*- delete and replace -* **CA103.8 Construction documentation certificate.**~~
~~A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder, registered design professional or design professional.~~

CC101.1 Purpose.
The purpose of this appendix is to supplement the International Energy Conservation Code and require renewable energy systems of adequate capacity to achieve net zero carbon.

CC101.2 Scope.
This appendix applies to new buildings that are addressed by the International Energy Conservation Code.

Exceptions:
1. Detached one- and two-family dwellings and townhouses as well as Group R2 buildings three stories or less in height above grade plane, manufactured homes (mobile dwellings), and manufactured houses (modular dwellings).
2. Buildings that use neither electricity nor fossil fuel.

SECTION CC102 DEFINITIONS

CC102.1 Definitions.
The definitions contained in this section supplement or modify the definitions in the International Energy Conservation Code.

ADJUSTED OFF-SITE RENEWABLE ENERGY. The amount of energy production from offsite renewable energy systems that may be used to offset building energy.

BUILDING ENERGY. All energy consumed at the building site as measured at the site boundary. Contributions from on-site or off-site renewable energy systems shall not be considered when determining the building energy.

ENERGY UTILIZATION INTENSITY (EUI). The site energy for either the baseline building or the proposed building divided by the gross conditioned floor area plus any semiheated floor area of the building. For the baseline building, the EUI can be divided between regulated energy use and unregulated energy use.

OFF-SITE RENEWABLE ENERGY SYSTEM. Renewable energy system not located on the building project.

ON-SITE RENEWABLE ENERGY SYSTEM. Renewable energy systems on the building project.

RENEWABLE ENERGY SYSTEM. Photovoltaic, solar thermal, geothermal energy and wind systems used to generate energy.

SEMIHEATED SPACE. An enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h × ft2 of floor area but is not a conditioned space.

ZERO ENERGY PERFORMANCE INDEX (ZEPIPB,EE). The ratio of the proposed building EUI without renewables to the baseline building EUI, expressed as a percentage.

SECTION CC103
MINIMUM RENEWABLE ENERGY

CC103.1 Renewable energy. On-site renewable energy systems shall be installed, or off-site renewable energy shall be procured to offset the building energy as calculated in Equation CC-1.

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

where:
RE_{onsite} = Annual site energy production from on-site renewable energy systems (see Section CC103.2).
$RE_{offsite}$ = Adjusted annual site energy production from off-site renewable energy systems that may be credited against building energy use (see Section CC103.3).
$E_{building}$ = Building energy use without consideration of renewable energy systems.

When Section C401.2.1(1) is used for compliance with the International Energy Conservation Code, building energy shall be determined by multiplying the gross conditioned floor area plus the gross semiheated floor area of the proposed building by an EUI selected from Table CC103.1. Use a weighted average for mixed-use buildings.

When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the International Energy Conservation Code, building energy shall be determined from energy simulations.

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

Building Area Type	**kBtu/ft² – yr**
Healthcare/hospital (I-2)	126
Hotel/motel (R-1)	77
Multiple-family (R-2)	53
Office (B)	33
Restaurant (A-2)	589
Retail (M)	60
School (E)	44
Warehouse (S)	32
All others	63

CC103.2 Calculation of on-site renewable energy.
The annual energy production from onsite renewable energy systems shall be determined using the PVWatts software or other software approved by the code official.

CC103.3 Off-site renewable energy.
Off-site energy shall comply with Sections CC103.3.1 and CC103.3.2.

CC103.3.1 Qualifying off-site procurement methods.

The following are considered qualifying off-site renewable energy procurement methods:

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

CC103.3.2 Requirements for all procurement methods.

The following requirements shall apply to all off-site renewable energy procurement methods:

1. The building owner shall sign a legally binding contract to procure qualifying offsite renewable energy.
2. The procurement contract shall have duration of not less than 15 years and shall be structured to survive a partial or full transfer of ownership of the property.
3. RECs and other environmental attributes associated with the procured off-site renewable energy shall be assigned to the building project for the duration of the contract.
4. The renewable energy generating source shall include one or more of the following: photovoltaic systems, solar thermal power plants, geothermal power plants and wind turbines.
5. The generation source shall be located where the energy can be delivered to the building site by the same utility or distribution entity, the same independent system operator (ISO) or regional transmission organization (RTO), or within integrated ISOs (electric coordination council).
6. The off-site renewable energy producer shall maintain transparent accounting that clearly assigns production to the building. Records on power sent to or purchased by the building shall be retained by the building owner and made available for inspection by the code official upon request.

CC103.3.3 Adjusted off-site renewable energy.

The process for calculating the adjusted off-site renewable energy is shown in Equation 2.

$$RE_{offsite} = \sum_{i=1}^{n} PF_i \times RE_i = PF_1 \times RE_1 + PF_2 \times RE_2 + \ldots + PF_n \times RE_n$$

(Equation CC-2)

where:

$RE_{offsite}$ = Adjusted off-site renewable energy.

PF_i = Procurement factor for the i^{th} renewable energy procurement method or class taken

from Table CC103.3.3.
RE_i = Annual energy production for the i^{th} renewable energy procurement method or class.
n = The number of renewable energy procurement options or classes considered.

TABLE CC103.3.3
DEFAULT OFF-SITE RENEWABLE ENERGY PROCUREMENT METHODS, CLASSES AND COEFFICIENTS

CLASS	PROCUREMENT FACTOR (PF)	PROCUREMENT OPTIONS	ADDITIONAL REQUIREMENTS (see also Section CC103.3.2)
1	0.75	Community Solar	-
		REIFs	Entity must be managed to prevent fraud or misuse of funds.
		Virtual PPA	-
		Self-owned off-site	Provisions shall prevent the generation from being sold separately from the building.
2	0.55	Green retail tariffs	The offering shall not include the purchase of unbundled RECs.
		Direct access	The offering shall not include the purchase of unbundled RECs.
3	0.20	Unbundled RECs	The vintage of the RECs shall align with building energy use.

State of Vermont
Agency of Administration
109 State Street
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[fax] 802-828-2428

Kristin L. Clouser, Secretary

INTERAGENCY COMMITTEE ON ADMINISTRATIVE RULES (ICAR) MINUTES

Meeting Date/Location: October 10, 2022, virtually via Microsoft Teams
Members Present: Chair Douglas Farnham, Brendan Atwood, Diane Bothfeld, Jared Adler, Jennifer Mojo, John Kessler, Diane Sherman, Michael Obuchowski and Donna Russo-Savage
Minutes By: Melissa Mazza-Paquette

- 2:01 p.m. meeting called to order, welcome and introductions.
- Review and approval of minutes from the September 12, 2022 meeting.
- No additions/deletions to agenda. Agenda approved as drafted.
- No public comments made.
- The following emergency rules were supported by ICAR Chair Farnham *(note the summaries may be found on the agenda)*:
  - Transitional Housing Program Emergency Rules, Agency of Human Services, Department for Children and Families, on 09/22/22
  - The Board of Medical Practice Emergency Rule, Agency of Human Services, Department of Health, on 09/30/22
  - PUC Emergency Rule 2.500 COVID-19 Emergency Procedures, Public Utility Commission, on 09/30/22
- Presentation of Proposed Rules on pages 3-9 to follow.
  1. Licensing Regulations for Foster Homes in Vermont, Agency of Human Services, Department for Children and Family Services, page 3
  2. Telehealth, Agency of Human Services, page 4
  3. Prosthetic and Orthotic Devices, Agency of Human Services, page 5
  4. Podiatry Services, Agency of Human Services, page 6
  5. Transplantation Services, Agency of Human Services, page 7
  6. Vermont Commercial Building Energy Standards, Department of Public Service, page 8
  7. Vermont Residential Building Energy Standards Amendments, Department of Public Service, page 9
- No other business.
- Next scheduled meeting is November 14, 2022 at 2:00 p.m.
- 3:47 p.m. meeting adjourned.

Proposed Rule: Vermont Commercial Building Energy Standards, Department of Public Service
Presented By: Ben Civiletti, Barry Murphy, Kelly Launder and Keith Levenson

Motion made to accept the rule by Diane Sherman, seconded by Brendan Atwood, and passed unanimously with the following recommendations:

1. Provide the year when referring to the ICC standards.
2. Proposed Filing Coversheet, #8: Include the date when the update occurred, what was updated, what is being done beyond the ICC, and explain the importance. Clearly identify that this is the Commercial rule – as it's written now, it's the same as the Residential rule.
3. Proposed Filing Coversheet, #12: Provide an overview of the cost and benefit. Define 'modest'.
4. Economic Impact Analysis, #3: Clarify units and title in the chart, and include references and footnotes.
5. Define acronyms early and often.
6. Economic Impact Analysis: Include parallel data to ICC.
7. Economic Impact Analysis: Clearly identify who benefits from the economic impacts. Perhaps include a narrative separating the affecting parties.
8. Environmental Impact Analysis, #9: Identify the sources of information used and the analysis done.
9. Administrative Procedures
10. Public Input Maximization Plan, #4: Remove duplicates.

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VERMONT
DEPARTMENT OF PUBLIC SERVICE

Louise Corliss
Office of the Secretary of State
1078 Route 2, Middlesex
Montpelier, Vt. 05633-7701

May 2, 2023

Legislative Committee on Administrative Rules
c/o, Legislative Council
Vermont State House
Montpelier, VT 05633-5301

RE: Vermont Commercial Building Energy Standards Rule Responsiveness Summary

Attached please find the responses of the Public Service Department ("Department") to comments and suggested changes (summarized in the document) received during the public comment period for the Commercial Building Energy Standards ("CBES") rule. Each comment received by the Department (in full) is also included in its filing.

As discussed in the Economic Impact Analysis section of the rule documents, modifications to the 2023 CBES since the initial filing with the Secretary of State on 10/27/2022 ("Proposed Rule Filing") were made to mirror changes to the proposed 2023 Residential Building Energy Standards ("RBES") filing to maintain parity between the building envelope requirements for multifamily construction. As described in the 2023 RBES filing, these changes were necessary after the 2020 code reference home used in the model for comparison to the proposed 2023 code was changed to better reflect a 2020 RBES-compliant home and cost estimates were updated based on feedback from stakeholders. The changes enacted in CBES were: 1) window U-factor requirements changing from 0.27 back to the former 2020 RBES value of 0.30 (see Chapter 4, Table R402.1.2.1); and 2) wall U-factor requirements changing from the value of 0.033 back to the former 2020 CBES value of 0.042 (See Chapter 4, Table C402.1(3)). These changes reduced the overall cost associated with complying with the Residential Building components of CBES and had an overall positive impact on payback and return on investment.

The Department also made other changes based on specific public comments, as noted in the attached summary of public comments and PSD responses.

The issue of code compliance and enforcement was a reoccurring topic during the lengthy stakeholder engagement process that the Department undertook to update this rule. It is not within the Departments purview to make the changes proposed by stakeholders, as compliance and enforcement requirements are embedded in statute. The core reason stated for wanting some level of enforcement and compliance was to 'level the playing field' by ensuring that all those involved in construction follow the law as described in this rule. Another related recommendation was to have code officials who can review technical plans and drawings prior to construction to ensure that the proposed structure meets the rule's requirements.

Please contact me if you need any additional information or clarification on this item.

