



# PROPOSED RULE MAKING

## CR-102 (December 2017) (Implements RCW 34.05.320)

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STATE OF WASHINGTON  
FILED

DATE: May 16, 2019

TIME: 3:10 PM

WSR 19-11-073

**Agency:** Washington State Building Code Council

☒ **Original Notice**

☐ **Supplemental Notice to WSR** \_\_\_\_\_

☐ **Continuance of WSR** \_\_\_\_\_

☒ **Preproposal Statement of Inquiry was filed as WSR** 18-09-085 ; or

☐ **Expedited Rule Making--Proposed notice was filed as WSR** \_\_\_\_\_; or

☐ **Proposal is exempt under RCW 34.05.310(4) or 34.05.330(1); or**

☐ **Proposal is exempt under RCW** \_\_\_\_\_.

**Title of rule and other identifying information:** (describe subject) WAC 51-11C, Adoption and amendment of the 2018 Washington State Energy Code, Commercial

### Hearing location(s):

Date:	Time:	Location: (be specific)	Comment:
July 12, 2019	10 am	Department of Enterprise Services Presentation Room (1213) 1500 Jefferson Street Olympia, WA 98504	

**Date of intended adoption:** July 26, 2019 (Note: This is **NOT** the **effective** date)

### Submit written comments to:

Name: Doug Orth, Council Chair

Address: PO Box 41449, Olympia WA 98504-1449

Email: sbcc@des.wa.gov

Fax:

Other:

By (date) July 12, 2019

### Assistance for persons with disabilities:

Contact Carrie Toebbe

Phone: 360-407-9255

Fax:

TTY:

Email: carrie.toebbe@des.wa.gov

Other:

By (date) July 1, 2019

**Purpose of the proposal and its anticipated effects, including any changes in existing rules:** Update from the 2015 edition of the Washington State Energy Code to the 2018 edition, incorporating changes from the 2018 International Energy Conservation Code and those code changes submitted to increase energy savings and provide better clarity.

Below are highlights of the significant changes in the 2018 Washington State Energy Code. A complete description of all changes can be found at <https://fortress.wa.gov/es/apps/sbcc/File.ashx?cid=8371>

Please note that Sections C402.1.5, C404.6, C503 and C505 are not in numerical order and can be found at the end of the filing document.

**Section C303.1.5:** Default table and associated equations and specifications for curtain wall and spandrel panels is added from the Seattle Energy Code.

**Throughout Chapter 4:** Exceptions previously provided for site-recovered or site-renewable energy were removed as they have become a more integral part of the code and satisfy an option in Section C406.

**Section C402.1.1.3 Greenhouses.** A new section is added to define exactly when a greenhouse is exempt from the envelope requirements of the WSEC.

**Table C402.4, Building envelope fenestration** maximum U-factor and SHGC requirements. This table was revised to include Class AW windows for curtain wall systems and similar fenestration. All other metal windows will now be included in the same category as non-metal windows and will need to meet those U-factors.

**Section C402.4.1.1, Increased vertical fenestration area with daylight responsive controls.** This section was revised to require 50% of the conditioned floor area to be within a daylight zone regardless of building height.

**Section C402.5.1.2, Building test/air infiltration.** The allowable air leakage rate was reduced to 0.25 cfm per square foot, and the building is required to meet this threshold without exception. A correlated change was made to Section C406.9 to lower the infiltration rate in the additional energy credit section to 0.17 cfm per square foot.

**Sections C402.5.6 Loading dock weatherseals:** The code now specifically requires that loading dock doors provide weatherseals that provide direct contact with the top and sides of vehicles.

**Section C403** of the 2018 International Energy Conservation Code was **extensive reorganized** to be easier to use, reduce redundancies and be more specific to equipment type. Most of this language is marked as a change, but the language itself has not changed in most cases—just the location. These changes are reflected in the 2018 Washington State Energy Code. For a crosswalk of this change, see <https://fortress.wa.gov/es/apps/sbcc/File.aspx?cid=8370>

**Section C403.1.1, HVAC total system performance ratio (HVAC TSPR).** A new requirement is added for those buildings required to comply with the DOAS section. This section, along with new Appendix D, compares the intended mechanical system against a prototype system to ensure a baseline efficiency is met. PNNL is expected to release a tool to perform the calculations; however, the Appendix provides all inputs for alternate computer modeling to be used.

**Section C403.1.3, Data centers.** This section sets ASHRAE standard 130, with some modifications, as the standard for data centers.

**Section C403.4.1.6, Door switches for HVAC thermostatic control.** A new section was added to limit energy loss when doors to the outside are left open, based on a California requirement.

**Section C403.4.2.3, Automatic start and stop.** This section now adds requirements for automatic stop controls for HVAC systems.

**Sections C403.4.2.4 Exhaust system off-hour controls, and C403.4.2.5 Transfer and destratification fan system off-hour controls.** New sections for off hour scheduling for fan systems.

**Section C403.4.7.1, Combustion decorative appliance controls.** This section introduces requirements to shut down combustion appliances and combustion fireplaces and fire pits when the space is unoccupied.

**Section C403.9.8, Heat recovery for space heating.** New section to require heat recovery chillers where projects have a consistent heat sink for heat rejection

**Section C403.12, High efficiency single-zone variable air volume (VAV) systems.** A new section for single zone VAV systems was added.

**Section C405.2.4, Daylighting.** New terms are introduced, sidelit and toplit.

**Table C405.4.2, Lighting power allowance.** There are three different options up for public comment. Option 1 provides an estimated 4.5% energy savings over the current code. Option 2 provides an estimated 9% savings. Option 3 is estimated to be a 15% savings.

**Section C405.5, Exterior lighting power allowance.** The exterior lighting section has been reformatted to more closely resemble the interior lighting section.

**Section C406, Efficiency packages.** This section was reorganized to provide table of options with assigned points and indications of which occupancy types those options would apply to.

**Section C407, Total building performance.** This section now sends you to ASHRAE 90.1 appendix G for performance based compliance. A new table was added to reference all mandatory measures applicable to this path. The performance metric was switched to carbon emissions. A limit was also set on envelope reductions.

**Section C409, Energy metering.** Section C409.1 adds end use metering requirements for on-site renewable energy and electric vehicle charging stations. The requirements for on-site systems is also further clarified in C409.2.4. Section C409.1.3 adds a pointer to other code sections with metering requirements for dwelling units. Section C409.3 adds an exemption for minor loads and some healthcare facility loads, as well as electrical circuits serving only sleeping units. Section C409.3 also adds additional end use metering requirements for lighting systems, plug loads and process loads. Some tenant spaces comprising the majority of a floor must have metering data available to the tenant. Section C409.4.3 details changes on the display and reporting of data.

**Section C410, Refrigeration Systems.** Tables are updated to the latest federal requirements.

**Section C411, Solar readiness.** Requires 40% of net roof area to be minimally prepared for future installation of solar PV arrays, and for space to be provided near the electrical service entry for future equipment.

**Chapter 5, Existing Buildings.** Clarifications and editorial changes to enhance understanding and compliance. The existing building economizer table was updated.

**Two new appendix chapters are proposed:**

1. **Appendix D: HVAC TSPR.** A new requirement is added for those buildings required to comply with the DOAS section. New Section C403.1.1, along with new Appendix D, compares the intended mechanical system against a prototype system to ensure a baseline efficiency is met.
2. **Appendix F: Outcome based energy budget.** This is an optional appendix that jurisdictions may adopt to provide an alternate outcome-based energy budget compliance option.

**Reasons supporting proposal:** The proposal helps increase energy efficiency towards the goals in RCW 19.27A.160 and Executive Order 16-07 and provides additional clarity in regulations to assist both builders and enforcers.

**Statutory authority for adoption:** RCW 19.27A.020, 19.27A.025, 19.27A.160

**Statute being implemented:** RCW 19.27A, 19.27

**Is rule necessary because of a:**

Federal Law?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Federal Court Decision?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
State Court Decision?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No

If yes, CITATION:

**Agency comments or recommendations, if any, as to statutory language, implementation, enforcement, and fiscal matters:** In addition to comments on all of the proposed changes, the Council is looking for testimony and guidance on **Table C405.4.2, Lighting power allowance**. There are three different options proposed for public comment. Option 1 provides an estimated 4.5% energy savings over the current code. Option 2 provides an estimated 9% savings. Option 3 is estimated to be a 15% savings.

<b>Name of proponent:</b> (person or organization) Washington State Building Code Council and various stakeholders	<input type="checkbox"/> Private
	<input type="checkbox"/> Public
	<input checked="" type="checkbox"/> Governmental

**Name of agency personnel responsible for:**

	Name	Office Location	Phone
Drafting:	Krista Braaksma	1500 Jefferson SE, PO Box 41449, Olympia WA	(360) 407-9278

Implementation: Krista Braaksma 1500 Jefferson SE, PO Box 41449, Olympia WA (360) 407-9278

Enforcement: Local Jurisdictions

**Is a school district fiscal impact statement required under RCW 28A.305.135?**

☐ Yes ☒ No

If yes, insert statement here:

The public may obtain a copy of the school district fiscal impact statement by contacting:

Name:

Address:

Phone:

Fax:

TTY:

Email:

Other:

**Is a cost-benefit analysis required under RCW 34.05.328?**

☒ Yes: A preliminary cost-benefit analysis may be obtained by contacting:

Name: Richard Brown

Address: 1500 Jefferson SE, PO Box 41449, Olympia WA 98504-1449

Phone: (360) 407-9277

Fax:

TTY:

Email: Richard.Brown@des.wa.gov

Other:

☐ No: Please explain:

**Regulatory Fairness Act Cost Considerations for a Small Business Economic Impact Statement:**

This rule proposal, or portions of the proposal, **may be exempt** from requirements of the Regulatory Fairness Act (see chapter 19.85 RCW). Please check the box for any applicable exemption(s):

☐ This rule proposal, or portions of the proposal, is exempt under RCW 19.85.061 because this rule making is being adopted solely to conform and/or comply with federal statute or regulations. Please cite the specific federal statute or regulation this rule is being adopted to conform or comply with, and describe the consequences to the state if the rule is not adopted.