Regards,

Barry Murphy
Energy Program Specialist,
Energy and Efficiency Resources Division
Public Service Department
Barry.Murphy@vermont.gov

Date	Name	Organization	Section	Comments	PSD Response	Decision and Resulting Changes Made
11/1/2022	Walt Adams			At the last committee meeting the idea that there would not be insulation under the floor anymore in the new code was introduced by Mr. Faesy. I asked about the justification for that and was told he would forward it to me. I have asked twice more and haven't even received a response. I used my building modeler on a soon to be constructed 55,000 sf warehouse building with the following results: 1.Based on 2020 CBES without section 406 EUI 25.796 2.Based on Proposed 2023 without 406 EUI 27.369 3.Based on Proposed 2023 and R10 slab EUI 23.015 4.Actual building design EUI 19.206 Envelope is 40% better than 2020 code(at least 10 points in 406) Electrical use is 10% less than 2023, and Ngas use 30% less than 2023 code	Comments and discussions during the update process indicated that this was not cost-effective for buildings with large footprints, and could have counter intuitive impacts to climate being maintained within the structure.	PSD now only requires under slab insulation for heated slabs. This is consistant with the current IECC.
12/1/2022	Kevin Dennis			On the CBES side, DFS reviews drawings for life safety compliance. Their expertise is in life safety, not energy. Again, while design professionals are voluntarily demonstrating compliance, there is no review or enforcement of energy code.	This is an enforcement issue. DFS are looking for acknedgement that the CBES was taken into consideration when designing the building, they are not checking for compliance.	This is outwith the PSD remit of updating the code.
11/8/2022	Paul Conner	City of South Burlington		That the Residential and Commercial codes require that buildings and roofs be oriented to maximize solar potential and to require that solar ready zones on new commercial buildings be required to have solar PV systems that reasonable maximize those solar ready zones.	Building orientation is somewhat outside of scope for CBES. That would more fall within the jurisdiction of the local planning office or zoning administrator.	No Change was made to require specific building orientation.
11/7/2022	Rob Pickett	RobPickett &Associates, LLC		...these two attachments reflect the work done in the ICC Energy Standards Committees. These two public comment drafts present a different minimum specification for the building thermal envelope that had been published in the 2021 IECC/IRC Ch. 11. Based on my participation on the VT Stakeholders calls, I believe that what has happened in the ICC residential energy standard reflects the comments of builders in VT. For example, the minimum requirement for Climate Zone 6 roof insulation has been reduced from R60 to R49. I propose to the Energy Code Update Team that the RBES that has been developed works great as a Stretch Code, but the base energy code needs to be a realistic minimum level similar to that in the attached draft.	This comment is referencing RBES and not CBES, however the R-49 references is set as a minimum with potetial points availible for going further. However going from R-49 to R-60 is not cost-effective as per PSD modeling.	No change made to CBES.
12/1/2022	Walt Adams			Include a definition of "net zero ready" in RBES and CBES.	The PSd is still developing a definition of 'netzero ready' for commercial buildings. The issue is that diffeent buildig types and uses would have a different application of the term.	No change made to CBES.
12/1/2022	Walt Adams			Unheated Under Slab insulation: Imaging that you built a building in an environment where the temperature was always 50F. Would you not insulate that building? For most of the building shell the heat loss varies based on the exterior temperature. However the soil under the floor is always about 50F so the heat loss into the space is the same on May 5th as it is on January 10th. And it doesn't make any difference where that square foot of floor is, near the outside wall or in the center of the building for slab loss. For most single story buildings the floor heat loss uninsulated will be about 18-20% of the heat loss of the rest of the envelope. You can reduce it to under 8% with R10 insulation. However if you air condition you will lose the cooling effect of the floor so you will have to add .1 tons of capacity for every 1000 square feet of floor. The average Burlington VT temperature is 45F. However we don't insulate our buildings for that, we insulate for the extremes of -9F and 95F.	This is a similar comment made by the participant earlier referening to underslab insulation.	No Changes made.

12/1/2022	Walt Adams			Duplex outlet control: The cost benefit ratio for two items proposed it the new code are clearly not worth it. The first is controlled duplex outlets. My clients cringe when I bring this up and I worry about the cost to install compared to the savings. Computers today use significantly less energy than they used to and when shut off thru software, or go into sleep mode, preserve you current work. If you leave it on and shut the power off most computers get very unhappy and they don't preserve any open work. Desk lamps are, if installed are mostly Led and are very low wattage. It would seem that the only thing left is small electric heaters and it would be easier and much cheaper to require then, if they exist, to have an occupancy sensor so they would not run unless there was someone to heat. When modeling a space the closed hours have 10% of the duplex outlet load of the open. So what we're talking about controlling is that 10% not the 100%.	this is in reference to section C406.1.2 renewable and load management.	PSD reviewed this section and offered a method to bypass these requirements if sufficent points were accrued in C406.1.1
11/13/2022	Walt Adams			Long term open door controls: Door controls that notice when a door is open more than 15 minutes and effect the set points of the local HVAC equipment. I have asked for the cost of this equipment, so I can compare it to any potential savings. In Vermont the penalty for leaving a door open, especially in the winter, is significant, from a work environment stand point, that's why you don't see it. So what's the point of this complex arrangement, and how do you decide what the savings will be. And over time these systems will fail and there will be no incentive to fix them because the added fuel cost is so low and the cost to fix is so high. If a client had a door he wanted to leave open they would have to comply with this, (think Costco), even if they installed air curtains? And did Costco get an exemption from the vestibule standards, oh right the door opens into a space bigger than 3000 sf, so none required. Perhaps it was argued that these warehouse store building are such energy hogs that those open doors don 't really matter.	This refers to a requirement for mechainal interlocks on the heating system to prevent heat loss due to a open loading door or other large door. It would have required the heating system to stop heating that space for the duration the door was open.	Given the difficulty in implimenting this the PSD removed this requirement. However it should be noted that is requirement is likely to be included in the IECC 2024 and will come back up for discussion in the next update.
11/17/2022	Erin DeSantis	American Chemistry Council		Our members produce products for the whole of the U.S. market and in some cases have a global presence as well. This includes but is not limited to plastic building materials like foam plastic board insulation, spray foam insulation and air sealants, house and building wraps, liquid applied water resistive barriers, plastic pipe, plastic glazing, and roof membranes. These products provide a wide range of benefits including thermal, air, and moisture management. ACC has concerns with the proposed amendments to Vermont CBES and RBES that give preference to low embodied carbon insulation materials. If adopted, this would be a significant expansion of the energy code; no other state has adopted any mandated or optional points for low embodied carbon insulation materials. We encourage the consideration of the following information: All materials require an investment of carbon to produce them including those with high embodied carbon like concrete, steel, and glass. However, only some materials provide carbon savings benefits during the operational life of the building like insulation and air barriers. The building and construction sector accounts for 37 percent of global carbon emissions. Embodied carbon accounts for 10 percent while building operations account for 27 percent of emissions of those emissions.1 Building materials like concrete, steel, and glass account for the largest portion of the embodied carbon. Cement, steel and glass are the next highest contributors, which means insulation makes up an extremely small portion of a building's embodied carbon. Despite its relatively small percentage in overall building embodied carbon impact, insulation		

12/8/2022	Erin DeSantis (cont.)	American Chemistry Council		Insulation products offer significant savings with a minor impact on the building's embodied carbon profile. The preference for low embodied carbon insulation could lead to improper product selection and negatively impact the operation carbon use of the building. Insulation materials provide important benefits beyond thermal protection like air sealing and vapor management which are beneficial to a building's overall performance. Insulation manufacturers have been optimizing their products to lower their carbon footprints for many decades. They have also been very transparent, and Environmental Product Declarations (EPDs) are available for most products. • We support a whole building approach that includes operation carbon benefits and product transparency. • We believe that manufacturers that have been optimizing the carbon intensity of their products should be rewarded rather than disincentivized from doing the right thing. • We believe Vermont should recognize product contributions to operational carbon savings. • We believe insulation choice should not be limited by this policy as insulation products save more carbon and energy than it takes to produce them.3		
12/8/2022	Erin DeSantis (cont.)	American Chemistry Council		ACC members have been making great progress in lowering their embodied carbon emissions. Their innovative and durable building materials enable greater carbon savings over their service life than it takes to produce them. Their progress has also minimized the difference in CO2 emissions between different insulation products.4 A recent report by McKinsey & Company also demonstrates the carbon benefits of plastic building materials in comparison to alternative products. In fact, this report shows that in most cases plastic materials provide lower total GHG emissions over their life. This climate-related benefit commonly associated with the use plastics, including plastic construction materials, is further detailed in McKinsey's report.5 Insulation manufacturers have been providing transparency information for the industry in the form of Environmental Product Declarations (EPDs) that provide CO2 embodied carbon emissions data for over a decade. This data was not intended for comparison purposes. If it is used in this manner, it is important for users to be educated regarding the limitations of comparisons as well as the tools and data sources they are using. Unfortunately, many tools do not accurately account for industry improvements in a timely manner or follow standard guidance for comparing products. They often allow products with different baseline assumptions and utilize different Product Category Rules. They also often include comparisons between industry and product specific EPDs, etc.		

12/8/2022	Erin DeSantis (cont.)	American Chemistry Council		Due to the above concerns, we recommend that total carbon accounting be used to understand the full impact different products have over the life of the building. We do not recommend providing incentives for embodied carbon as a single attribute that could lead to regrettable substitutions. Embodied carbon decisions should not be made prior to considering the other primary and necessary functions of building materials like their ability to eliminate other products, mitigate air leakage, manage moisture, etc. Operational offsets must be considered. Decoupling the embodied carbon of products like insulation can have negative effects on building performance and the performance characteristics of the insulation regarding thermal protection, moisture management and air leakage should not be sacrificed for relatively small differences in embodied carbon. ACC along with several other insulation industry associations published a Building Decarbonization Statement of Policy Principles that supports this total carbon or whole building view of the carbon impacts. This is important so that decisions are not made that would affect the building performance (thermal, air, moisture management, etc.). Please see more regarding the Insulation Industry Decarbonization Policy Principles here: Building Decarbonization Statement of Policy Principles (americanchemistry.com)	The proposed CBES does not contain any prohibitions of particular insulation or building materials. The embodied carbon provisions in the proposed code are limited to providing optional points toward compliance in the Prescriptive compliance pathway. Should a builder choose to complete a carbon inventory of insulation products used in a particular home, that inventory can and should contain the default GWP value or values from Type III Productspecific Environmental Product Declaration (EPD), which should accurately reflect the degree to which a particular product has been optimized for carbon intensity.	No Changes made.
12/9/2022	Chris Miksic	Vermont Pasive House		VTPH recommends strongly including the CBES 2030 targets now in the code as an option , as a gold 2030 standard for those Developers that would like to achieve the 2030 target now, only 7 years away.	Defined in RBES as NET ZERO ENERGY READY. A highly efficient and cost-effective building designed and constructed so that renewable energy could offset all or most of its annual energy consumption	Included definiion in C202.
12/9/2022	Chris Miksic	Vermont Pasive House		We strongly advocate that CBES also include and indicate an option for Certified Passive House projects.	Compliance pathways are set in statutory language. The addition of passive house as a compliance option may need a statute change. (this could be explored but not in this update.)	No Action taken.
12/9/2022	Chris Miksic	Vermont Pasive House		VTPH strongly suggests that the State incentives for Passive House Certified Multi-Family housing projects be increased	This is beyond the scope of the update.	Legislative action required.
12/9/2022	Chris Miksic	Vermont Pasive House		VTPH can offer a subsidy up to 50%, to Builders and designers for Passive House training. The VTPH program is for interested professionals who would like to complete PHIUS and PHI consulting and builder certifications .VTPH would like also to integrate/partner with any educational/workforce training/vocational sector opportunities.	Not relevant within the scope of the code update.	No action taken.
12/9/2022	Sandra Vitzthum	Sandra Vitzthum Architect LLC	C101	Sections 109 and 110 are missing. Both are connected, related parts of an integrated administration for all building codes. There is no reason I know of to eliminate them, particularly because they reinforce other building codes and also other sections of this code.	These are administrative sections relating to stop work orders and a board of appeals. Without an enforcement mechanism these are moot. Adding them back in isn't a big deal but could lead to confusion until and unless there is enforcement. Recomending keeping these out.	No Action taken.
12/9/2022	Aaron Gunzner	AMCA International	C403	AMCA does have one recommendation for the current version of CBES, as was mentioned during verbal testimony at the December 2 hearing. In our limited reading of the CBES 2023 Full-Text Redline 9/23/2022 (Current Version), it seems that the inclusion of Fan Efficiency Grade (FEG) reporting requirements in mechanical equipment schedules, such as mentioned on PDF page 28 of 354, should instead be updated to Fan Energy Index (FEI), per other changes drafted in the CBES update.	Agreed.	FEG updated to FEI within the code.
12/9/2022	Isaac Elnecave	Passive House US		Add a Passive House alternative compliance path to commercial and high-rise multifamily projects certified by Phius.	Compliance pathways are set in statutory language. The addition of passive house as a compliance option may need a statute change. Perhaps next update cycle.	Legislation action would be required to impliment this change, no action taken.

12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.		Any proposed VT CBES customizations from the IECC, unless taken from another similar source such as Standard 90.1, should be fully vetted before including.	Most changes suggested come from subject matter experts who submit recommendations to ICC for changes. For the most part sugested changes that occur in CBES are later mirrored in part or full in future versions of the IECC.	No action taken.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.		The VT CBES is generally considered to be unenforced, and public feedback throughout the last few updates has continued to be that this needs to change for the Code to be effective. Recognizing that this implementing enforcement is complicated and beyond the scope of the update process, the fact that enforcement doesn't exist should be taken into account when considering modifications to the Code.	Updates to the code are on a recommended trajectory to achieve net-zero ready construction. Enforcement of the code is a legislative matter as it was removed by that body from the authorty granted to the PSD.	No Action taken.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.		The cost effectiveness of requirements which exceed those in the IECC or Standard 90.1 should be clearly proven before implementing.	Most changes suggested come from subject matter experts who submit recommendations to ICC fir changes. For the most part sugested changes that occur in CBES are later mirrored in part or full in future versions of the IECC.	No Action taken.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.		Experience by many local practitioners demonstrates that above-deck roof insulation beyond that required in the IECC/90.1 is not cost-effective.	Above deck insulation requirements have not changed and are almost exactly the same as those in the draft 2024 IECC.	No actionn taken.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.		For slab-on-grade insulation in particular, little energy impact can be demonstrated in the difference between the IECC/90.1 requirements and anything beyond them due to ground heat and the thermal resistance capacity of soil.	We took this into consideration when we removed the underslab insulation requirements for unheated slabs.	underslab insulation requiments for unheated slabs removed.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Electric Resistance Space Heating (C403.2.3)	The historical exception for "replacement of electric resistance unit" appears to have been removed, however the justification is not clear.	language wll be checked but existing "approved" resistence heaters are still allowed to be replaced.	Language allowing replacement of existing electrical heaters still in place.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Heating and Cooling Equipment Sizing (C403.3.1)	Text regarding heat pump sizing has been added to the proposed VT CBES. This requirement states that "equipment shall not be sized greater than the calculated peak heating and cooling loads". Given that equipment is not available in an infinite amount of capacities, text similar to that within the main requirement ("to the next nearest available size") should be used.	Agreed. This should be added to the redline.	lanaguage added.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Economizers (C403.5)	The basis for the requirement exempting "VRF system installed with a dedicated outdoor air system" is not clear. It is understood that this exception is not VT custom, is included in the IECC, but is not in Standard 90.1.	This exemption pertains to the VRF system portion of a system with DOAS. The economizer is addressed in the DOAS section of the code.	No action required.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Nontransient Dwelling Units (C403.7.4.1)	The proposed VT CBES has been customized from the IECC to included recovery requirements at cooling design condition, and increases both cooling and heating recovery effectiveness minimum thresholds from 50 to 60% and 60 to 70% respectively. Have these thresholds been determined to be achievable with commercially available equipment, particularly the cooling threshold? Or at a minimum, is equipment meeting these thresholds been proved to be cost effective?	We have verified equipment is available and have conducted cost-effectiveness modeling which has proven it is cost-effective.	No action required.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Automatic Control of HVAC Systems Serving Guestrooms (C403.7.6)	Temperature reset is required for guestrooms, however zones served exclusively by cold-climate heat pumps are generally exempt from off-hour controls by the proposed VT CBES customized requirement in C403.4.2. Are these controls required for cold-climate heat pumps serving guestrooms? If not, maybe this should be added to C403.7.6.	The reason we didn't add this exemption to guestrooms is that these rooms could be unrented for long periods of time, but it probably makes sense to be consistent and add this language to C403.7.6.	Language added.

12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Fan Airflow Control (C403.8.6)	The proposed VT CBES have been customized from the IECC regarding duct located in a conditioned space - this is understood to be intended to apply to untreated air. It appears that rather than replacing the existing requirement for duct located within a building envelope assembly (a different location than a conditioned space), the modification should be in addition to the existing requirements.	Reviewed section C403.8.6 and no edits took place to the existing language	No action taken.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Duct and Plenum Insulation and Sealing (C403.12)	This new CBES requirement is understood to be included in both the IECC and Standard 90.1 and not custom to the CBES. However, has the actual effectiveness of this requirement been demonstrated? From a technical standpoint, it is understood that uncontrolled plug loads consume a considerable amount of energy and should be a target for energy reduction. From a practical standpoint, it seems like if a user values minimizing energy use, they either manually control their device or set up automated control on the device, resulting in a controlled receptacle providing no value.	Measures contained within the IECC and 90.1 undergo a rigorous process including cost-effectiveness before becoming part of the standard.	No Action taken.
12/9/2022	Nicholas Thiltgen	DuBois & King, Inc.	Additional Electric Infrastructure (C405.14)	Is the intent of this requirement to add a burden to install fossil fuel heating equipment so it is not chosen, or to add necessary infrastructure for future electric heating equipment? If the former, it seems like it would mostly apply to buildings with R-2 occupancy classifications which are exempt but where reasonable alternatives are available and many are already using non-fossil fuel equipment. Other occupancies have less desirable electric options for some end-uses at the moment and projected near future.	The intent of the requirement is to future proof the trend towards heat pump and other electrification technology so that buildings would have an option to choose fossil or electric tech in the future. The wording comes from an NBI proposal for the 2024 IECC and was passed unanimously by an IECC subcomittee. This would apply to all space heating and water heating buildings.	No Action taken.
12/9/2022	Jonathan Dowds	Renewable Energy Vermont		support of the EV readiness standards in the proposed updates to the CBES and RBES.		No action required.
12/9/2022	Emily Kelly	ChargePoint		ChargePoint applauds the Vermont Department of Public Service for the strong inclusion of EV Ready parking requirements and standards in both versions of the building energy standards. To support the adoption of EVs, it is critical that drivers have access to convenient places to charge. Most charging occurs at home, and access to home charging is a key factor in determining whether households will adopt an EV as their next vehicle. EV Ready codes promote new residential, multi-family, and commercial buildings to expand breaker panels, lay conduit, and wire through a raceway to parking spots based on a percentage of parking. This preparation for electric vehicles enables a site to reduce costs, complexity, and disruptive construction by incorporating EV-ready infrastructure at time of construction rather than during retrofits.		No action required.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.	C401.2.1.2	C401.2.1.2 replaces the equation for PCIt with an equation that appears to include process (plug, etc.) loads in the overall equation, even though these are not directly regulated by the code elsewhere and this is not standard modeling practice with fewer guidelines for baseline or reasonable targets. Recommend deleting this equation change.	the largest uncontrolled load in a builing is currently plug (process) loads. The intent of this equation is to beging addressing these loads.	No action taken.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.	C406	C406 the improvements are good, but a bit of rearranging the deck chairs on the Titanic. Primary challenge with this section is trying to define around the myriad of building types and overall good planning goals for broadly multi-use buildings which flexibly change use in the future. In combination with lack of understanding and enforcement I believe this section should not be relied upon to justify energy performance improvements over the remainder of	Enforcement is outside the authority of the PSD.	No action taken.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.	C406	C406 needs better guidance on how to handle multi-use buildings. For example, from a building code standpoint a new school is typically occupancies B, A-2, A-4, and E at least. Is this intended to fall into the All Other category? By space allocation it may not typically have more than 50% of the space in any one of these categories.	Mixed use buildings are defined either as 'other' or by space allocation.	No action taken.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.	C402.1(1)	C402.1(1) on recent large commercial/institutional projects where we have modeled insulation beyond the current R-20ci level for a metal framed wall the payback has not consistently been worthwhile. Strongly recommend not raising insulations levels as proposed in this table and instead informing legislature that economical path to Net Zero would involved addressing energy production side rather than overly tightening these numbers to force expensive solutions that don't perform significantly better than current construction.	Overall PSD modeling shows cost effectiveness for this change.	No action taken.

12/9/2022	Brian Leet	Freeman French Freeman, Inc.	C402.1(1)	C402.1(1) change to remove requirement for full underslab insulation is very good. On a recent project initial energy modeling revealed that this approach would save the project over $200,000 in construction costs while simultaneously lowering predicted energy use.		No action required.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.	C402.3	C402.3 why should storefront as a product get an exception? This exception is an acknowledgement that the standard is exceeding affordable and feasible solutions across the range of acceptable construction products. Recommend instead informing legislature that economical path to Net Zero would involved addressing energy production side rather than overly tightening these numbers to force expensive solutions that don't perform significantly better than current construction.	Availibility of materials and costs are driving this change. Increases apparently can not be cost effectivly implimented.	No action required.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.		What is basis of support for exemplary lighting solutions being achievable with 15% less LPD? Based on input from trusted lighting designers, this may overly constrain projects and there is no viable alternative approach for this issue short of full project energy modeling. Recommend not making these changes out of line with national standards	National standards excess LPD as they still include florecent and other types of lights. These standards are focused on LED capacity.	No action taken.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.		EV Charging Parking Spaces – it would help to have multi-use/occupancy guidance for this as well. Likely tied to zoning definitions of requirements for parking. EV capable spaces seems very high for non-residential parking lots. Even just putting conduit in place becomes very pricey at scale. Is this based on any data or state or national plan for approach to charging stations?	The EV capable spaces used within CBES is lower than those proposed in the 2024 IECC.	No changes made.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.		Operable Openings Interlocking – recommend adding an exception similar to the third bullet point for double doors which are primarily used for egress. This standard impacts any typical 6'x7' double door condition and could be very challenging to implement with many mechanical systems causing significant additional costs out of proportion with energy savings.	Agreed this is problimatic to impliment currently.	Language removed.
12/9/2022	Brian Leet	Freeman French Freeman, Inc.		It would be helpful to publish the data on Automatic Receptacle Controls identifying the benefits, documented savings relative to costs and successful use by occupants of space throughout all building types.	Plug loads are the larest single remaining uncontroled load in most buildings. This is taken from an approved ammendment to the 2024 IECC which has been vetted by Industry proffessionals.	No change made
12/9/2022	Jeff Stetter	Pella Architectural Consultant	Table C402.3	Table C402.3 Building Envelope Fenestration Maximum U-Factor and SHGC Requirements •How is storefront defined? Pella often utilizes our fiberglass line Impervia for storefronts. We can factory glaze or site glaze, so having a definition associated with glazing location doesn't really make much sense (if that is the approach).	Definition in redline: "STOREFRONT. A system of doors and windows mulled as a composite fenestration structure that has been designed to resist heavy use. Storefront systems include, but are not limited to, exterior fenestration systems that span from the floor level or above to the ceiling of the same story on commercial buildings, with or without	No action required.
12/9/2022	Jeff Stetter	Pella Architectural Consultant	Table C402.3	•Ramifications of a .27 U-Value Requirement for Operable Fenestration for R2. oWith the proposed .27 requirement most, if not all, Aluminum Clad Wood Windows will require switching to a glazing package which includes an additional interior coat of Low-E. Depending on the line of windows, this can increase the overall window cost between 9-16%. These are real numbers. To change to triple pane windows would increase the base cost between 38-46%. oThe glazing package that requires an additional interior coat of Low-E lowers the interior surface temperature of the glass, and thus decreases the window's resistance to condensation. oVinyl windows can typically meet the standard without any increase in cost. oFiberglass windows have fewer options to meet the new standard without triple pane and typically will have increased cost.	To align with RBES, this has reverted to U 0.30.	Opreable fenestration requirements reverted back to U-0.30 for multifamily R2, to align with RBES.
12/9/2022	Charlie Willner	evernorth		Add " - FOR ALL USES EXCEPT MULTIFAMILY" after ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE).		Specific exemption included in test for multifamily buildings.