Citation and description:

☐ This rule proposal, or portions of the proposal, is exempt because the agency has completed the pilot rule process defined by RCW 34.05.313 before filing the notice of this proposed rule.

☐ This rule proposal, or portions of the proposal, is exempt under the provisions of RCW 15.65.570(2) because it was adopted by a referendum.

☐ This rule proposal, or portions of the proposal, is exempt under RCW 19.85.025(3). Check all that apply:

☐ RCW 34.05.310 (4)(b)  
(Internal government operations)

☐ RCW 34.05.310 (4)(e)  
(Dictated by statute)

☐ RCW 34.05.310 (4)(c)  
(Incorporation by reference)

☐ RCW 34.05.310 (4)(f)  
(Set or adjust fees)

☐ RCW 34.05.310 (4)(d)  
(Correct or clarify language)

☐ RCW 34.05.310 (4)(g)  
((i) Relating to agency hearings; or (ii) process requirements for applying to an agency for a license or permit)

☐ This rule proposal, or portions of the proposal, is exempt under RCW \_\_\_\_.

Explanation of exemptions, if necessary:

**COMPLETE THIS SECTION ONLY IF NO EXEMPTION APPLIES**

If the proposed rule is **not exempt**, does it impose more-than-minor costs (as defined by RCW 19.85.020(2)) on businesses?

☐ No Briefly summarize the agency's analysis showing how costs were calculated. \_\_\_\_\_

☒ Yes Calculations show the rule proposal likely imposes more-than-minor cost to businesses, and a small business economic impact statement is required. Insert statement here:

There are costs imposed by the proposed rules but the costs do not fall disproportionately on small businesses. These rules will not affect the distribution of impacted work, whether by small businesses or not, doing the work. The rules do not impact employment, reporting or record keeping

#### **Description**

The Washington State Building Code Council (Council) is filing a proposed rule to adopt the updated 2015 edition of the International Energy Conservation Code with state amendments, known as the 2015 Washington State Energy Code (WSEC): WAC 51-11R & WAC 51-11C. Since 1985 the state building code council has been responsible to update to new editions of the building code per RCW19.27.074.

The administrative compliance requirements are under the authority of the local government. RCW19.27.050. Enforcement activities including permit issuance, plan review and approval, and inspections occur at the local level. Requirements for construction document submittal and other reporting requirements are determined by the local jurisdiction and are consistent with previously established policies. The proposed amendments to WAC 51-51 include specific technical requirements for building construction to be consistent with national standards.

The WSEC is updated every three years by the Council. The code development process conducted by the model code organization is open to all interest groups within the design and construction industry and from governmental organizations. See [www.iccsafe.org](http://www.iccsafe.org) for more information about the model code development process.

#### **Professional Services**

Washington has had a statewide building code in effect since 1974. The local enforcement authority having jurisdiction administers the codes through the building and/or fire departments. Administrative procedures for state building code compliance are established and will not be changed by the adoption of the update to the current building codes. Small businesses will employ the same types of professional services for the design and construction of buildings and systems to comply with the state building code.

The proposed rule updates the state building code and does not require additional equipment, supplies, labor or other services. Services needed to comply with the building code are existing within the construction industry as required by the local authority having jurisdiction.

#### **Costs of Compliance for Businesses**

The Council accepts proposals to amend the WSEC to meet the legislative goals. The statewide code amendment proposal process is defined in WAC 51-04 and the Council by-laws. Proposals must increase the energy efficiency in buildings. Each proponent must identify where a proposed amendment has an economic impact and must quantify costs. The Council developed a specific set of forms for the Washington state energy code, so proponents could identify where a proposed amendment was editorial, technical or a policy change.

The Council received 171 proposals to improve the Washington state energy code. The energy code technical advisory group (TAG) recommended approval of 124 amendments as submitted or as modified. 21 proposed amendments were identified by the TAG as having a significant cost.

The Energy Code technical advisory group (TAG) and the Council Economic workgroup determined there is a cost for compliance on businesses for the following proposed state amendments. The Council recommended filing the proposed rule to allow input through the public hearing process.

1. WSEC C402.1.1, C402.1.1.1, and C402.1.1.3 Low energy buildings, and semi-heated buildings and greenhouses (Proposal Env013-2018 Revised 6/15/18) **Savings:** Creates a new compliance path and defines non-opaque thermal envelope requirements. The primary economic impact is a significant reduction in energy consumption through the use of increased envelope insulation. Predicts an annual energy savings of 375 KBTU/ square foot.
2. WSEC Table C402.4 Semi-heated buildings and spaces (Proposal Env035-2018): Window requirements are re-categorized to reflect window construction. This will reduce the energy use from multifamily by requiring more efficient windows for punched window openings (typically installed in multifamily dwelling units). Predicts a utility bill reduction of \$0.06/square foot. Total cost difference of windows / square foot of project (33,700 sq.ft.) = \$0.06 incremental cost increase. Predicted annual energy savings is 0.004 KWH/ square foot.
3. WSEC C402.1.1.1 Increased vertical fenestration area with daylight responsive controls (Proposal Env038-2018 Revised 7/13/18): **Savings** The fraction of floor area required to be in daylight zones is increased. The cost of this proposal depends upon fixture make up. Projects using significant amounts of track lighting may see, or wall sconce fixtures will see reduced costs. Projects not using these fixtures will need to purchase slightly more efficient fixtures. The savings from this proposal will be modest. Reducing the number of projects needing to document the net floor area and the dlz to net floor area fraction should decrease plan review time.
4. WSEC C402.5.1.2, C403.2.2.1, and C406.9 - C402.5.1.2 Building Test, C403.2.2.1 Ventilation – Group R-2, and C406.9 Reduced Air Infiltration (Proposal Env046-2018 Revised 7/13/18): Addresses improvements for building enclosure quality and durability along with providing balanced mechanical ventilation with heat recovery to multifamily living units reducing overall building

energy use, annual heating demand, and peak heating load - all combining to reduce heating equipment sizes while delivering improved thermal comfort. Also cost effectively provides balanced ventilation with filtered outdoor air delivered to living spaces, a substantial health and well-being benefit to occupants and tenants. Modeling a 4-story multifamily structure there is an estimated 19% reduction in building energy use, 47% reduction in annual heating demand, and 37% reduction in peak heating load. For the C406 option there is a predicted 24% reduction in building energy use, 61% reduction in annual heating demand, and 52% reduction in peak heating load. The 10-story multifamily model yielded a 23% reduction in building energy use, 53% reduction in annual heating demand, and reduction in peak heating load. The C406 option yielded 31% reduction in building energy use, 70% reduction in heating demand, and 57% reduction in peak heating load. For a medium size office building baseline model with 33 EUI, modeling results are a 15% reduction in building energy use, 28% reduction in annual heating demand, and 28% reduction in peak heating demand. The C406 models a 23% reduction in building energy use, 42% reduction in annual heating demand, and 44% reduction in peak heating load.

5. WSEC Definitions, C403.1.1, TABLE C407.2, C406.2, Appendix E - Total system performance ratio, MANDATORY COMPLIANCE MEASURES FOR HVAC TOTAL BUILDING PERFORMANCE METHOD, More efficient HVAC equipment and fan performance, Appendix E Calculation of HVAC Total System Performance Ratio (Proposal EM050-2018 Modified 8/10/18): Requires a more efficient HVAC system that will reduce life cycle costs for owners or tenants of retail buildings, schools, and office buildings. The exact economic impact will vary based on building type and selected HVAC systems. As an example, when a stand-alone retail store designed with standard efficiency air source heat pumps with economizers, DOAS, and high efficiency sensible energy recovery is compared to the same building with a baseline system consisting of a standard efficiency gas furnace without economizer, DOAS, and minimum efficiency sensible energy recovery the estimate of the construction cost is \$0.16 /square foot. Code official might need to spend 0.5 to 1.5 hours reviewing the submitted material. Potentially less once familiar with the process.
1. WSEC C403.4.2.3 - Automatic start and stop (Proposal EM070-2018 Revised 7/27/18): Requires Automatic Stop in addition to Automatic Start to further reduce overall HVAC energy use by adding a control scheme to further reduce heating and cooling energy as the building enters the unoccupied period. Reduces energy consumption with existing building controls. Estimated construction cost is \$0.000375/square foot. Estimated annual energy savings is 0.313KWH/ square foot, No significant additional review time expected.
2. WSEC C403.4.7.1 - Decorative vented appliance and fire pit controls (Proposal EM075-2018 Revised 7/27/18): Adds an end use metering category for electric vehicle charging stations. Owners will better understand energy for transportation used and energy for renewable created on their building sites. Some type of switch is already required. This is just a slightly more expensive switch: ~\$25-50 per appliance. Estimated annual energy savings is - KWH/ square foot or KBTU/ square foot depends on usage -. No additional time is anticipated for compliance review and inspection.
3. WSEC C403.7.9 – Shutoff dampers (Proposal EM091-2018 Revised 8/3/18): **Savings** Does not require motorized dampers on small exhaust fans or systems intended for continuous operation. For a 6” exhaust system saves \$138.69 without accounting for additional control requirements.
4. WSEC C403.8.4 - Group R occupancy exhaust fan efficacy (Proposal EM 097-2018): Requires that exhaust fans installed in mid-to high-rise residential comply with minimum fan efficacy requirements and updates the requirements to the latest Energy Star requirement (Version 4.0). Using conservative fan efficacy values results in an energy savings of 0.067 KWH/ square foot. No additional plan review or inspection time is required.
5. WSEC Table C403.8.5.1 - FAN CONTROL (Proposal EM098-2018): Requires smaller fans in DX cooling systems to have 2-speed fan control. Uses commonly available fan controls for a wider range of cooling unit fans. Savings = 700 kWh/Yr or \$70/Yr at \$0.10/kWh. Incremental cost for 2-speed or variable speed motor and controls is \$500.
6. WSEC C403.5, C403.7.7.1, and C403.9 - Economizers, Energy recovery ventilation systems, Heat recovery for space heating (Proposal EM099-2018 Revised 7/27/18): Requires heat recovery chillers/heat pumps in situations where there is a constant relationship between heat rejected from the building and heat required for re-heat/tempering of zones with high minimum airflows. Estimated construction cost is \$2/square foot Estimated annual energy savings is 50 KBTU/ square foot
7. WSEC C401.2 & C402.2 - High input-rated service water heating systems, Renewable and site-recovered heat (Proposal EW101-2018 Revised 8/10/2018): Requires more high-output water heating system. Estimated annual energy savings is 2.071KWH/ square foot. Gas Central DHW to 95 EF Gas Central Storage DHW - Install gas central boiler to serve all of the apartment units \$0.28/square foot. Estimated annual energy savings is 4.1 KBTU/ square foot. No additional time is required by the plan review and inspection staff to enforce this provision.
8. WSEC C405.2 - Lighting controls (Proposal EL113-2018 Revised 7/27/18): **Savings** Adds interior lighting controls to the WSEC based on the existing requirements in ASHARE 90.1-2016. Also clarifies requirements for warehouse and other spaces with 50% dimming requirements. Estimated annual energy savings: 1) Corridor OS Control: 1.67 KWH/ square foot of treatment, 2) Stairwell OS Control: 2.4 KWH/ square foot of treatment, and 3) Parking OS Control: 0.33 KWH/ square foot of treatment.
9. WSEC C405.4.1 - Total connected interior lighting power (Proposal EL118-2018): **Savings** Adds a luminous efficacy statement to ensure that incandescent lamps will not be allowed. Estimated annual energy savings: 1) Corridor OS Control: 1.67 KWH/ square foot of treatment, 2) Stairwell OS Control: 2.4 KWH/ square foot of treatment, and 3) Parking OS Control: 0.33 KWH/ square foot of treatment.