12/9/2022	Charlie Willner	evernorth		Add new definition: "ELECTRIC VEHICLE CHARGING - LEVEL 2 CAPABLE (MULTI-FAMILY): provide appropriate sized pathway to the building electrical room to accommodate a future electrical upgrade for Level 2 EVSE electric vehicle charging; provide adequate wall and floor space in the building electrical room for future EV charging related electrical equipment; provide the appropriate sized pathways to exterior on-grade surface parking spaces for future Level 2 EVSE electric vehicle charging; if the building includes garage or covered parking, provide a line diagram on the electrical drawings demonstrating a pathway for future Level 2 EVSE electric vehicle charging. Quantity of future Level 2 EVSE electric vehicle charging stations shall be as required by Table R404.3."		R-2 occpancies have has language similar to that proposed implimented.
12/9/2022	Charlie Willner	evernorth	C402.5.1	The solar ready provisions do not apply to multifamily buildings in RBES, but does apply to multifamily buildings in CBES. It should either apply to multifamily buildings in both or neither.	While alignement between RBES and CBES for multifamily construction is desired certain requirements will differ.	No changes made.
12/9/2022	Charlie Willner	evernorth	C405.6	This language should be clarified and aligned with the corresponding RBES (R404.5) language. We suggest both codes read "Exception: Buildings where a majority of the living units serve tenants at or below %80 percent of area median income."	Agreed	Language added.
12/9/2022	Charlie Willner	evernorth	C405.12	Add Exceptions: R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet of conditioned floor area.	Agreed	Language added
12/9/2022	Charlie Willner	evernorth	C405.13	405.13 Electric Vehicle Power Transfer Infrastructure Table C405.13.1: delete Equation 4-11 and replace with the requirement to "provide EV Capable spaces at 25% of the parking spaces provided for the multifamily development. Note that EV Capable requirements vary according to whether spaces are in a garage/covered versus exterior on-grade spaces (see DEFINITIONS)." C405.13.2: modify this Section so as to be consistent with the new definitions of EV Capable spaces as suggested above.	number of spaces remains consistant it is up to the building where these spaces are deployed.	Definitions between RBES and CBES syncronized. Specific exemptions for multi-family to EV requirements included.
12/9/2022	Charlie Willner	evernorth	C405.14.1.1	Item 2 appears to require that a complete circuit (breaker, wiring, termination) be installed. If this section was changed to require space in the panel and conduit from the panel to the future equipment location the intention (facilitate future transition to Heat Pump technology) will be preserved while reducing current cost burden to the building owner.	Language wll be checked but existing "approved" resistence heaters are still allowed to be replaced.	Language for high capacity heating clarified to show that the high capacity heating requirement only requires conduit, no wire or breaker.
12/9/2022	Charlie Willner	evernorth	C405.14.2.1	Item 1 appears to require that a complete circuit (breaker, wiring, termination) be installed. If this section was changed to require space in the panel and conduit from the panel to the future equipment location the intention (facilitate future transition to Heat Pump technology) will be preserved while reducing current cost burden to the building owner	Agreed	Language updated to reflect conduit ony approch.
12/9/2022	Charlie Willner	evernorth	C405.14.4.2	C405.14.4.2 Residential drying Rather than require a complete circuit be installed we request only installation of conduit and space in the electrical panel for future circuit installation.	Agreed	Language updated to reflect a conduit only approch
12/9/2022	Charlie Willner	evernorth	C406.1.1	C406.1.1 + C406.1.2 These code section mandate additional energy efficiency requirements. This is a similar section in RBES (402.1.2.2), but the RBES requirements mandate different point values based on the average living unit size in multifamily buildings. We request that a similar provision (points required are scaled to average living unit size) be applied in multifamily buildings that are built under CBES. The current point values should apply to the largest unit size category created. This is consistent with the Departments stated goal to align the RBES/CBES requirements for multifamily buildings.	This approch is no easily implimentable withn CBES without creating a separate multifamily chapter.	No changes made.

12/9/2022	Charlie Willner	evernorth	C406.2.1.3	C406.2.1.3 E03 Reduced air leakage "Energy credits shall be achieved where tested building air leakage is **not** less than .15 cmf/ft2….." The bolded "not" should be deleted from this code section if the intent is to incentivize tight building construction. These points do not appear to apply to R-2 type occupancies less than six stories, as the baseline air leakage rate in this type of building is .15 cfm/ft2 @ 50pa. Please provide an	Agreed	Change made.
12/9/2022	Charlie Willner	evernorth	C407.1.1	407.1.1 Qualifications, subsection 2. "Be an independent third-party entity. The commissioning authority shall not be an employee of the design team, construction team, owner or developer." We recommend striking 'owner or developer'. We understand the importance of the commissioning provider being independent of the construction team, however we believe that as long as the provider is qualified, they could be an employee of the owner or developer. The owner/developer's incentives are aligned with the intent of this requirement. As owners/developers, we want our systems to function properly, meet the design requirements. Furthermore, the 2020 CBES requirement varies from other standards; for example LEED NC allows the CxA to be a qualified employee of the owner (but not a member of the construction/design team).	PSD feels its language on who qualifies as a commissioning ageent is broad and would include the example meanton in the comment.	No change made.
12/9/2022	Charlie Willner	evernorth	C403.2	Suggested Addition to C403.2. We suggest adding a subsection to C403.2 with language similar to the following: "Hydronic heating systems and associated equipment shall be sized for and operated at a maximum heating hot water temperature of 140F." One goal of this requirement is that it ensures that condensing boilers will actually condense and operate at higher efficiencies. Many boiler systems have constant primary pumps, which means that at part-load conditions the delta-T across in the primary loop is very low and the boiler will not condense if the supply water temperature is above 140F. The second goal of this requirement is to future-proof buildings for electrification. Air-to-water heat pumps struggle to provide hot water over 140F. If a building's hot water coils, radiators, etc. are designed to operate at 180F, they would all need to be replaced in order to electrify a building in the future (assuming the building would heat the hydronic loop with heat pumps).	We concur with this statement and will add this to the redline.	language added to C403.2
12/9/2022	Charlie Willner	evernorth	C403	Suggested Additional to C403; Sequence of Operations (SOO). Evernorth has had challenges getting a SOO for projects, receiving generic SOOs, and/or receiving SOOs after the project is constructed. This challenge makes it difficult to have our buildings set up as efficiently as we would like them. To that end, we suggest requiring that Construction Drawings include a Sequence of Operations for all mechanical equipment. CBES 2020 C406.4.5 requires a SOO for lighting controls, but we do not believe there is a comparable requirement for mechanical systems. Proposed additional to C403: "Construction documents shall include submittal of a	We concur with this statement and will add this to the redline.	Language updated.
12/9/2022	Charlie Willner	evernorth	C403.7	Suggested Additional Requirement to C403.7 relating to dehumidification in Energy Recovery Ventilation Systems. We have had several projects with central Energy Recovery Ventilation (ERV) systems that include a dehumidification sequence. The factory control method of dehumidification was to assume that the unit needed to dehumidify whenever the outside air temperature was above 65F (i.e. it used dry bulb temperature to control humidity). This results in the unit subcooling air with a compressor for a significant number of hours when it is not necessary. We suggest that CBES not allow this type of control. Proposed requirement: "For Energy recovery ventilation systems that utilize dehumidification, not fewer than one humidity control device shall be provided for each humidity control system. A humidity control device is a device that measures relative humidity or enthalpy (dry bulb temperature sensors do not qualify as humidity control devices)." Our experience relates to ERVs w/ dehumidification, but it may also make sense to expand this requirement to other heating/cooling equipment, in which case it would likely be an update to C403.4.1.	We concur with this statement and will add this to the redline in both section C403.7 and section C403.4.1. In section C403.1 we will replace 'Energy recovery ventilation systemswith dehumidification" with "HVAC systems with dehumidification".	Language added

12/8/2022	Henry Amistadi	Operations Monitoring and Analytics LLC	TABLE C403.1.2(1	TABLE C403.1.2(1) Maximum DESIGN Mechanical Load Component (Design MLC) is based on the 2016 version of the standard. In the 2019 and proposed 2023 standard, DESIGN MLC pathway has been eliminated. DESIGN MLC was eliminated because it didn't consider part load energy performance of partially filled data centers. Since Design MLC has been eliminated, data centers requirements shouldn't be located in C403.1.1 Calculation of heating and cooling loads. The 2019 and 2023 standard only have Maximum ANNUALIZED MLC. • In the 2019 standard, TABLE C403.1.2(2) Maximum ANNUALIZED Mechanical Load Component (Annualized MLC) table values were updated.	Table should be updated to the 2023 standard, Maximum ANNUALIZED MLC cooling table values.	
12/10/2022	Henry Amistadi	Operations Monitoring and Analytics LLC	C403.5.3	C403.5.3.3 High-limit shutoff. "Air economizers shall be configured to automatically reduce outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will not reduce cooling energy usage. High-limit shutoff control types for SPECIFIC CLIMATES shall be chosen from Table C403.5.3.3". Which device types are recommended for VT?	We will remove "for specific climates" verbiage from VT CBES for clarity.	Language Updated
12/10/2022	Rupal Choksi	Madison Indoor Air Quality (IAQ)	C403.7.4.1 Nontransient dwelling units	For better alignment with the proposed RBES language it is suggested the following changes be made to C403.7.4.1. See attachment for full details. C403.7.4.1 Nontransient dwelling units. Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems with an enthalpy recovery ratio of not less than 60 percent at cooling design condition and not less than 70 percent at heating design condition. Exception: 1. Systems with a minimum sensible recovery efficiency (SRE) of 75 percent at 32°F (0°C), determined in accordance with HVI Publication 920 at an airflow greater than or equal to the design airflow.	Limited change which makes sense.	Language updated

Levenson, Keith

From: Brian Leet <bleet@fffinc.com>
Sent: Sunday, December 4, 2022 10:22 AM
To: PSD - Code Update Comm
Subject: CBES Energy Code Update Comments

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For official comments:

Overall:

Code changes at this point are definitely impacting construction costs and based on energy modeling they are sometimes changes with minimal energy savings relative to the added cost, depending on building overall design, type, occupancy, etc. Legislature should be informed of limitations to this code improvement process including lack of enforcement, lack of ability to regulate certain domains due to federal preemption, and the impossibility of achieving a Net Zero target without clearly defining Net Zero and including energy generation within the same code framework as the building efficiency measures.

--

C401.2.1.2 replaces the equation for PCIt with an equation that appears to include process (plug, etc.) loads in the overall equation, even though these are not directly regulated by the code elsewhere and this is not standard modeling practice with fewer guidelines for baseline or reasonable targets. Recommend deleting this equation change.

--

C406 the improvements are good, but a bit of rearranging the deck chairs on the Titanic. Primary challenge with this section is trying to define around the myriad of building types and overall good planning goals for broadly multi-use buildings which flexibly change use in the future. In combination with lack of understanding and enforcement I believe this section should not be relied upon to justify energy performance improvements over the remainder of the code.

--

C406 needs better guidance on how to handle multi-use buildings. For example, from a building code standpoint a new school is typically occupancies B, A-2, A-4, and E at least. Is this intended to fall into the All Other category? By space allocation it may not typically have more than 50% of the space in any one of these categories.

--

C402.1(1) on recent large commercial/institutional projects where we have modeled insulation beyond the current R-20ci level for a metal framed wall the payback has not consistently been worthwhile. Strongly recommend not raising insulations levels as proposed in this table and instead informing legislature that economical path to Net Zero would involved addressing energy production side rather than overly tightening these numbers to force expensive solutions that don't perform significantly better than current construction.

--

C402.1(1) change to remove requirement for full underslab insulation is very good. On a recent project initial energy modeling revealed that this approach would save the project over $200,000 in construction costs while simultaneously lowering predicted energy use.

--

C402.3 why should storefront as a product get an exception? This exception is an acknowledgement that the standard is exceeding affordable and feasible solutions across the range of acceptable construction products. Recommend instead informing legislature that economical path to Net Zero would involved addressing energy production side rather than overly tightening these numbers to force expensive solutions that don't perform significantly better than current construction.

--

What is basis of support for exemplary lighting solutions being achievable with 15% less LPD? Based on input from trusted lighting designers, this may overly constrain projects and there is no viable alternative approach for this issue short of full project energy modeling. Recommend not making these changes out of line with national standards.

--

EV Charging Parking Spaces – it would help to have multi-use/occupancy guidance for this as well. Likely tied to zoning definitions of requirements for parking. EV capable spaces seems very high for non-residential parking lots. Even just putting conduit in place becomes very pricey at scale. Is this based on any data or state or national plan for approach to charging stations?

--

Operable Openings Interlocking – recommend adding an exception similar to the third bullet point for double doors which are primarily used for egress. This standard impacts any typical 6'x7' double door condition and could be very challenging to implement with many mechanical systems causing significant additional costs out of proportion with energy savings.

--

It would be helpful to publish the data on Automatic Receptacle Controls identifying the benefits, documented savings relative to costs and successful use by occupants of space throughout all building types.

Brian Leet AIA, CSI, LEED AP BD+C (He/Him)
Senior Project Manager

Freeman French Freeman, Inc.
Architecture + Interior Design + Planning

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Levenson, Keith

From: Jeff Stetter <jstetter@pellasales.com>
Sent: Monday, December 5, 2022 3:02 PM
To: PSD - Code Update Comm
Subject: CBES Comments

EXTERNAL SENDER: Do not open attachments or click on links unless you recognize and trust the sender.

Based upon reviewing the slide deck from the CBES 12/2/2022 presentation, I offer the following for consideration:

Table C402.3 Building Envelope Fenestration Maximum U-Factor and SHGC Requirements

- How is storefront defined? Pella often utilizes our fiberglass line Impervia for storefronts. We can factory glaze or site glaze, so having a definition associated with glazing location doesn't really make much sense (if that is the approach).
- Ramifications of a .27 U-Value Requirement for Operable Fenestration for R2.
  - With the proposed .27 requirement most, if not all, Aluminum Clad Wood Windows will require switching to a glazing package which includes an additional interior coat of Low-E. Depending on the line of windows, this can increase the overall window cost between 9-16%. These are real numbers. To change to triple pane windows would increase the base cost between 38-46%.
  - The glazing package that requires an additional interior coat of Low-E lowers the interior surface temperature of the glass, and thus decreases the window's resistance to condensation.
  - Vinyl windows can typically meet the standard without any increase in cost.
  - Fiberglass windows have fewer options to meet the new standard without triple pane and typically will have increased cost.

I am the Architectural Representative for Pella Windows for Vermont. Pella offers 8 lines of windows in Vinyl, Fiberglass, Wood and Aluminum Clad Wood for both Residential and Commercial projects. Feel free to reach out with any questions or concerns.

Jeff Stetter, AIA
Pella Architectural Consultant
802.498.4682

Celebrating 60 Years in Vermont
1962 - 2022

December 8, 2022

Commissioner June E. Tierney
State of Vermont Department of Public Service
112 State Street
Montpelier, VT 05620

RE: Vermont Residential Building Energy Standards and Vermont Commercial Building Energy Standards

Submitted electronically to:
psd.codeupdateres@vermont.gov
psd.codeupdatecomm@vermont.gov

Dear Commissioner Tierney:

The American Chemistry Council appreciates the opportunity to comment on the proposed rules to amend the Vermont Commercial Building Energy Standards (CBES) and Vermont Residential Building Energy Standards (RBES).

The American Chemistry Council (ACC) is a national trade association representing chemicals and plastics manufacturers in the United.

Over 96% of all manufactured goods are directly touched by the business of chemistry, making this industry an essential part of every facet of our nation's economy. The industry supports a quarter of U.S. gross domestic product (GDP) and creates more than half a million skilled, good-paying American jobs. The products of chemistry enable higher living standards and are crucial to meeting the needs of a growing global population.

The American Chemistry Council's Plastics Division represents America's Plastic Makers℠. Plus the half million+ scientists, engineers, technicians, and other innovators who make plastics for many essential and lifesaving products that are vital to modern life. Our members produce products for the whole of the U.S. market and in some cases have a global presence as well.

This includes but is not limited to plastic building materials like foam plastic board insulation, spray foam insulation and air sealants, house and building wraps, liquid applied water resistive barriers, plastic pipe, plastic glazing, and roof membranes. These products provide a wide range of benefits including thermal, air, and moisture management.

ACC has concerns with the proposed amendments to Vermont CBES and RBES that give preference to low embodied carbon insulation materials. If adopted, this would be a significant expansion of the energy code; no other state has adopted any mandated or optional points for low embodied carbon insulation materials.

We encourage the consideration of the following information:**

All materials require an investment of carbon to produce them including those with high embodied carbon like concrete, steel, and glass. However, only some materials provide carbon savings benefits during the operational life of the building like insulation and air barriers.

The building and construction sector accounts for 37 percent of global carbon emissions. Embodied carbon accounts for 10 percent while building operations account for 27 percent of emissions of those emissions.[1] Building materials like concrete, steel, and glass account for the largest portion of the embodied carbon. Cement, steel and glass are the next highest contributors, which means insulation makes up an extremely small portion of a building's embodied carbon.

Despite its relatively small percentage in overall building embodied carbon impact, insulation does however have a significant contribution to operational energy and greenhouse gas emissions savings. Energy Star estimates that you can save an average of 15% on heating and cooling costs by air sealing and adding insulation to the typical existing U.S. home.[2]

Insulation products offer significant savings with a minor impact on the building's embodied carbon profile. The preference for low embodied carbon insulation could lead to improper product selection and negatively impact the operation carbon use of the building. Insulation materials provide important benefits beyond thermal protection like air sealing and vapor management which are beneficial to a building's overall performance.

Insulation manufacturers have been optimizing their products to lower their carbon footprints for many decades. They have also been very transparent, and Environmental Product Declarations (EPDs) are available for most products.

- We support a whole building approach that includes operation carbon benefits and product transparency.
- We believe that manufacturers that have been optimizing the carbon intensity of their products should be rewarded rather than disincentivized from doing the right thing.
- We believe Vermont should recognize product contributions to operational carbon savings.
- We believe insulation choice should not be limited by this policy as insulation products save more carbon and energy than it takes to produce them.[3]

[1] See: GABC_Buildings-GSR-2021_BOOK.pdf (globalabc.org)
[2] See: Methodology for Estimated Energy Savings from Cost-Effective Air Sealing and Insulating | ENERGY STAR
[3] See: Life Cycle Greenhouse Gas Emissions Reduction from Rigid Thermal Insulation Use in Buildings by Michael H. Mazor, John D. Mutton, David Russell, Gregory A. Keoleian :: SSRN

ACC members have been making great progress in lowering their embodied carbon emissions. Their innovative and durable building materials enable greater carbon savings over their service life than it takes to produce them. Their progress has also minimized the difference in CO_2 emissions between different insulation products.[4]

A recent report by McKinsey & Company also demonstrates the carbon benefits of plastic building materials in comparison to alternative products. In fact, this report shows that in most cases plastic materials provide lower total GHG emissions over their life. This climate-related benefit commonly associated with the use plastics, including plastic construction materials, is further detailed in McKinsey's report.[5]

Insulation manufacturers have been providing transparency information for the industry in the form of Environmental Product Declarations (EPDs) that provide CO_2 embodied carbon emissions data for over a decade. This data was not intended for comparison purposes. If it is used in this manner, it is important for users to be educated regarding the limitations of comparisons as well as the tools and data sources they are using. Unfortunately, many tools do not accurately account for industry improvements in a timely manner or follow standard guidance for comparing products. They often allow products with different baseline assumptions and utilize different Product Category Rules. They also often include comparisons between industry and product specific EPDs, etc.

Due to the above concerns, we recommend that total carbon accounting be used to understand the full impact different products have over the life of the building. We do not recommend providing incentives for embodied carbon as a single attribute that could lead to regrettable substitutions.

Embodied carbon decisions should not be made prior to considering the other primary and necessary functions of building materials like their ability to eliminate other products, mitigate air leakage, manage moisture, etc. Operational offsets must be considered.

Decoupling the embodied carbon of products like insulation can have negative effects on building performance and the performance characteristics of the insulation regarding thermal protection, moisture management and air leakage should not be sacrificed for relatively small differences in embodied carbon.

ACC along with several other insulation industry associations published a Building Decarbonization Statement of Policy Principles that supports this total carbon or whole building view of the carbon impacts.[6] This is important so that decisions are not made that would affect

[4] See Life Cycle Greenhouse Gas Emissions Reduction from Rigid Thermal Insulation Use in Buildings by Michael H. Mazor, John D. Mutton, David Russell, Gregory A. Keoleian :: SSRN
[5] See Climate impact of plastics | McKinsey
[6] See Building Decarbonization Statement of Policy Principles (americanchemistry.com)

the building performance (thermal, air, moisture management, etc.). Please see more regarding the Insulation Industry Decarbonization Policy Principles here:
[Building Decarbonization Statement of Policy Principles (americanchemistry.com)]

Thank you again for the opportunity to comment. Please feel free to contact me if you have any questions.

Sincerely,

Amy Q. Schmidt

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American Chemistry Council
Director, Plastics Building and Construction
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December 8, 2022

To: State of Vermont Department of Public Service
From: Emily Kelly, Manager, Public Policy – ChargePoint
RE: Support for CBES and RBES Updated Language

To Whom it May Concern

Thank you for the opportunity to provide comments on the updates to the Vermont Commercial and Residential Building Energy Standards.   My name is Emily Kelly, and I am the Public Policy Manager at ChargePoint. ChargePoint is the nation's leading electric vehicle ("EV") charging network, with charging solutions for all driver needs and for all the places EV drivers go. ChargePoint designs, develops, and deploys residential and commercial AC Level 2 and DC fast charging stations, cloud-based software applications, and related customer and driver services aimed at creating a robust EV charging ecosystem.

ChargePoint applauds the Vermont Department of Public Service for the strong inclusion of EV Ready parking requirements and standards in both versions of the building energy standards. To support the adoption of EVs, it is critical that drivers have access to convenient places to charge. Most charging occurs at home, and access to home charging is a key factor in determining whether households will adopt an EV as their next vehicle. EV Ready codes promote new residential, multi-family, and commercial buildings to expand breaker panels, lay conduit, and wire through a raceway to parking spots based on a percentage of parking. This preparation for electric vehicles enables a site to reduce costs, complexity, and disruptive construction by incorporating EV-ready infrastructure at time of construction rather than during retrofits.

Numerous studies have been conducted regarding the cost difference between new construction vs. retrofit regarding EV infrastructure. In 2019, ChargePoint and Tesla engaged with the California Electric Transportation Coalition to publish the Plug-In Electric Vehicle Infrastructure Cost Analysis Report, which found that for 10% of spaces at a medium sized office/school parking lot the costs for new construction of EV-capable spaces were $901 vs $4,155 for retrofit construction. In addition to this, the City of Orlando highlighted a local EV-Ready building cost example prior to the passage of the City's EV-Ready Ordinance in 2021; finding 20% EV-capable and 2% EV-installed contributed to .0009% of total new construction project costs for a 116 unit Affordable Multi-family housing dwelling. ChargePoint supports strongly supports the language in the proposed codes regarding EV ready parking in commercial and residential settings.