10. WSEC C405.4.1, TABLE C405.4.2 - Definitions, Total connected interior lighting power, INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD, INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD, BUILDING SPECIFIC SPACE-BY-SPACE TYPES (Proposal EL119-2018 Revised 8/10/18): **Savings** Modifies the connected lighting power equation, the lighting power allowance ceiling height adjustment, and the lighting power allowances. The cost of this proposal depends upon fixture make up. Projects using significant amounts of track, can, or wall sconce fixtures will see reduced costs. Projects not using these fixtures will need to purchase slightly more efficient fixtures. Estimated annual energy savings is 0.175KWH/ square foot. The savings will be modest. In office, lighting power will be reduced 10.7% from 0.66 W/sf to 0.59 W/sf. Assuming 2500 hours per year of operation. Assuming VRF heating and cooling the interactive effects will cancel out.
11. WSEC C405.5.1 - Exterior building grounds lighting (Proposal EL122-2018 Revised 8/8/18): Requires exterior grounds lighting greater than 50 watts meet minimum efficacy requirements of 100 lumens/watt or greater or 80 lumens per watt if less than or equal to 50 watts. Also allows for lower efficacy luminaire sources if they are connected by automatic lighting controls, are solar-powered or exempted. Estimated cost is \$0.14 square foot. Estimated annual energy savings is 0.178 KWH/ square foot. No additional enforcement time is required. This requirement is currently in the code and is just being updated.
12. WSEC C406, C406.10 - EFFICIENCY PACKAGE, Enhanced commercial kitchen equipment (Proposal EO127-2018 Revised 8/10/18): Provides a targeted option for commercial kitchens to comply with code while saving substantial energy using cost-effective efficient equipment. The primary economic impact is a reduction in energy consumption through the purchase of efficient commercial cooking equipment. There is a direct benefit to the building owner and business via a reduction in energy costs related to reduced energy consumption from foodservice equipment with high run hours. Estimated construction cost is \$1.55 /square foot. Estimated annual energy savings is 22.6 KBTU/ square foot.
13. WSEC C406.11 - High Performance Service Water Heating in Multifamily Buildings (Proposal EO130\*2018 Revised 8/10/18): Provides an additional measure for heat pump water heating in multifamily buildings. Estimated annual energy savings is 1.75KWH/ square foot (or) 6KBTU/ square foot; For residential projects, 1750KWH / dwelling unit.
14. WSEC Primarily Section C407, but related requirements in C401.2, C402.4.1.3, C402.4.1.4, C403.5, C403.6.10 - Adoption of ASHRAE 90.1 Appendix G for Performance based compliance (Proposal EP141-2018): Replaces the current whole building performance path in the code with the procedures ASHRAE Standard 90.1 Appendix G along with Washington State specific performance targets to maintain the stringency of the Washington code. The proposal is expected to save modeling costs for building owners pursuing LEED, Standard 189.1 (IGCC) or other beyond code programs since a second baseline model will not be needed. It could potentially save additional modeling costs if software becomes available to automate the process generating the baseline models. Jurisdiction review costs should be reduced if nationally developed compliance documentation is required. Estimated construction cost is \$0.07/square foot for a 50,000 sq.ft. building Typical modeling costs vary significantly, but an estimate of \$0.18 - \$0.24/ft<sup>2</sup> for a 50,000 sq.ft. building with a single baseline model is reasonable. If a second baseline model is needed, costs can be expected to increase by 1/3 or about \$0.07/ft<sup>2</sup>. Codes enforcement time is expected to decrease based on available compliance documentation, higher quality of models due to a more universal ruleset, and potentially elimination of the baseline model review if automated software is used.
15. WSEC C408, C410, C501.7 - Chapter 4 Commercial Energy Efficiency, Chapter 5 Existing Buildings (Proposal EC150-2018 Revised 8/3/18): Changes the scope of commissioning requirements. Implementing an entire commissioning process for a new construction project is approximately \$1.16/square foot or 0.4% of project cost.
16. WSEC C409.3 - End-Use Metering (Proposal E155-2018 Revised 10/8/18): Requires end-use metering for lighting, plug loads, and process equipment (in addition to HVAC and water heating). Best case: all end-uses are separated/isolated at the main electrical switchgear. Cost estimate: \$2,000 meter + \$1,000 controls + \$2,000 markups/Cx = \$5,000 per meter. Total cost for three additional meters (lighting, plug, process) = \$15,000 per building. Worse case: electrical distribution requires multiple sub-meters throughout the building in order to distinguish between load types. Cost will vary greatly depending on the size and type of building, as well as the design of the electrical distribution system.

### **Loss of Sales or Revenue**

The proposed rules make the state code for building construction consistent with national standards. Businesses with new products or updated test or design standards are recognized in the updated building code. For these businesses there will be a gain in sales and revenue.

The results of reduced energy use in buildings include avoiding the need for new power generation, reducing environmental impact, and providing local employment. The legislative findings state that energy efficiency is the cheapest, quickest, and cleanest way to meet rising energy needs, confront climate change, and boost our economy.

### **Cost of Compliance for Small Businesses**

The majority of businesses affected by the updates to the building codes are small businesses; over 95 percent of those listed in the construction and related industries have under 50 employees. The costs per employee are comparable between the largest businesses and the majority of small businesses. The cost to comply with the updated codes is not a disproportionate impact on small business. Where the Council found the cost of compliance for small businesses to be disproportionate, the proposed rule

mitigates the cost. The proposed rules include a definition of small business and provide exceptions for compliance with the updated rule.

#### **Small Businesses Involved in the Development of the Rule**

The SBCC conducted open public meetings of the energy code technical advisory group (TAG), available via telephone conference bridge and over the internet, and allowed comment on every item on every agenda. The SBCC appointed over 100 representatives of all segments of the business and construction community to serve on the technical advisory groups.

#### **List of Industries**

Below is a list of industries required to comply with the building code:

<b>North American Industry Classification System (NAICS) Code</b>	<b>NAICS Code Definition</b>	<b>Number of Establishments in Washington State</b>	<b>TOTAL Annual Payroll</b>	<b>TOTAL Annual Revenue</b>	<b>AVG Annual Payroll</b>	<b>AVG Annual Revenue</b>	<b>1% of Avg Annual Payroll</b>	<b>0.3% of Avg Annual Revenue</b>
236115	New single-family housing construction (except for-sale builders)	1261	\$186,272,000	---	\$147,718	---	\$1,477	---
236116	New multifamily housing construction (except for-sale builders)	45	\$54,622,000	---	\$1,213,822	---	\$12,138	---
236118	Residential remodelers	2777	\$318,180,000	\$1,536,217,000	\$114,577	\$553,193	\$1,146	\$1,660
236210	Industrial building construction	53 (s)	\$99,790,000	---	---	---	---	---
236220	Commercial and institutional building construction	862	\$772,473,000	\$6,925,925,000	\$896,140	\$8,034,716	\$8,961	\$24,104
238110	Poured concrete foundation and structure contractors	511	\$144,643,000	\$479,256,000	\$283,059	\$937,879	\$2,831	\$2,814
238120	Structural steel and precast concrete contractors	68	\$93,454,000	\$336,100,000	\$1,374,324	\$4,942,647	\$13,743	\$14,828
238130	Framing contractors	417	\$79,196,000	\$279,226,000	\$189,918	\$669,607	\$1,899	\$2,009
238140	Masonry contractors	293	\$74,067,000	\$215,274,000	\$252,788	\$734,724	\$2,528	\$2,204
238150	Glass and glazing contractors	141	\$67,626,000	\$237,985,000	\$479,617	\$1,687,837	\$4,796	\$5,064
238160	Roofing contractors	537	\$179,942,000	\$660,911,000	\$335,088	\$1,230,747	\$3,351	\$3,692