ChargePoint appreciates the opportunity to weigh in on the standards being proposed and encourages the Department to adopt them as drafted.

Sincerely,

Emily Kelly

Emily Kelly

Manager, Public Policy
ChargePoint

evernorth

Investing in communities. Building possibilities.

To: Richard Faesey – Energy Futures Group
Kelly Launder – Department of Public Service
From: Kathy Beyer - Evernorth
Charlie Willner - Evernorth
Date: December 6, 2022
Re: 2023 RBES code revisions

Introductory comments:

Evernorth has very much appreciated being included in the RBES/CBES Advisory Group during these past few months. Evernorth and our local nonprofit partners have worked with Efficiency Vermont and our architects and engineers to build among the most energy efficient multifamily buildings in the state. And as long-term owners of these buildings, we also have feedback data on where energy efficiency measures are working, and in some cases, where they are not working.

We are submitting our comments in a time of unprecedented increases in construction costs. We are closing on construction that is 30% more costly than it was a year ago. With this construction cost environment, it is imperative that our choices in the 2023 energy code update includes a thorough assessment of the energy efficiency gains in comparison to a payback analysis. With each building, each decision made, we balance both the climate crisis and the housing crisis. This step in the energy code update gets at the foundation of the authorizing statute for the revision of the energy standards: any amendments to CBES will be consistent with State energy policy, State housing policy, evaluated relative to technical reliability, and cost-effective and affordable from the consumer's perspective.

Diving more into the details of the code update, we have appreciated the Department's efforts to start to differentiate between single family and multifamily buildings. Multifamily buildings are inherently more energy efficient than single family homes, and also have much more complex building systems. The state energy plan's goal of net zero for all new construction by 2030 should be interpreted in a different approach for multifamily buildings. It is imperative that this distinction starts to be made in the energy code update for 2023, and in the discussions around net zero by 2030.

Lastly, the Department is keenly aware of the lack of enforcement for the energy code. Each cycle of the code update, where enforcement is not addressed, creates an ever growing gap between buildings that are constructed by conscientious owners, and those built by owners who are ignorant, or do not care about the energy code. The march towards net zero by 2030 is a fallacy, without code enforcement.

<u>Feedback on specific code sections:</u>

Definitions:

Add " - FOR ALL USES EXCEPT MULTIFAMILY" after ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE).

Add new definition:
"ELECTRIC VEHICLE CHARGING - LEVEL 2 CAPABLE (MULTI-FAMILY): provide appropriate sized pathway to the building electrical room to accommodate a future electrical upgrade for Level 2 EVSE electric vehicle charging; provide adequate wall and floor space in the building electrical room for future EV charging related electrical equipment; provide the appropriate sized pathways to exterior on-grade surface parking spaces for future Level 2 EVSE electric vehicle charging; if the building includes garage or covered parking, provide a line diagram on the electrical drawings demonstrating a pathway for future Level 2 EVSE electric vehicle charging. Quantity of future Level 2 EVSE electric vehicle charging stations shall be as required by Table R404.3."

C402.5.1

The solar ready provisions do not apply to multifamily buildings in RBES, but does apply to multifamily buildings in CBES. It should either apply to multifamily buildings in both or neither.

C405.~~5~~ 6 Dwelling electrical meter ~~(Mandatory)~~.
Each dwelling unit located in a *Group R*-2 building shall have a separate electrical meter.

> **Exception:** Building constructed and/or operated by non-profit affordable house organizations. Future electrical metering must be considered and planned for in the electrical layout of the buildings.~~Buildings serving low-income occupants.~~

This language should be clarified and aligned with the corresponding RBES (R404.5) language. We suggest both codes read "Exception: Buildings where a majority of the living units serve tenants at or below %80 percent of area median income."

C405.12 Energy monitoring.
New buildings with a gross conditioned floor area of 25,000 square feet (2322 m²) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

Exception:
R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet (464.5 m²) of conditioned floor area.

C405.12.1 Electrical energy metering.
For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

C405.12.2 End-use metering categories.
Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:
1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m²) where a dedicated source meter

~~2020~~ 2023 Vermont Commercial Building Energy Standards

complying with Section C405.12.3 is provided.

C405.12

Exceptions:
R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet of conditioned floor area.

We suggest adding this language to the end of the exception "or where an exception to the utility meter requirement C405.6 is taken." An exception to the utility meter requirement granted to affordable housing should not trigger a requirement for metering individual unit HVAC, lighting, and plug loads. This would be cost prohibitive and contrary to the intent of the exception granted in C405.6.

405.13 Electric Vehicle Power Transfer Infrastructure
Table C405.13.1: delete Equation 4-11 and replace with the requirement to "*provide EV Capable spaces at 25% of the parking spaces provided for the multifamily development. Note that EV Capable requirements vary according to whether spaces are in a garage/covered versus exterior on-grade spaces (see DEFINITIONS).*"
C405.13.2: modify this Section so as to be consistent with the new definitions of EV Capable spaces as suggested above.

C405.14.1.1 Low-capacity heating

2. A dedicated branch circuit….

Item 2 appears to require that a complete circuit (breaker, wiring, termination) be installed. If this section was changed to require space in the panel and conduit from the panel to the future equipment location the intention (facilitate future transition to Heat Pump technology) will be preserved while reducing current cost burden to the building owner.

C405.14.2.1 Low capacity water heating

1. A dedicated 208/240V branch circuit with a …..

Item 1 appears to require that a complete circuit (breaker, wiring, termination) be installed. If this section was changed to require space in the panel and conduit from the panel to the future equipment location the intention (facilitate future transition to Heat Pump technology) will be preserved while reducing current cost burden to the building owner

C405.14.4.2 Residential drying
Rather than require a complete circuit be installed we request only installation of conduit and space in the electrical panel for future circuit installation.
C406.1.1 + C406.1.2
These code section mandate additional energy efficiency requirements. This is a similar section in RBES (402.1.2.2), but the RBES requirements mandate different point values based on the average living unit size in multifamily buildings. We request that a similar provision (points required are scaled to average living unit size) be applied in multifamily buildings that are built under CBES. The current point values should apply to the largest unit size category created. This is consistent with the Departments stated goal to align the RBES/CBES requirements for multifamily buildings.

C406.2.1.3 E03 Reduced air leakage

"Energy credits shall be achieved where tested building air leakage is **not** less than .15 cmf/ft2….."

The bolded "not" should be deleted from this code section if the intent is to incentivize tight building construction.

These points do not appear to apply to R-2 type occupancies less than six stories, as the baseline air leakage rate in this type of building is .15 cfm/ft2 @ 50pa. Please provide an equivalent incentive for low air leakage R-2 occupancy buildings when testing at 50pa. Suggested language for this incentive:

"Multifamily buildings testing @ 50pa shall receive these credits where the tested air leakage is less than .1 cfm/ft2 @ 50pa."

407.1.1 Qualifications, subsection 2. *"Be an independent third-party entity. The commissioning authority shall not be an employee of the design team, construction team~~, owner or developer~~."* We recommend striking 'owner or developer'. We understand the importance of the commissioning provider being independent of the construction team, however we believe that as long as the provider is qualified, they could be an employee of the owner or developer. The owner/developer's incentives are aligned with the intent of this requirement. As owners/developers, we want our systems to function properly, meet the design requirements. Furthermore, the 2020 CBES requirement varies from other standards; for example LEED NC allows the CxA to be a qualified employee of the owner (but not a member of the construction/design team).

Suggested Addition to C403.2. We suggest adding a subsection to C403.2 with language similar to the following: "*Hydronic heating systems and associated equipment shall be sized for and operated at a maximum heating hot water temperature of 140F*." One goal of this requirement is that it ensures that condensing boilers will actually condense and operate at higher efficiencies. Many boiler systems have constant primary pumps, which means that at part-load conditions the delta-T across in the primary loop is very low and the boiler will not condense if the supply water temperature is above 140F. The second goal of this requirement is to future-proof buildings for electrification. Air-to-water heat pumps struggle to provide hot water over 140F. If a building's hot water coils, radiators, etc. are designed to operate at 180F, they would all need to be replaced in order to electrify a building in the future (assuming the building would heat the hydronic loop with heat pumps).

Suggested Additional to C403; Sequence of Operations (SOO). Evernorth has had challenges getting a SOO for projects, receiving generic SOOs, and/or receiving SOOs after the project is constructed. This challenge makes it difficult to have our buildings set up as efficiently as we would like them. To that end, we suggest requiring that Construction Drawings include a Sequence of Operations for all mechanical equipment. CBES 2020 C406.4.5 requires a SOO for lighting controls, but we do not believe there is a comparable requirement for mechanical systems. Proposed additional to C403: "*Construction* *documents shall include submittal of a Sequence of Operations for all mechanical equipment, including a specification outlining each of the functions required by this section."*

Suggested Additional Requirement to C403.7 relating to dehumidification in Energy Recovery Ventilation Systems. We have had several projects with central Energy Recovery Ventilation (ERV) systems that include a dehumidification sequence. The factory control method of dehumidification was to assume that the unit needed to dehumidify whenever the outside air temperature was above 65F (i.e. it used dry bulb temperature to control humidity). This results in the unit subcooling air with a compressor for a significant number of hours when it is not necessary. We suggest that CBES not allow this type of control. Proposed requirement: "*For Energy recovery ventilation systems that utilize dehumidification, not fewer than one humidity control device shall be provided for each humidity control system. A humidity control device is a device that measures relative humidity or enthalpy (dry bulb temperature sensors do not qualify as humidity control devices)."* Our experience relates to ERVs w/ dehumidification, but it may also make sense to expand this requirement to other heating/cooling equipment, in which case it would likely be an update to C403.4.1.

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December 9, 2022

Vermont Public Service Board
112 State Street
Montpelier, VT 05620

Re: EV Readiness in Building Energy Standards Update

Renewable Energy Vermont (REV) appreciates the opportunity to comment on the ongoing efforts to update Vermont's Commercial and Residential Building Energy Standards. As a state, our capacity to meet our climate goals rests heavily on the rapid electrification of our transportation and thermal sectors. REV applauds the Department's proactive efforts to prepare Vermont's building stock for this transition.

Incorporating strong EV Ready parking requirements and standards in both the CBES and RBES is a vital step to supporting widespread electrification. Access to convenient and reliable charging opportunities is essential for consumer adoption of EVs. Currently, most charging occurs at home, and ensuring that new single and, especially, multi-family properties have access to home charging will be a key factor for promoting equitable EV adoption opportunities. Ensuring that charging opportunities are readily available at commercial buildings will further facilitate EV adoption and provide for greater flexibility in when and where vehicles charge. As we electrify an increasing share of the economy, utilizing EVs as flexible sources of the load has potentially significant system advantages. These advantages stand to benefit vehicle owners, distribution utilities, and Vermont ratepayers alike. Standards that prepare new residential and commercial buildings for EV charging will have significant benefits for advancing our climate goals, promoting equitable access to the benefits of electrification, and building a robust and resilient grid.

The cost of installing charging infrastructure during a building retrofit is substantially higher than during new construction, as much as four times higher according to a report prepared for the California Electric Transportation Coalition, ChargePoint, and Tesla.[i] EV Ready codes such as those currently proposed, that result in expanded breaker panels, conduit, and wire access at parking spots will reduce the cost and complexity of making EV infrastructure widely available. REV strongly supports the EV readiness standards that have been proposed and encourages the Department to adopt them as drafted.

Sincerely,

Jonathan Dowds
Deputy Director

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[i]Energy Solutions (2019). *Plug-In Electric Vehicle Infrastructure Cost Analysis Report for CALGreen Nonresidential Update* https://caletc.com/assets/files/CALGreen-2019-Supplement-Cost-Analysis-Final-1.pdf

2023 CBES Update Comments

Nick Thiltgen, PE, LEED-AP

12/09/2022

These comments are generally based on those from the mechanical engineering community in VT, and ASHRAE Guidelines and Standards, but are not intended to be or should not be construed as representing the opinions of the entire ME community, the local ASHRAE Chapter, or ASHRAE Organization as a whole.