238170	Siding contractors	327	\$58,557,000	\$286,471,000	\$179,073	\$876,058	\$1,791	\$2,628
238190	Other foundation, structure, and building exterior contractors	113	\$37,585,000	\$123,771,000	\$332,611	\$1,095,319	\$3,326	\$3,286
238210	Electrical contractors and other wiring installation contractors	1847	\$940,854,000	\$3,026,762,000	\$509,396	\$1,638,745	\$5,094	\$4,916
238220	Plumbing, heating, and air-conditioning contractors	1664	\$959,976,000	\$3,169,548,000	\$576,909	\$1,904,776	\$5,769	\$5,714
238290	Other building equipment contractors	81	\$117,696,000	---	\$1,453,037	---	\$14,530	---
238310	Drywall and insulation contractors	653	\$282,929,000	\$723,945,000	\$433,276	\$1,108,644	\$4,333	\$3,325
238990	All other specialty trade contractors	547	\$182,710,000	\$573,308,000	\$334,022	\$1,048,095	\$3,340	\$3,144
321213	Engineered wood member (except truss) manufacturing	11	\$14,216,000	\$79,051,000	\$1,292,364	\$7,186,455	\$12,924	\$21,559
321214	Truss manufacturing	22	---	---	---	---	---	---
321219	Reconstituted wood product manufacturing	3	---	---	---	---	---	---
321911	Wood window and door manufacturing	39	\$37,814,000	\$145,137,000	\$969,590	\$3,721,462	\$9,696	\$11,164
321992	Prefabricated wood building manufacturing	18	\$6,891,000	---	\$382,833	---	\$382,833	---
327310	Cement manufacturing	7	---	---	---	---	---	---
327320	Ready-mix concrete manufacturing	93	\$74,457,000	---	\$800,613	---	\$8,006	---
327331	Concrete block and brick manufacturing	18	\$11,218,000	---	\$623,222	---	\$6,232	---

332311	Prefabricated metal building and component manufacturing	9	\$3,564,000	---	\$396,000	---	\$3,960	---
332312	Fabricated structural metal manufacturing	94	\$125,755,000	---	\$1,337,819	---	\$13,378	---
332321	Metal window and door manufacturing	16	\$23,776,000	---	\$1,486,000	---	\$14,860	---
332322	Sheet metal work manufacturing	122	\$122,956,000	\$573,443,000	\$1,007,836	\$4,700,352	\$10,078	\$14,101
335121	Residential electric lighting fixture manufacturing	9	---	---	---	---	---	---
335122	Commercial, industrial, and institutional electric lighting fixture manufacturing	8	\$2,625,000	---	\$328,125	---	\$3,281	---
335129	Other lighting equipment manufacturing	4	---	---	---	---	---	---
423720	Plumbing and heating equipment and supplies (hydronics) merchant wholesalers	168	\$82,225,000	\$897,748,000	\$489,435	\$5,343,738	\$4,894	\$16,031
541310	Architectural services	635	\$326,798,000	\$921,033,000	\$514,643	\$1,450,446	\$5,146	\$4,351
541330	Engineering services	1599	\$1,758,825,000	\$3,946,553,000	\$1,099,953	\$2,468,138	\$11,000	\$7,404
541350	Building inspection services	154	\$9,724,000	\$28,297,000	\$63,143	\$183,747	\$631	\$551
561621	Security systems services (except locksmiths)	109	\$86,072,000	\$233,388,000	\$789,651	\$2,141,174	\$7,897	\$6,424

Note: Data is blank in some fields to protect data source.

Data Source: Economic Census of the United States

The public may obtain a copy of the small business economic impact statement or the detailed cost calculations by contacting:

Name: Richard Brown

Address: 1500 Jefferson SE, PO Box 41449, Olympia WA 98504-1449

Phone: (360) 407-9277

Fax:  
TTY:  
Email: Richard.Brown@des.wa.gov  
Other:

**Date:** May 8, 2019

**Name:** Doug Orth

**Title:** Council Chair

**Signature:**

A handwritten signature in blue ink, appearing to read "Doug Orth", is written over a light blue rectangular background.

**Chapter 51-11C WAC**  
**STATE BUILDING CODE ADOPTION AND AMENDMENT OF THE ((2015)) 2018 EDITION OF THE INTERNATIONAL ENERGY CONSERVATION CODE, COMMERCIAL**

AMENDATORY SECTION (Amending WSR 17-17-162, filed 8/23/17, effective 10/1/17)

**WAC 51-11C-10100 Section C101—Scope and general requirements.**

**C101.1 Title.** This code shall be known as the *Washington State Energy Code*, and shall be cited as such. It is referred to herein as "this code."

**C101.2 Scope.** This code applies to *commercial buildings* and the buildings sites and associated systems and equipment. References in this code to Group R shall include Group I-1, Condition 2 assisted living facilities licensed by Washington state under chapter 388-78A WAC and Group I-1, Condition 2 residential treatment facilities licensed by Washington state under chapter 246-337 WAC. Building areas that contain Group R sleeping units, regardless of the number of stories in height, are required to comply with the commercial sections of the energy code.

EXCEPTION: The provisions of this code do not apply to *temporary growing structures* used solely for the commercial production of horticultural plants including ornamental plants, flowers, vegetables, and fruits. A temporary growing structure is not considered a building for the purposes of this code. However, the installation of other than listed, portable mechanical equipment or listed, portable lighting fixtures is not allowed.

**C101.3 Intent.** This code shall regulate the design and construction of buildings for the use and conservation of energy over the 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.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-10140 Section C101.4—Applicability.**

**C101.4 Applicability.** Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall govern.

**C101.4.1 Mixed ((~~occupancy~~)) residential and commercial buildings.** Where a building includes both *residential building* and *commercial* ((~~occupancies, each occupancy~~)) building portions, each portion shall be separately considered and meet the applicable provisions of WSEC—Commercial Provisions or WSEC—Residential Provisions.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-10150 Section C101.5—Compliance.**

**C101.5 Compliance.** *Residential buildings* shall meet the provisions of WSEC—Residential Provisions. *Commercial buildings* shall meet the provisions of WSEC—Commercial Provisions.

**C101.5.1 Compliance materials.** The *code official* shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code.

**C101.6 Appendices.** Appendices A, B, C, and D are included in the adoption of this code. Provisions in Appendices E and F shall not apply unless specifically adopted by the local jurisdiction.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-10200 Section C102—~~((Alternate materials Method))~~  
Alternative materials, design and methods of construction~~((, design or insulating systems))~~ and equipment.**

**C102.1 General.** The provisions of this code ~~((is))~~ are not intended to prevent the ~~((use of any material, method of construction, design or insulating system not specifically prescribed herein, provided that such construction, design or insulating system has been approved by the code official as meeting the intent of this code))~~ 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. An alternative material, design or method of construction shall be approved where the *code official* finds 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 shall respond in writing, stating the reasons why the alternative was not approved.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-10300 Section C103—Construction documents.**

**C103.1 General.** Construction documents and other supporting data shall be submitted in one or more sets 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 ex-

ist, the *code official* is authorized to require necessary construction documents to be prepared by a registered design professional.

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

**C103.2 Information on construction documents.** Construction documents shall be drawn to scale upon suitable material. Electronic media documents are permitted to be submitted when *approved* by the *code official*. 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, as applicable:

1. Insulation materials and their *R*-values.
2. Fenestration *U*-factors and SHGCs.
3. Area-weighted *U*-factor and SHGC calculations.
4. Mechanical system design criteria.
5. Mechanical and service water heating system and equipment types, sizes and efficiencies.
6. Economizer description.
7. Equipment and systems controls.
8. Fan motor horsepower (hp) and controls.
9. Duct sealing, duct and pipe insulation and location.
10. Lighting fixture schedule with wattage and control narrative.
11. Location of daylight zones on floor plan.
12. Air barrier details including all air barrier boundaries and associated square foot calculations on all six sides of the air barrier as applicable.

**C103.2.1 Building thermal envelope depiction.** The building's thermal envelope shall be represented on the construction documents.

**C103.3 Examination of documents.** The *code official* 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.

**C103.3.1 Approval of construction documents.** When the *code official* 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*. 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 a duly authorized representative.

**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.

**C103.3.3 Phased approval.** The *code official* 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 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.

**C103.4 Amended construction documents.** Changes made during construction that are not in compliance with the *approved* construction documents shall be resubmitted for approval as an amended set of construction documents.

**C103.5 Retention of construction documents.** One set of *approved* construction documents shall be retained by the *code official* 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.

**C103.6 Building documentation and close out submittal requirements.** The construction documents shall specify that the documents described in this section be provided to the building owner or owner's authorized agent within ((180)) a maximum of 90 days of the date of receipt of the certificate of occupancy.

**C103.6.1 Record documents.** Construction documents shall be updated by the installing contractor and architect or engineer of record to convey a record of the completed work. Such updates shall include building envelope, mechanical, plumbing, electrical and control drawings red-lined, or redrawn if specified, that show all changes to size, type and locations of components, equipment and assemblies. Record documents shall include the location and model number of each piece of equipment as installed. The architect, engineer of record or installing contractor is required to provide consolidated record drawings in compliance with this section to the building owner or owner's authorized agent with the timeline specified in Section C103.6.

**C103.6.2 Building operations and maintenance information.** Required regular maintenance actions for equipment and systems shall be clearly stated on a readily visible label on the equipment. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product and the manufacture date or installation date.

**C103.6.2.1 Manuals.** An operating and maintenance manual shall be provided for each component, device, piece of equipment, and system governed by this code. The manual shall include all of the following:

1. Submittal data indicating all selected options for each piece of equipment and control devices.

2. Manufacturer's operation manuals and maintenance manuals for each device, piece of equipment, and system requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions, cleaning and recommended relamping shall be clearly identified.

3. Name and address of at least one service agency.

4. Controls system inspection schedule, maintenance and calibration information, wiring diagrams, schematics, and control sequence descriptions. A schedule for inspecting and recalibrating all lighting controls. Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, on the graphic where settings may be changed.

5. A narrative of how each system is intended to operate, including recommended setpoints. Sequence of operation alone is not acceptable for this requirement.

**C103.6.3 Compliance documentation.** All energy code compliance forms and calculations shall be delivered in one document to the building owner as part of the project record documents ~~((7))~~ or manuals, or as a standalone document. This document shall include the specific energy code year utilized for compliance determination for each system. NFRC certificates for the installed windows, list of total area for each NFRC certificate, the interior lighting power compliance path (building area, space-by-space) used to calculate the lighting power allowance.

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

1. The ~~((envelop))~~ envelope insulation compliance path (prescriptive or component performance).
2. All completed code compliance forms, and all compliance calculations including, but not limited to, those required by sections C402.1.5, C403.2.12.1, C405.4, and C405.5.

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

1. A list of all proposed envelope component types, areas and U-values.
2. A list of all lighting area types with areas, lighting power allowance, and installed lighting power density.
3. A list of each HVAC system modeled with the assigned and proposed system type.
4. Electronic copies of the baseline and proposed model input and output file. The input files shall be in a format suitable for rerunning the model and shall not consist solely of formatted reports of the inputs.