Review and comments based on "CBES 2023 Full-Text Redline 9/23/2022" document.

General, Customization - Any proposed VT CBES customizations from the IECC, unless taken from another similar source such as Standard 90.1, should be fully vetted before including. Much work goes into developing the IEEC and 90.1 including energy calculations, cost estimates, equipment availability assessments, etc. and any changes to these documents should go through the same process to ensure effective requirements. Approaches such as "trying it out", simply increasing/decreasing a threshold, or purely relying on public commentary should not be acceptable. If detailed calculations and data can be provided with public commentary, and fully reviewed by a qualified professional, this could be acceptable justification, however relying on only a single data point is still a questionable approach.

General, Compliance – The VT CBES is generally considered to be unenforced, and public feedback throughout the last few updates has continued to be that this needs to change for the Code to be effective. Recognizing that this implementing enforcement is complicated and beyond the scope of the update process, the fact that enforcement doesn't exist should be taken into account when considering modifications to the Code. In particular, without enforcement, the more complicated the Code requirements are, the less likely they will be met. Particularly for the work of the less sophisticated practitioners which the Code requirements would be expected to differ the most from. For example, while the technical rigor of the extensive custom requirements in Sections 406 and 408 is impressive and appreciated, the actual impact in VT without enforcement is questionable. Please consider the fact that the Code is not enforced in VT and the expected impact of any changes to the Code given this fact.

Building Envelope Requirements

- The basis for the proposed VT CBES building envelope requirements versus those in the IECC or Standard 90.1 is not clear. The proposed CBES update introduction specifically states that construction cost data was not able to be obtained for an accurate evaluation. Insulation beyond that required by the IECC/90.1 is <u>not</u> suggested by the ASHRAE/ AIA/ IES/ USGBC/ USDOE Zero Energy Design Guides for Schools or Offices. The cost effectiveness of requirements which exceed those in the IECC or Standard 90.1 should be clearly proven before implementing.
- Particularly for roofs with insulation entirely above deck, the difference between the requirement for attic roofs in the IECC/90.1 is not due to the potential energy savings, but due to the construction cost and resulting cost-effectives. The idea that these two different applications should have close to similar thermal resistance value in the VT CBES ignores the cost-effectiveness

aspect. Experience by many local practitioners demonstrates that above-deck roof insulation beyond that required in the IECC/90.1 is not cost-effective. Particularly with the foam insulation typically used, the payback of the embodied energy from the resulting incremental energy savings is beyond the life of the material.

- For slab-on-grade insulation in particular, little energy impact can be demonstrated in the difference between the IECC/90.1 requirements and anything beyond them due to ground heat and the thermal resistance capacity of soil. A detailed description is provided in the ASHRAE Fundamentals Handbook among others. Any analysis which demonstrates energy impacts is likely assuming no soil resistance to heat transfer (ultimately to the cold outdoor above-grade air) and a constant slab exterior surface temperature of 50°F or similar, which is not accurate.

Electric Resistance Space Heating (C403.2.3) – The historical exception for "replacement of electric resistance unit" appears to have been removed, however the justification is not clear. It seems that there are applications where A. Replacing an existing electric resistance unit would require significant modifications and associated expense and not be cost effective, B. The replacement unit would include fossil fuel heating, which appears that it would not a desirable outcome of the VT CBES. Unless a strong case is made for the benefits of removing this exception, recommend continuing to include it, or modifying it in some other way (ex. allowing it only if the electric resistance is a back-up to an electric heat pump).

Heating and Cooling Equipment Sizing (C403.3.1) – Text regarding heat pump sizing has been added to the proposed VT CBES. This requirement states that "equipment shall not be sized greater than the calculated peak heating and cooling loads". Given that equipment is not available in an infinite amount of capacities, text similar to that within the main requirement ("to the next nearest available size") should be used. Unless the intent is to require equipment smaller than the calculated peak heating and cooling loads, which if the case, would be a questionable approach.

Economizers (C403.5) – The basis for the requirement exempting "VRF system installed with a dedicated outdoor air system" is not clear. It is understood that this exception is not VT custom, is included in the IECC, but is not in Standard 90.1. Individual fan systems with a cooling capacity less than 54 MBh are already exempt, so is the intent of the custom text to exempt individual fan VRF systems greater than or equal to 54 MBh? If so, is this valuable? It seems like economizer controls would reduce energy use for that application. Also, why only VRF systems and not others with a DOAS system (ex. WSHP)?

Ventilation & Exhaust Systems – Nontransient Dwelling Units (C403.7.4.1) – The proposed VT CBES has been customized from the IECC to included recovery requirements at cooling design condition, and increases both cooling and heating recovery effectiveness minimum thresholds from 50 to 60% and 60 to 70% respectively. Have these thresholds been determined to be achievable with commercially available equipment, particularly the cooling threshold? Or at a minimum, is equipment meeting these thresholds been proved to be cost effective? If not, recommend using IECC language with no modifications. This comment also generally applies to the thresholds in the C406 Additional Efficiency Package – Energy Recovery option.

Automatic Control of HVAC Systems Serving Guestrooms (C403.7.6) – Temperature reset is required for guestrooms, however zones served exclusively by cold-climate heat pumps are generally exempt from off-hour controls by the proposed VT CBES customized requirement in C403.4.2. Are these controls required for cold-climate heat pumps serving guestrooms? If not, maybe this should be added to C403.7.6.

Fan Airflow Control (C403.8.6) – The proposed VT CBES has been customized from the IECC to reduce the mechanical cooling capacity threshold for Dx Cooling from 65 to 24 MBh. Has this threshold been determined to be achievable with commercially available equipment? If not, recommend using IECC language with no modifications. Water-source heat pumps and unit ventilators for example may have EC fan motors either as an option or standard but not have multispeed operational controls for the lower capacity units in particular.

Duct and Plenum Insulation and Sealing (C403.12) – The proposed VT CBES have been customized from the IECC regarding duct located in a conditioned space - this is understood to be intended to apply to untreated air. It appears that rather than replacing the existing requirement for duct located within a building envelope assembly (a different location than a conditioned space), the modification should be in addition to the existing requirements.

Automatic Receptacle Control (C405.11) – This new CBES requirement is understood to be included in both the IECC and Standard 90.1 and not custom to the CBES. However, has the actual effectiveness of this requirement been demonstrated? From a technical standpoint, it is understood that uncontrolled plug loads consume a considerable amount of energy and should be a target for energy reduction. From a practical standpoint, it seems like if a user values minimizing energy use, they either manually control their device or set up automated control on the device, resulting in a controlled receptacle providing no value. For a user who doesn't value minimizing energy use, it's hard to imagine they would choose to plug their device into a controlled receptacle, giving away their control.

Additional Electric Infrastructure (C405.14) – Is the intent of this requirement to add a burden to install fossil fuel heating equipment so it is not chosen, or to add necessary infrastructure for future electric heating equipment? If the former, it seems like it would mostly apply to buildings with R-2 occupancy classifications which are exempt but where reasonable alternatives are available and many are already using non-fossil fuel equipment. Other occupancies have less desirable electric options for some end-uses at the moment and projected near future. If the latter, the requirements don't seem completely developed to be reasonable. For example:

- For low capacity heating equipment, it seems like a designated exterior location is required for future electric equipment, however the power termination is required to be within 3 feet of the space heating equipment which would be interior. This seems to be both conflicting, and problematic, given the location of the required power supply to future heating equipment could be interior or exterior depending on the type of equipment.
- The requirement is not clear how the electric power supply would actually be sized. It references the requirement for calculating building heating loads (403.1.1), but that load could be met with various types of equipment with different electric power needs – for example, electric resistance, air-source heat pump, ground-source heat pump.
- The requirement is based on the assumption that the future non-fossil fuel equipment will be electric. Given the fact that wood or biogas options are both also non-fossil fuel, and more likely alternatives for many commercial end uses, the requirement does not seem reasonable.
- Requirements which seems like they would apply to R-2 buildings only – residential clothes drying – are included, however this occupancy is exempt.

December 7, 2022

Kelly Launder
Assistant Director
Vermont Department of Public Service
112 State St.
Montpelier, VT 05620-2601

Dear Ms. Launder,

Phius (Passive House Institute US) is a non-profit 501(c)(3) organization committed to making high-performance passive building the mainstream market standard. Phius trains and certifies professionals, maintains the Phius climate-specific passive building standard, certifies and quality assures passive buildings, and conducts research to advance high-performance building**.** Buildings constructed to the Phius standard provide superior indoor air quality, resilience during power outages, and an extremely quiet, comfortable indoor environment. Project teams are increasingly adopting passive building principles and the Phius standard for single-family, multifamily, and commercial buildings to achieve Net Zero buildings, resulting in over 7,000 units certified, and totaling over 7.4 million square feet across North America.

Phius appreciates the opportunity to provide comments suggesting amendments to the proposed adoption of both the 2023 REBS and 2023 CEBS. Phius congratulates the Vermont Department of Public Service (VT DPS) for proposing to adopt one of the strongest energy codes in the country. However, Phius believes that VT DPS can include two amendments that would upgrade the energy code.

1. **Add a Phius alternative compliance path to the 2023 Residential Building Efficiency Standard (RBES)**
2. **Add a Phius alternative compliance path to the 2023 Commercial Building Efficiency Standard (CBES)**

1.Suggested Amendments:

A. Add a Passive House alternative compliance path to residential and low-rise multifamily projects certified by Phius.

Proposed Amended Language: (Amended language underlined)

R401.2 Compliance
Projects for both Base Code and Stretch Code shall comply with one of the following:

1 **Package Plus Points**: R402 through R404
2 **REScheck software;** Section R405 and the provisions of Sections R401 through R404 indicated as "Mandatory"
3 **Home Energy Rating System (HERS):** An energy rating index (ERI) approach in Section R406
4 Phius 2021 CORE (or later edition): Section R406.8 through R406.9

Section R406.8 Passive House Alternative Compliance Option

R406.8.1 Scope. This section establishes criteria for compliance via the Phius CORE 2021 (or later edition) standard.

R406.8.1.1 Projects shall comply with Phius CORE 2021 (or later edition)

R406.8.1.2 Phius documentation. Prior to the issuance of a building permit, the following items must be provided to the code official:

1. **A list of compliance features.**
2. **A Phius precertification letter.**

Prior to the issuance of a certificate of occupancy, the following item must be provided to the code official:

1. **A Phius CORE 2021 (or later edition) project certificate**.

B. Add a Passive House alternative compliance path to commercial and high-rise multifamily projects certified by Phius.

C401.2 Application
Commercial buildings shall comply with Section 401.2.1 or Section 401.2.2 or Section 408

Section C408 Phius Alternative Compliance Option

C408.1 Scope. This section establishes criteria for compliance via the Phius CORE 2021 (or later).

C408.1.1 Projects shall comply with Phius CORE 2021 (or later).

<u>C408.1.1.1 Phius documentation. Prior to the issuance of a building permit, the following items must be provided to the code official:</u>

<u>1. A list of compliance features.</u>

<u>2. A Phius precertification letter.</u>

<u>Prior to the issuance of a certificate of occupancy, the following item must be provided to the code official:</u>

<u>1. A Phius 2021 CORE (or later) project certificate</u>.

Rationale:

This amendment will simplify the path for those homebuilders/homebuyers/developers who would like a home/multi-family or commercial building that is more energy efficient than a similar building built to the 2021 IECC.[1]

In addition, because Phius requires a robust 3rd party review and construction inspection process, owners will be assured of a high-quality energy-efficient building that will allow code officials to focus on enforcing other sections of the energy code.

Comments:

Based on the enforcement/compliance concerns stated by multiple commenters at the RBES Public Hearing from December 2, 2022, these comments will focus on how the proposed amendment will help improve enforcement and ultimately compliance.