**C103.6.4 Systems operation training.** Training of the maintenance staff for equipment included in the manuals required by Section C103.6.2 shall include at a minimum:

1. Review of manuals and permanent certificate.
2. Hands-on demonstration of all normal maintenance procedures, normal operating modes, and all emergency shutdown and start-up procedures.
3. Training completion report.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

## **WAC 51-11C-10400 Section C104—Inspections.**

**C104.1 General.** Construction or work for which a permit is required shall be subject to inspection by the *code official* ~~((or))~~, his or her designated agent, or an approved agency, and such construction or work shall remain ~~((accessible and exposed))~~ 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 ((accessible and exposed)) visible and able to be accessed for inspection purposes. Neither the code official 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.

**C104.2 Required inspections.** The code official ~~((or))~~, his or her designated agent, or an approved agency, upon notification, shall make the inspections set forth in Sections C104.2.1 through C104.2.6.

**C104.2.1 Footing and foundation ~~((inspection))~~ insulation.** Inspections ~~((associated with footings and foundations))~~ shall verify ~~((compliance with the code as to))~~ footing and/or foundation insulation R-value, location, thickness, depth of burial and protection of insulation as required by the code ((and)), approved plans and specifications.

**C104.2.2 ~~((Insulation and fenestration inspection.))~~ Thermal envelope.** Inspections shall be made before application of interior finish and shall verify ~~((compliance with the code as to types of insulation and corresponding R-values and their correct location and proper installation; fenestration properties (U-factor, SHGC and VT) and proper installation; and air leakage controls))~~ that envelope components with the correct type of insulation, the R-values, the correct location of insulation, the correct fenestration, the U-factor, SHGC, VT, and air leakage controls are properly installed as required by the code ((and)), approved plans and specifications, including envelope components in future tenant spaces of multitenant buildings.

**C104.2.3 Plumbing ~~((inspection))~~ system.** Inspections shall verify ~~((compliance as required by the code and approved plans and specifications as to types of insulation and corresponding R-values and protection, required controls and required heat traps))~~ the type of insulation, the R-values, the protection required, controls, and heat traps as required by the code, approved plans and specifications.

**C104.2.4 Mechanical ~~((inspection))~~ system.** Inspections shall verify ~~((compliance as required by the code and approved plans and specifications as to))~~ the installed HVAC equipment for the correct type and size, ((required)) controls, duct and piping ((system)) insulation ((and corresponding)) R-values, duct system and damper air leakage ((and required energy recovery and/or economizers)), minimum fan efficiency, energy recovery and economizer as required by the code, approved plans and specifications.

**C104.2.5 Electrical ~~((and lighting inspection))~~ system.** Inspections shall verify ~~((compliance as required by the code and approved plans and specifications as to installed))~~ lighting system((s)) controls, components ((and controls)), meters, motors and installation of an electric meter for each dwelling unit as required by the code, approved plans and specifications.

**C104.2.6 Final inspection.** The ~~((building shall have a final inspection and not be occupied until approved))~~ 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 in accordance with Section C408.

**C104.3 Reinspection.** A building shall be reinspected when determined necessary by the *code official*.

**C104.4 Approved inspection agencies.** The *code official* is authorized to accept reports of *approved* inspection agencies, provided such agencies satisfy the requirements as to qualifications and reliability relevant to the building components and systems they are inspecting.

**C104.5 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official* 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.

**C104.6 Reinspection and testing.** Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this code. The work or installation shall then be resubmitted to the *code official* for inspection and testing.

**C104.7 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*.

**C104.7.1 Revocation.** The *code official* is authorized to, in writing, suspend or revoke 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.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-20201 Section C202.1—A.**

**ABOVE-GRADE WALL.** A wall enclosing *conditioned space* that is not a below-grade wall. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

~~((**ACCESSIBLE.** Admitting close approach as a result of not being guarded by locked doors, elevation or other effective means (see "Readily accessible").))~~ **ACCESS (TO).** That which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel or similar obstruction.

**ADDITION.** An extension or increase in the *conditioned space* floor area, number of stories, or height of a building or structure.

**AIR BARRIER.** ~~((Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.))~~ One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the building thermal envelope and its assemblies.

**AIR CURTAIN.** A device, installed at the building entrance, that generates and discharges a laminar air stream intended to prevent the infiltra-

tion of external, unconditioned air into the conditioned spaces, or the loss of interior, conditioned air to the outside.

**ALTERATION.** Any construction, retrofit or renovation to an existing structure other than repair or addition (~~((that requires a permit))~~). Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, addition or change to the arrangement, type or purpose of the original installation (~~((that requires a permit))~~).

**APPROVED.** (~~((Approval by))~~) Acceptable to the code official (~~((as a result of investigation and tests conducted by him or her, or by reason of accepted principles or tests by nationally recognized organizations))~~).

**APPROVED AGENCY.** An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, or furnishing product certification research reports, when such agency has been approved by the code official.

**ATTIC AND OTHER ROOFS.** All other roofs, including roofs with insulation entirely below (inside of) the roof structure (i.e., attics, cathedral ceilings, and single-rafter ceilings), roofs with insulation both above and below the roof structure, and roofs without insulation but excluding roofs with insulation entirely above deck and metal building roofs.

**AUTOMATIC.** Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see "Manual").

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

## **WAC 51-11C-20202 Section C202.2—B.**

**BELOW-GRADE WALL.** That portion of a wall in the building envelope that is entirely below the finish grade and in contact with the ground.

**BLOCK.** A generic concept used in energy simulation. It can include one or more thermal zones. It represents a whole building or portion of a building with the same use type served by the same HVAC system type.

**BOILER, MODULATING.** A boiler that is capable of more than a single firing rate in response to a varying temperature or heating load.

**BOILER SYSTEM.** One or more boilers, their piping and controls that work together to supply steam or hot water to heat output devices remote from the boiler.

**BUBBLE POINT.** The refrigerant liquid saturation temperature at a specified pressure.

**BUILDING.** Any structure used or intended for supporting or sheltering any use or occupancy, including any mechanical systems, service water heating systems and electric power and lighting systems located on the building site and supporting the building.

**BUILDING COMMISSIONING.** A process that verifies and documents that the (~~((selected))~~) building systems have been (~~((designed,))~~) installed(~~((,))~~) and function according to the (~~((owner's project requirements and))~~) approved construction documents(~~((, and to minimum code requirements))~~).

**BUILDING ENTRANCE.** Any (~~((door))~~) doorway, set of doors, (~~((doorway,))~~) revolving door, vestibule or other form of portal that is ordinarily used to gain access to the building (~~((from the outside by the public))~~) or to

exit from the building by its users and occupants. This does not include doors solely used to directly enter mechanical, electrical and other building utility service equipment rooms, or doors for emergency egress only.

**BUILDING SITE.** A contiguous area of land that is under the ownership or control of one entity.

**BUILDING THERMAL ENVELOPE.** The below-grade walls, above-grade walls, floors, ceilings, roofs, and any other building element((s)) assemblies that enclose conditioned space or provides a boundary between conditioned space, semiheated space and exempt or unconditioned space.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

### **WAC 51-11C-20203 Section C202.3—C.**

**C-FACTOR (THERMAL CONDUCTANCE).** The coefficient of heat transmission (surface to surface) through a building component or assembly, equal to the time rate of heat flow per unit area and the unit temperature difference between the warm side and cold side surfaces (Btu/h ft<sup>2</sup> x °F) [W/(m<sup>2</sup> x K)].

**CAPTIVE KEY DEVICE.** A lighting control that will not release the key that activates the override when the lighting is on.

**CAVITY INSULATION.** Insulating material located between framing members.

**CERTIFIED COMMISSIONING PROFESSIONAL.** An individual who is certified by an ANSI/ISO/IEC 17024:2012 accredited organization to lead, plan, coordinate and manage commissioning teams and implement the commissioning (~~((processes, or a licensed professional engineer in Washington state))~~) process.

**CHANGE OF OCCUPANCY.** A change in the use of a building or a portion of a building that results in any of the following:

1. A change of occupancy classification.
2. A change from one group to another group within an occupancy classification.
3. Any change in use within a group for which there is a change in the application of the requirements of this code.

**CIRCULATING HOT WATER SYSTEM.** A specifically designed water distribution system where one or more pumps are operated in the service hot water piping to circulate heated water from the water-heating equipment to the fixture supply and back to the water-heating equipment.

**CLERESTORY FENESTRATION.** See "FENESTRATION."

**CLIMATE ZONE.** A geographical region based on climatic criteria as specified in this code.

**CODE OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

**COEFFICIENT OF PERFORMANCE (COP) - COOLING.** The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

**COEFFICIENT OF PERFORMANCE (COP) - HEATING.** The ratio of the rate of heat removal to the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system, including the compressor and, if applicable, auxiliary heat, under designated operating conditions.

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

**COMPUTER ROOM.** A room whose primary function is to house equipment for the processing and storage of electronic data and that has a design ~~((electronic data))~~ total information technology equipment (IET) equipment power ((density exceeding)) less than or equal to 20 watts per square foot of conditioned area and a design IET equipment load less than or equal to 10 kW.

**CONDENSING UNIT.** A factory-made assembly of refrigeration components designed to compress and liquefy a specific refrigerant. The unit consists of one or more refrigerant compressors, refrigerant condensers (air-cooled, evaporatively cooled, or water-cooled), condenser fans and motors (where used) and factory-supplied accessories.

**CONDITIONED FLOOR AREA.** The horizontal projection of the floors associated with the *conditioned space*.

**CONDITIONED SPACE.** An area, room or space that is enclosed within the building thermal envelope and that is directly heated or cooled or that is indirectly heated or cooled. 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.

~~((CONTINUOUS AIR BARRIER. A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.))~~

**CONTINUOUS INSULATION (CI).** Insulating material that is continuous across all structural members without metal thermal bridges other than fasteners that have a total cross-sectional area not greater than 0.04 percent of the envelope surface through which they penetrate, and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

**CONTROLLED PLANT GROWTH ENVIRONMENT.** Group F and U buildings or spaces that are specifically controlled to facilitate and enhance plant growth and production by manipulating various indoor ~~((environment))~~ environmental conditions. Technologies include indoor agriculture, cannabis growing, hydroponics, aquaculture and aquaponics. Controlled indoor environment variables include, but are not limited to, temperature, air quality, humidity, and carbon dioxide.