Description of Phius Standard

All buildings built to the Phius standard foreground five principles:

- Using continuous insulation throughout the building envelope to minimize or eliminate thermal bridging.
- Building a well-detailed and extremely airtight building envelope, preventing infiltration of outside air and loss of conditioned air while increasing envelope durability and longevity.
- Using high-performance windows (double or triple-paned windows depending on climate and building type) and doors - solar gain is managed to exploit the sun's energy for heating purposes in the heating season and to minimize overheating during the cooling season.
- Using balanced heat- and moisture-recovery ventilation to significantly enhance indoor air quality.
- Minimizing the space conditioning system because of lower space conditioning loads.

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[1] [1] For more information on the Phius standard, energy savings and other jurisdictions using the Phius Alternative Compliance Path, please see the comments submitted by the Vermont Phius Alliance sent to the department on August 9, 2022.

The Phius standard incorporates all these principles. Moreover, to receive certification, all residential buildings must also meet the criteria laid out in these pre-requisite programs:

- US Environmental Protection Agency (EPA) ENERGY STAR Program
- EPA Indoor airPLUS program
- EPA WaterSense Program
- US Department of Energy (DOE) Zero Energy Ready Home program
- ASHRAE 62.2 ventilation requirements

The Phius Alternative Compliance Path Provides a Compliance Framework

The remainder of these comments will focus on how the Phius Alternative Compliance path can raise the compliance percentage particularly for residential projects.

All buildings seeking Phius certification go through a two-part process: design review, post-construction verification:

PART 1:

First, Phius certification staff reviews construction drawings, product specifications, and modeling to ensure that the building energy use is below the stringent values specified in the standard. In addition to reviewing energy performance, Phius evaluates building envelope components and details for moisture and condensation performance. After identifying and resolving all issues, the building design is design certified.

PART 2:

After design certification, a Phius-trained Rater/Verifier reviews the actual construction on-site ensuring that the building is constructed to the pre-certified plans and that it meets the criteria of the programs listed above. This review ensures that the building is built according to the model and the drawings. The work of the rater/verifier is itself subject to a QA/QC review. If changes to the design occur, the modeling is updated, and the new energy use of the building must still meet the Phius standards for certification. This process ensures that the completed building matches the modeled building.

The certification process functions as both a permitting and construction review ensuring that the finished project meets all the standards and requirements embodied within the Phius standard.

Addressing Code Compliance:

The Phius Alternate Compliance Path helps address the code compliance concerns in three ways:

1.It provides a proven path to code compliance. All projects that choose to meet the Phius standard will be code compliant.

2. As it is an alternate compliance path administered by a third party, it would not add costs to municipalities administering the code.

3.It provides a means for showing how a third-party enforcement system could work beyond Phius projects. As noted above, municipalities in Vermont typically will not have the resources to provide the requisite enforcement for single family projects. Third party enforcement does provide one solution. However, a third-party enforcement system must be appropriately designed with respect to training, certified personnel and the relationship between the third-party rater and the authority having jurisdiction. Currently, NYSERDA has established a third-party enforcement system and the Vermont Department of Public Service can use best practices from their program as well as the Phius certification process to establish its own.

Thank you for the opportunity to comment on these critical issues. Phius congratulates Vermont Department of Public Service (VT DPS) for proposing to adopt both the 2023 RBES and 2023 CBES, which, as among the strongest codes in the country, will result in significant energy savings and higher quality buildings and commercial buildings across Vermont. Phius also feels that by incorporating the suggested amendments, VT DPS will strengthen compliance with the energy code which addresses an important and long-standing concern.

Sincerely,

Isaac Elnecave
Policy Specialist
Phius

AMCA International
Air Movement and Control Association International, Inc.
The International Authority on Air System Components Since 1917

30 West University Drive
Arlington Heights, IL 60004, USA
847-394-0150
communications@amca.org
www.amca.org

9 December 2022

Department of Public Service
112 State Street
Montpelier, VT 05620-2601
Email: psd.codeupdatecomm@vermont.gov

Dear Vermont Department of Public Service:

We are writing to you on behalf of the Air Movement and Control Association (AMCA) International, which is a not-for-profit trade association representing nearly 400 manufacturers worldwide of fans, blowers, control dampers, life-safety dampers, louvers, and other air-system products for commercial and industrial applications. AMCA is an international standards developer and administers a Certified Ratings Program that currently covers nearly 4,000 product lines globally.

AMCA supports the draft commercial energy code language in which Vermont adopts the Fan Energy Index (FEI) metric, reflective of fan efficiency language present in the 2021 IECC and ASHRAE 90.1-2019. This update will help phase out the Fan Efficiency Grade (FEG) metric, thereby continuing to move towards national unity on a fan-efficiency metric and to accelerate energy savings and carbon reduction in Vermont. Several years of AMCA's advocacy efforts have strongly focused on advancing the FEI metric's adoption for use in commercial and industrial air-systems design, and for use in energy-efficiency codes, standards, and regulations.

The FEI metric was developed several years ago during early stages of a U.S. Department of Energy (DOE) rulemaking for fans by AMCA and its member companies in collaboration with the DOE and efficiency-advocacy organizations. FEI is a rating calculation defined in ANSI/AMCA Standard 208-2018, *Calculation of the Fan Energy Index*.

To date, the Fan Energy Index (FEI) metric has replaced the Fan Efficiency Grade (FEG) metric in:

- ASHRAE 90.1-2019
- 2021 IECC
- ASHRAE 189.1-2020
- California Energy Commission Title 20 appliance regulation
- California Title 24 energy code
- A handful of other state energy codes

To assist energy codes and industry with adopting and enforcing FEI, AMCA has made substantial resources available. A web page at www.amca.org/fei has numerous technical papers, videos, and PowerPoint presentations. There also are links to self-paced online training materials at the introductory (for designers and code officials) and advanced (for manufacturers) levels. Additionally, the AMCA Certified Ratings Program has certified FEI ratings in hundreds of fan product lines for dozens of fan manufacturers (available online here).

AMCA does have one recommendation for the current version of CBES, as was mentioned during verbal testimony at the December 2 hearing. In our limited reading of the CBES 2023 Full-Text Redline 9/23/2022 (Current Version), it seems that the inclusion of Fan Efficiency Grade (FEG) reporting requirements in mechanical equipment schedules, such as mentioned on PDF page 28 of 354, should instead be updated to Fan Energy Index (FEI), per other changes drafted in the CBES update.

Thank you for your time, and best wishes to the Vermont Department of Public Services in completing the commercial energy code revision.

Aaron Gunzner, PE, Senior Manager, Advocacy, AMCA International, agunzner@amca.org
Zac Johnson, Codes & Standards Engineer, AMCA International, zjohnson@amca.org

Aligning Authority and Enforcement in the CBES
Comments from Sandra Vitzthum, AIA
Sandra Vitzthum Architect, LLC
Montpelier, Vermont

Reference: "CBES 2023 Full Text Redline" dated 9/23/22. It is recommended that the below is reviewed alongside the rough draft red lines.

Specific recommendations are highlighted, and comments are in blue.

CHAPTER 1 SCOPE & ADMINISTRATION

Sections 109 and 110 are missing. Both are connected, related parts of an integrated administration for all building codes. There is no reason I know of to eliminate them, particularly because they reinforce other building codes and also other sections of this code.

SECTION C109 STOP WORK ORDER
C109.1 Authority.
Where the *code official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code or in a dangerous or unsafe manner, the *code official* is authorized to issue a stop work order.
C109.2 Issuance.
The stop work order shall be in writing and shall be given to the owner of the property, the owner's authorized agent or the person performing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order and the conditions under which the cited work is authorized to resume.
C109.3 Emergencies.
Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.
C109.4 Failure to Comply.
Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be subject to fines established by the authority having jurisdiction.
[Discussion: This entire section is taken from the IECC.]

SECTION C110 BOARD OF APPEALS
C110.1 General.
In order to hear and decide appeals of order, decisions or determinations by the *code official* relative to the application and the interpretation of this code, there shall be and is hereby created a board of appeals. Refer to Appendix CA Board of Appeals – Commercial.
[Discussion: Beyond the importance of including this typical section of a building code, this should be the primary reference to Appendix CA. In other words, this is where people look for appeal specifics.]

I'd like to thank the Public Service Department, their advisory committee, and their consultants for incorporating my other suggestions. Much appreciated! I apologize for not being clearer about these two suggestions earlier.

MADISON
IAQ
making the world safer, healthier, and more productive

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Vermont Department of Public Service
June E. Tierney, Commissioner
112 State Street
Montpelier, VT 05620-2601

(Submitted electronically at https://publicservice.vermont.gov/content/energy-code-update-comments)

Re: Madison IAQ Comments in Response to Commercial Building Energy Standards Proposals

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Dear State of Vermont Department of Public Service:

Madison Indoor Air Quality (MIAQ) respectfully submits these comments in response to State of Vermont Department of Public Service's update to the building codes, specifically to the Commercial Building Energy Standards (CBES).

MIAQ is one of the largest and most successful privately held companies in the world with a significant footprint in the HVAC market. MIAQ's mission is to make the world safer, healthier, and more productive by creating innovative solutions that deliver outstanding customer value. MIAQ's portfolio comprises of at least 15 companies including Airxchange, InnergyTech, Heatex, and NovelAire. Through these companies, MIAQ offers Energy Recovery Ventilators to the residential and commercial markets that could be impacted by Vermont's Department of Public Service (DPS) proposed revisions to the Commercial Building Energy Standards.

MIAQ greatly appreciates Vermont's DPS active stakeholder outreach and request for feedback on the regulation. Due to our continuous review of market demands and advancement to higher efficiency equipment, MIAQ feels uniquely qualified to provide feedback to Vermont's DPS staff on the issues they wish to address. We thank Vermont's DPS staff for taking time to read these comments and encourages them to work with Madison IAQ to address our thoughts and concerns during the rulemaking process.

§ C403.7.4.1 Nontransient dwelling units

The proposed changes to the Commercial Building Energy Standards includes the following language for energy recovery ventilation (ERV) systems:

> C403.7.4.1 Nontransient dwelling units. Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems with an enthalpy recovery ratio of not less than ~~50~~60 percent at cooling design condition and not less than ~~60~~70 percent at heating design condition.

The above requirement refences enthalpy recovery ratio; however, most states use the simpler Sensible Recovery Efficiency (SRE) measure which is readily certified by Home Ventilating Institute (HVI). The net sensible energy recovered by the supply airstream as adjusted by electric consumption, case heat loss or heat gain, air leakage, airflow mass imbalance between the two airstreams and the energy used for defrost, as a percent of the potential sensible energy that could be recovered plus the exhaust fan energy. This value is used to predict and compare Heating Season Performance of the ERV. Since the enthalpy recovery ratio (ERR) is self-declared value rather than a certified value; it provides manufactures opportunities to tweak the value to meet code requirements.

The Residential Building Energy Standard (RBES) proposal includes the following language for heat or ERV systems:

> R403.6.1 Heat or energy recovery ventilation. Dwelling units shall be provided with a heat recovery or energy recovery ventilation system. ~~in Climate Zones 7 and 8.~~ The system shall be balanced with a minimum sensible ~~heat~~ recovery efficiency (SRE) or 7~~6~~5 percent at 32° (0°C) at a flow greater than or equal to the design airflow.

Therefore, to eliminate any confusion on which metric to is required for compliance, MIAQ recommends revising the requirement in the CBES proposal to the following to ensure consistency between commercial and residential buildings as well as to provide merit to required metric:

> C403.7.4.1 Nontransient dwelling units. Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems with a~~n~~ ~~enthalpy recovery ratio~~ minimum sensible recovery efficiency (SRE) of not less than ~~50~~60 percent at cooling design condition and not less than ~~60~~70 percent at heating design condition.

Madison Indoor Air Quality appreciates the opportunity to provide these comments. If you have any questions regarding this submission, please do not hesitate to contact me.

Sincerely,

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