**CURTAIN WALL.** Fenestration products used to create an external nonload-bearing wall that is designed to separate the exterior and interior environments.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

#### **WAC 51-11C-20204 Section C202.4—D.**

**DATA ACQUISITION SYSTEM.** An electronic system managed by the building owner to collect, tabulate and display metering information.

**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, which has a design total information technology equipment (ITE) power density exceeding 20 watts per square

foot of conditioned area and a total design ITE equipment load greater than 10 kW.

DATA CENTER SYSTEMS. HVAC systems, electrical systems, equipment, or portions thereof used to condition ITE or electrical systems in a data center.

DAYLIGHT RESPONSIVE CONTROL. A device or system that provides automatic control of electric light levels based on the amount of daylight in a space.

DAYLIGHT ZONE. The portion of the building interior floor area that is illuminated by natural daylight through ~~((sidelight and toplight))~~ side-lit and toplit fenestration.

DECORATIVE APPLIANCE, VENTED. A vented appliance wherein the primary function lies in the aesthetic effect of the flames.

DEMAND CONTROL VENTILATION (DCV). A ventilation system capability that provides for the automatic reduction of outdoor air intake below design rates when the actual occupancy of spaces served by the system is less than design occupancy.

DEMAND RECIRCULATION WATER SYSTEM. A water distribution system ~~((where pumps prime the service hot water piping with heated water upon demand for hot water))~~ having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water source through a cold water supply pipe.

DOOR, NONSWINGING. Roll-up, tilt-up, metal coiling and sliding doors, access hatches, and all other doors that are not swinging doors.

DOOR, SWINGING. Doors that are hinged on one side and revolving doors.

DUCT. A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

DUCT SYSTEM. A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling equipment and appliances.

DWELLING UNIT. A single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

DX-DEDICATED OUTDOOR AIR SYSTEM UNITS (DX-DOAS UNITS). A type of air-cooled, water-cooled or water source factory assembled product that dehumidifies 100 percent outdoor air to a low dew point and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designated supply air temperature. This conditioned outdoor air is then delivered directly or indirectly to the conditioned spaces. It may precondition outdoor air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus.

DYNAMIC GLAZING. Any fenestration product that has the fully reversible ability to change its performance properties, including U-factor, SHGC, or VT.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

#### **WAC 51-11C-20205 Section C202.5—E.**

**ECONOMIZER, AIR.** A duct and damper arrangement and automatic control system that allows a cooling system to supply outside air to reduce or eliminate the need for mechanical cooling during mild or cold weather.

**ECONOMIZER, WATER.** A system where the supply air of a cooling system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling.

**ELECTRICAL LOAD COEFFICIENT (ELC).** In a data center, the ratio of the sum of three specific electrical losses (or losses calculated from efficiencies) to the ITE load itself. Specifically, ELC equals the sum of the incoming (to ITE) electrical service losses, UPS losses, and ITE distribution losses all divided by the peak ITE load. The design ELC is calculated at the full load design condition with active redundant equipment engaged, and the annual ELC is calculated the same way because it is assumed that ITE runs constantly at full power all year.

**ENCLOSED SPACE.** A volume surrounded by solid surfaces such as walls, floors, roofs, and openable devices such as doors and operable windows.

**END USE CATEGORY.** A load or group of loads that consume energy in a common or similar manner.

**ENERGY ANALYSIS.** A method for estimating the annual energy use of the *proposed design* and *standard reference design* based on estimates of energy use.

**ENERGY COST.** The total estimated annual cost for purchased energy for the building functions regulated by this code, including applicable demand charges.

**ENERGY RECOVERY VENTILATION SYSTEM.** Systems that employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying outdoor ventilation air prior to supplying the air to a space, either directly or as part of an HVAC system.

**ENERGY SIMULATION TOOL.** An *approved* software program or calculation-based methodology that projects the annual energy use of a building.

**ENERGY SOURCE METER.** A meter placed at the source of the incoming energy that measures the energy delivered to the whole building or metered space.

**ENTRANCE DOOR.** A vertical fenestration product((s)) used for occupant ingress, egress and access in nonresidential buildings including, but not limited to, exterior entrances ((that utilize)) utilizing latching hardware and automatic closers and ((contain)) containing over 50 percent ((glass)) glazing specifically designed to withstand heavy ((use and possibly abuse)) duty usage.

**EQUIPMENT ROOM.** A space that contains either electrical equipment, mechanical equipment, machinery, water pumps or hydraulic pumps that are a function of the building's services.

**EXTERIOR WALL.** Walls including both above-grade walls and below-grade walls.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

## **WAC 51-11C-20206 Section C202.6—F.**

**FAN BRAKE HORSEPOWER (BHP).** The horsepower delivered to the fan's shaft. Brake horsepower does not include the mechanical drive losses (belts, gears, etc.).

**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.

**FAN SYSTEM BHP.** The sum of the fan brake horsepower 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 space(s)* and return it to the source or exhaust it to the outdoors.

**FAN SYSTEM DESIGN CONDITIONS.** Operating conditions that can be expected to occur during normal system operation that result in the highest supply fan airflow rate to conditioned spaces served by the system, other than during air economizer operation.

**FAN SYSTEM MOTOR NAMEPLATE HP.** The sum of the motor nameplate horsepower of all fans that are required to operate at design conditions to supply air from the heating or cooling source to the *conditioned space(s)* and return it to the source or exhaust it to the outdoors.

**FENESTRATION.** Products classified as either skylights or vertical fenestration (~~(or skylights)~~).

**SKYLIGHTS.** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (91.05 rad) from horizontal, including unit skylights, tubular daylighting devices and glazing materials in solariums, sunrooms, roofs and sloped walls.

**VERTICAL FENESTRATION.** Windows (~~((fixed or moveable))~~) that are fixed or operable, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope (~~((of at least))~~) not less than 60 degrees (91.05 rad) from horizontal. Opaque areas such as spandrel panels are not considered vertical fenestration.

**CLERESTORY FENESTRATION.** An upper region of vertical fenestration provided for the purpose of admitting daylight beyond the perimeter of a space. The entire clerestory fenestration assembly is installed at a height greater than 8 feet above the finished floor.

**FENESTRATION AREA.** Total area of the fenestration measured using the rough opening, and including the glazing, sash and frame.

**FENESTRATION PRODUCT, FIELD-FABRICATED.** A fenestration product whose frame is made at the construction site of standard dimensional lumber or other materials that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product or exterior door. Field fabricated does not include site-built fenestration.

**FENESTRATION PRODUCT, SITE-BUILT.** A fenestration designed to be made up of field-glazed or field-assembled units using specific factory cut or otherwise factory-formed framing and glazing units. Examples of site-built fenestration include storefront systems, curtain walls, and atrium roof systems.

**F-FACTOR.** The perimeter heat loss factor for slab-on-grade floors (Btu/h x ft x °F) [W/(m x K)].

**FLOOR AREA, NET.** The actual occupied area not including unoccupied accessory areas such as corridors, stairways, toilet rooms, mechanical rooms and closets.

**FURNACE ELECTRICITY RATIO.** The ratio of furnace electricity use to total furnace energy computed as  $\text{ratio} = (3.412 \times E_{AE}) / 1000 \times E_F + 3.412 \times E_{AE}$  where  $E_{AE}$  (average annual auxiliary electrical consumption) and  $E_F$  (average annual fuel energy consumption) are defined in Appendix N to



Subpart B of Part 430 of Title 10 of the Code of Federal Regulations and  $E_F$  is expressed in millions of Btus per year.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-20207 Section C202.7—G.**

**GENERAL LIGHTING.** Lighting that provides a substantially uniform level of illumination throughout an area. General lighting shall not include lighting that provides a dissimilar level of illumination to serve a specific application or decorative feature within such area.

~~((GENERAL PURPOSE ELECTRIC MOTOR (SUBTYPE I). A motor that is designed in standard ratings with either of the following:~~

~~1. Standard operating characteristics and standard mechanical construction for use under usual service conditions, such as those specified in NEMA MG1, paragraph 14.02, "Usual Service Conditions," and without restriction to a particular application or type of application.~~

~~2. Standard operating characteristics or standard mechanical construction for use under unusual service conditions, such as those specified in NEMA MG1, paragraph 14.03, "Unusual Service Conditions," or for a particular type of application, and that can be used in most general purpose applications.~~

~~General purpose electric motors (Subtype I) are constructed in NEMA T-frame sizes or IEC metric equivalent, starting at 143T.~~

~~GENERAL PURPOSE ELECTRIC MOTOR (SUBTYPE II). A motor incorporating the design elements of a general purpose electric motor (Subtype I) that is configured as one of the following:~~

~~1. A U-frame motor.~~

~~2. A Design C motor.~~

~~3. A close-coupled pump motor.~~

~~4. A footless motor.~~

~~5. A vertical, solid-shaft, normal-thrust motor (as tested in a horizontal configuration).~~

~~6. An 8-pole motor (900 rpm).~~

~~7. A polyphase motor with voltage of not more than 600 volts (other than 230 or 460 volts).)~~

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

GROUP R. Buildings or portions of buildings that contain any of the following occupancies as established in the *International Building Code*:

1. Group R-1.

2. Group R-2 where located more than three stories in height above grade plane.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-20208 Section C202.8—H.**

**HEAT TRAP.** An arrangement of piping and fittings, such as elbows, or a commercially available heat trap that prevents thermosyphoning of hot water during standby periods.

**HEAT TRAP, PIPE CONFIGURED.** A pipe configured heat trap is either, as applicable:

1. A device specifically designed for the purpose or an arrangement of tubing that forms a loop of 360 degrees; or
2. Piping that from the point of connection to the water heater (inlet or outlet) includes a length of piping directed downward before connection to the vertical piping of the supply water or hot-water distribution system.

**HEATED SLAB-ON-GRADE FLOOR.** Slab-on-grade floor construction in which the heating elements, hydronic tubing, or hot air distribution system is in contact with, or placed within or under, the slab.

**HEATED WATER CIRCULATION SYSTEM.** A water distribution system having one or more recirculation pumps that pump water from a heated water source through a dedicated hot water circulation pipe or piping system.

**HIGH SPEED DOOR.** A nonswinging 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.

**HISTORIC BUILDINGS.** Buildings that are listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.

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

**HVAC TOTAL SYSTEM PERFORMANCE RATIO (HVAC TSPR).** The ratio of the sum of a building's annual heating and cooling load in thousands of Btus to the sum of annual carbon emissions in pounds from energy consumption of the building HVAC systems. Carbon emissions shall be calculated by multiplying site energy consumption by the carbon emission factors from Table C407.1.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-20209 Section C202.9—I.**

**IEC DESIGN H MOTOR.** An electric motor that meets all of the following:

1. It is an induction motor designed for use with three-phase power.
2. It contains a cage rotor.
3. It is capable of direct-on-line starting.
4. It has 4, 6 or 8 poles.
5. It is rated from 0.4 kW to 1600 kW at a frequency of 60 Hz.

**IEC DESIGN N MOTOR.** An electric motor that meets all of the following:

1. It is an inductor motor designed for use with three-phase power.

2. It contains a cage rotor.
3. It is capable of direct-on-line starting.
4. It has 2, 4, 6 or 8 poles.
5. It is rated from 0.4 kW to 1600 kW at a frequency of 60 Hz.

**INFILTRATION.** The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.

**INFORMATION TECHNOLOGY EQUIPMENT (ITE).** ITE includes computers, data storage, servers and network/communications equipment.

**INSULATION ENTIRELY ABOVE DECK.** A roof with all insulation:

1. Installed above (outside of) the roof structure; and
2. Continuous (i.e., uninterrupted by framing members).

**INTEGRATED ENERGY EFFICIENCY RATIO (IEER).** A single-number figure of merit expressing cooling part-load EER efficiency for unitary air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

**INTEGRATED PART LOAD VALUE (IPLV).** A single number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air conditioning and heat pump equipment on the basis of weighted operation at various load capacities for equipment.

**INTEGRATED SEASONAL COEFFICIENT OF PERFORMANCE (ISCOP).** A seasonal efficiency number that is a combined value based on the formula listed in AHRI Standard 920 of the two COP values for the heating season of a DX-DOAS unit water or air source heat pump, expressed in W/W.

**INTEGRATED SEASONAL MOISTURE REMOVAL EFFICIENCY (ISMRE).** A seasonal efficiency number that is a combined value based on the formula listed in AHRI Standard 920 of the four dehumidification moisture removal efficiency (MRE) ratings required for DX-DOAS units, expressed in lb. of moisture/kWh.

**ISOLATION DEVICES.** Devices that isolate HVAC zones so they can be operated independently of one another. Isolation devices include separate systems, isolation dampers and controls providing shutoff at terminal boxes.

**AMENDATORY SECTION** (Amending WSR 17-10-062, filed 5/2/17, effective 6/2/17)

## **WAC 51-11C-20212 Section C202.12—L.**

**LABELED.** Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, (~~((inspection))~~) approved agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

**LINER SYSTEM (LS).** A system that includes the following:

1. A continuous vapor barrier liner membrane that is installed below the purlins and that is uninterrupted by framing members.
2. An uncompressed, unfaced insulation resting on top of the liner membrane and located 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.

**LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the *code official* and concerned with evaluation of products or services that maintains periodic inspection of production of *listed* equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

**LOW-SLOPED ROOF.** A roof having a slope less than 2 units vertical in 12 units horizontal.

**LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMER.** A transformer that is air-cooled, does not use oil as a coolant, has an input voltage less than or equal to 600 volts and is rated for operation at a frequency of 60 hertz.

**LOW-VOLTAGE LIGHTING.** A lighting system consisting of an isolating power supply, the low voltage luminaires, and associated equipment that are all identified for the use. ~~((The output circuits of the power supply operate at 30 volts (42.4 volts peak) or less under all load conditions.))~~

**LUMINAIRE.** A complete lighting unit consisting of a lamp or lamps together with the housing designed to distribute the light, position and protect the lamps, and connect the lamps to the power supply.

**LUMINAIRE-LEVEL LIGHTING CONTROL.** A lighting system consisting of one or more ~~((luminaire(s) each with))~~ luminaires where each luminaire has embedded lighting control logic, occupancy and ambient light sensors, ((local or central wireless networking capabilities,)) and local override switching capability, where required. Each luminaire shall also have wireless networking capabilities to detect and share information with other luminaires to adjust to occupancy and/or daylight in the space.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

## **WAC 51-11C-20213 Section C202.13—M.**

**MANUAL.** Capable of being operated by personal intervention (see "Automatic").

**MASS TRANSFER DECK SLAB EDGE.** That portion of the above-grade wall made up of the concrete slab where it extends past the footprint of the floor above, and there is space (conditioned or unconditioned) below the slab. The area of the slab edge shall be defined as the thickness of the slab multiplied by the perimeter of the edge condition. Examples of this condition include, but are not limited to, the transition from an above-grade structure to a below-grade structure or the transition from a tower to a podium. Cantilevered balconies do not meet this definition.

**MECHANICAL COOLING.** Reducing the temperature of a gas or liquid by using vapor compression, absorption, desiccant dehumidification combined with evaporative cooling, or another energy-driven thermodynamic cycle. Indirect or direct evaporative cooling alone is not considered mechanical cooling.

**MECHANICAL HEATING.** Raising the temperature of a gas or liquid by use of fossil fuel burners, electric resistance heaters, heat pumps, or other systems that require energy to operate.

**MECHANICAL LOAD COEFFICIENT (MLC).** In a data center, the ratio of the cooling system's net use of energy to that of the ITE. The design MLC is cal-

culated for a local peak weather condition (stipulated in ASHRAE Standard 90.4) and equals the sum of all active cooling equipment input power, divided by total power into the ITE. The annual MLC is calculated using hourly TMY3 weather data for the data center's location and equals the sum of all energy flowing into the cooling system to respond to that weather, minus any energy successfully recovered to avoid any new energy use, all divided by the energy flowing into the ITE during the same period.

**METAL BUILDING ROOF.** A roof that:

1. Is constructed with a metal, structural, weathering surface;
2. Has no ventilated cavity; and
3. 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:
  - a. Metal roofing in direct contact with the steel framing members;
  - b. Metal roofing separated from the steel framing members by insulation;
  - c. Insulated metal roofing panels installed as described in a or b.

**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).

**METER.** A device that measures the flow of energy.

**MICROCELL.** A wireless communication facility consisting of an antenna that is either: (a) Four (4) feet in height and with an area of not more than 580 square inches; or (b) if a tubular antenna, no more than four (4) inches in diameter and no more than six (6) feet in length; and the associated equipment cabinet that is six (6) feet or less in height and no more than 48 square feet in floor area.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

#### **WAC 51-11C-20214 Section C202.14—N.**

**NAMEPLATE HORSEPOWER.** The nominal motor ((horsepower)) output power rating stamped on the motor nameplate.

**NEMA DESIGN A MOTOR.** A squirrel-cage motor that meets all of the following:

1. It is designed to withstand full-voltage starting and developing locked-rotor torque as shown in paragraph 12.38.1 of NEMA MG 1.
2. It has pull-up torque not less than the values shown in paragraph 12.40.1 of NEMA MG 1.
3. It has breakdown torque not less than the values shown in paragraph 12.39.1 of NEMA MG 1.
4. It has a locked-rotor current higher than the values shown in paragraph 12.35.1 of NEMA MG 1 for 60 Hz and paragraph 12.35.2 of NEMA MG 1 for 50 Hz.
5. It has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

**NEMA DESIGN B MOTOR.** A squirrel-cage motor that meets all of the following:

1. It is designed to withstand full-voltage starting.

2. It develops locked-rotor, breakdown and pull-up torques adequate for general application as specified in Sections 12.38, 12.39 and 12.40 of NEMA MG 1.

3. It draws locked-rotor current not to exceed the values shown in paragraph 12.35.1 of NEMA MG 1 for 60 Hz and paragraph 12.35.2 of NEMA MG 1 for 50 Hz.

4. It has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

**NEMA DESIGN C MOTOR.** A squirrel-cage motor that meets all of the following:

1. It is designed to withstand full-voltage starting and developing locked-rotor torque for high-torque applications up to the values shown in paragraph 12.38.2 of NEMA MG 1 (incorporated by reference; see Sec. 431.15).

2. It has pull-up torque not less than the values shown in paragraph 12.40.2 of NEMA MG 1.

3. It has breakdown torque not less than the values shown in paragraph 12.39.2 of NEMA MG 1.

4. It has a locked-rotor current not to exceed the values shown in paragraph 12.35.1 of NEMA MG 1 for 60 Hz and paragraph 12.35.2 of NEMA MG 1 for 50 Hz.

5. It has a slip at rated load of less than 5 percent.

**NETWORKED GUEST ROOM CONTROL SYSTEM.** A control system, accessible from the front desk or other central location associated with a Group R-1 building, that is capable of identifying the occupancy status of each guest room according to a timed schedule, and is capable of controlling HVAC in each hotel and motel guest room separately.

**NONSTANDARD PART LOAD VALUE (NPLV).** A single-number part-load efficiency figure of merit calculated and referenced to conditions other than IPLV conditions, for units that are not designed to operate at ARI standard rating conditions.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

#### **WAC 51-11C-20215 Section C202.15—O.**

**OCCUPANT SENSOR CONTROL.** An automatic control device or system that detects the presence or absence of people within an area and causes lighting, equipment or appliances to be regulated accordingly.

**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 project site.

**OPAQUE DOOR.** A door that is not less than 50 percent opaque in surface area.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

#### **WAC 51-11C-20216 Section C202.16—P.**

**PERSONAL WIRELESS SERVICE FACILITY.** A wireless communication facility (WCF), including a microcell, which is a facility for the transmission and/or reception of radio frequency signals and which may include antennas, equipment shelter or cabinet, transmission cables, a support structure to achieve the necessary elevation, and reception and/or transmission devices or antennas.

**POWERED ROOF/WALL VENTILATORS.** A fan consisting of a centrifugal or axial impeller with an integral driver in a weather-resistant housing and with a base designed to fit, usually by means of a curb, over a wall or roof opening.

**POWER-OVER-ETHERNET LIGHTING (POE).** Lighting sources powered by DC current utilizing Ethernet cables.

**PROPOSED DESIGN.** A description of the proposed building used to estimate annual energy use and carbon emissions from energy consumption for determining compliance based on total building performance and HVAC total performance ratio.

**PUBLIC LAVATORY FAUCET.** A lavatory faucet that is not intended for private use as defined by the Uniform Plumbing Code and that is supplied with both potable cold and hot water.

**AMENDATORY SECTION** (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

#### **WAC 51-11C-20218 Section C202.18—R.**

**RADIANT HEATING SYSTEM.** A heating system that transfers heat to objects and surfaces within a conditioned space, primarily by infrared radiation.  
(~~(READILY ACCESSIBLE. Capable of being reached quickly for operation, renewal or inspection without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders or access equipment (see "Accessible").~~) **READY ACCESS (TO).** That which enables a device, appliance or equipment to be directly reached, without requiring the removal or movement of any panel or similar obstruction.

**REFRIGERANT DEW POINT.** The refrigerant vapor saturation temperature at a specified pressure.

**REFRIGERATED WAREHOUSE COOLER.** An enclosed storage space that has a total chilled storage area of 3,000 ft<sup>2</sup> or greater and is designed to maintain a temperature of greater than 32°F but less than 55°F.

**REFRIGERATED WAREHOUSE FREEZER.** An enclosed storage space that has a total chilled storage area of 3,000 ft<sup>2</sup> or greater and is designed to maintain a temperature at or below 32°F.

**REFRIGERATION SYSTEM, LOW TEMPERATURE.** Systems for maintaining food product in a frozen state in refrigeration applications.

**REFRIGERATION SYSTEM, MEDIUM TEMPERATURE.** Systems for maintaining food product above freezing in refrigeration applications.

**REGISTERED DESIGN PROFESSIONAL.** An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

**REPAIR.** The reconstruction or renewal of any part of an existing building.

REPLACEMENT AIR. Outdoor air that is used to replace air removed from a building through an exhaust system. Replacement air may be derived from one or more of the following: Make-up air, supply air, transfer air and infiltration. However, the ultimate source of all replacement air is outdoor air. When replacement air exceeds exhaust, the result is exfiltration.

**REROOFING.** The process of recovering or replacing an existing roof covering. See "Roof Recover" and "Roof Replacement."

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

RETROFIT, BUILDING ENVELOPE. Includes building envelope alterations and building envelope upgrades required for an area undergoing a change in space conditioning or a change in occupancy.

**ROOF ASSEMBLY.** A system designed to provide weather protection and resistance to design loads. The system consists of a roof covering and roof deck or a single component serving as both the roof covering and the roof deck. A roof assembly includes the roof covering, underlayment, roof deck, insulation, vapor retarder and interior finish. See also attic and other roofs, metal building roof, roof with insulation entirely above deck and single-rafter roof.

**ROOF RECOVER.** The process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.

**ROOF REPAIR.** Reconstruction or renewal of any part of an existing roof for the purposes of its maintenance.

**ROOF REPLACEMENT.** The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

**ROOFTOP MONITOR.** A raised section of a roof containing vertical fenestration along one or more sides.

**R-VALUE (THERMAL RESISTANCE).** The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area ( $h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ) [ $(\text{m}^2 \cdot \text{K})/\text{W}$ ].

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

## **WAC 51-11C-20219 Section C202.19—S.**

**SATURATED-CONDENSING TEMPERATURE.** The saturation temperature corresponding to the measured refrigerant pressure at the condenser inlet for single component and azeotropic refrigerants, and the arithmetic average of the dew point and bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance for zeotropic refrigerants.

~~((SCREW LAMP HOLDERS. A lamp base that requires a screw-in-type lamp, such as a compact-fluorescent, incandescent, or tungsten-halogen bulb.))~~

**SEMI-HEATED SPACE.** An enclosed space within a building, including adjacent connected spaces separated by an uninsulated component (e.g., basements, utility rooms, garages, corridors), which:

1. Is heated but not cooled, and has ~~((a maximum))~~ an installed heating system output capacity ((of)) greater than or equal to 3.4 Btu/(h-ft<sup>2</sup>) but not greater than 8 Btu/(h-ft<sup>2</sup>);



2. Is not a walk-in or warehouse cooler or freezer space.

**SENSIBLE RECOVERY EFFECTIVENESS.** Change in the dry-bulb temperature of the outdoor air supply divided by the difference between the outdoor air and return air dry-bulb temperatures, expressed as a percentage, governed by AHRI Standard 1060.

**SERVICE WATER HEATING.** Heating water for domestic or commercial purposes other than space heating and process requirements.

**SIDELIT.** See Section C405.2.4.2.

**SINGLE-RAFTER ROOF.** A roof where the roof above and the ceiling below are both attached to the same wood rafter and where insulation is located in the space between these wood rafters.

**SKYLIGHT.** See "Fenestration."

**SLAB BELOW GRADE.** Any portion of a slab floor in contact with the ground which is more than 24 inches below the final elevation of the nearest exterior grade.

**SLAB-ON-GRADE FLOOR.** That portion of a slab floor of the building envelope that is in contact with the ground and that is either above grade or is less than or equal to 24 inches below the final elevation of the nearest exterior grade.

**SLEEPING UNIT.** A room or space in which people sleep, which can also include permanent provisions for living, eating, and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a dwelling unit are not *sleeping units*.

**SMALL ELECTRIC MOTOR.** A general purpose, alternating current, single speed induction motor.

**SMALL BUSINESS.** Any business entity (including a sole proprietorship, corporation, partnership or other legal entity) which is owned and operated independently from all other businesses, which has the purpose of making a profit, and which has fifty or fewer employees.

**SOLAR HEAT GAIN COEFFICIENT (SHGC).** The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation which is then reradiated, conducted or convected into the space.

**SPACE CONDITIONING CATEGORY.** Categories are based on the allowed peak space conditioning output capacity per square foot of conditioned floor area, or the design set point temperature, for a building or space. Space conditioning categories from lowest to highest include: Low energy, semi-heated, conditioned, refrigerated walk-in and warehouse coolers, and refrigerated walk-in and warehouse freezers.

**STANDARD REFERENCE DESIGN.** A version of the proposed design that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement and carbon emissions from energy consumption for compliance based on total building performance and HVAC total system performance ratio.

**STEEL-FRAMED WALL.** A wall with a cavity (insulated or otherwise) whose exterior surfaces are separated by steel framing members (i.e., typical steel stud walls and curtain wall systems).

**STOREFRONT.** A ((nonresidential)) 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 mulled windows and doors.

**SUBSYSTEM METER.** A meter placed downstream of the energy supply meter that measures the energy delivered to a load or a group of loads.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-20220 Section C202.20—T.**

**TEMPORARY GROWING STRUCTURE.** A temporary growing structure has sides and roof covered with polyethylene, polyvinyl or similar flexible synthetic material and is used to provide plants with either frost protection or increased heat retention. Temporary structures are those that are erected for a period of less than 180 days.

**THERMOSTAT.** An automatic control device used to maintain temperature at a fixed or adjustable set point.

**TIME SWITCH CONTROL.** An automatic control device or system that controls lighting or other loads, including switching off, based on time schedules.

**TOPLIT.** See Section C405.2.4.3.

**TUBULAR DAYLIGHTING DEVICE (TDD).** A nonoperable skylight device primarily designed to transmit daylight from a roof surface to an interior ceiling surface via a tubular conduit. The device consists of an exterior glazed weathering surface, a light transmitting tube with a reflective inside surface and an interior sealing device, such as a translucent ceiling panel.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-20222 Section C202.22—V.**

**VARIABLE REFRIGERANT FLOW SYSTEM.** An engineered direct-expansion (DX) refrigerant system that incorporates a common condensing unit, at least one variable capacity compressor, a distributed refrigerant piping network to multiple indoor fan heating and cooling units each capable of individual zone temperature control, through integral zone temperature control devices and a common communications network. Variable refrigerant flow utilizes three or more steps of control on common interconnecting piping.

**VENTILATION.** The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

**VENTILATION AIR.** That portion of supply air that comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

**VERTICAL FENESTRATION.** See "FENESTRATION."

**VISIBLE TRANSMITTANCE [VT].** The ratio of visible light entering the space through the fenestration product assembly to the incident visible light, visible transmittance, includes the effects of glazing material and frame and is expressed as a number between 0 and 1. For skylights, VT shall be measured and rated in accordance with NFRC 202.

**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, visible transmittance, which includes the effects of glazing material, frame, and light well or tubular conduit, and is expressed as a number between 0 and 1. For

tubular daylighting devices, VT-annual shall be measured and rated in accordance with NFRC 203.

**VOLTAGE DROP.** A decrease in voltage caused by losses in the wiring system that connect the power source to the load.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-30310 Section 303.1—Identification.**

**C303.1 Identification.** Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

**C303.1.1 Building thermal envelope insulation.** An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be *listed* on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and *R*-value of installed thickness shall be *listed* on the certification. For insulated siding, the *R*-value shall be labeled on the product's package and shall be listed on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

EXCEPTION: For roof insulation installed above the deck, the *R*-value shall be labeled as required by the material standards specified in Table 1508.2 of the *International Building Code*.

**C303.1.1.1 Blown or sprayed roof/ceiling insulation.** The thickness of blown-in or sprayed fiberglass and cellulose roof/ceiling insulation (~~((fiberglass or cellulose))~~) shall be written in inches (mm) on markers (~~((that are installed at least one))~~) for every 300 square feet (28 m<sup>2</sup>) of attic area throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers of not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. Spray polyurethane foam thickness and installed *R*-value shall be *listed* on certification provided by the insulation installer.

**C303.1.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection.

**C303.1.3 Fenestration product rating.** *U*-factors of fenestration (~~((products (windows, doors and skylights)))~~) shall be determined (~~((in accordance with NFRC 100.~~

EXCEPTION: Where required, garage door *U*-factors shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.))

as follows:

1. For windows, doors and skylights, *U*-factor ratings shall be determined in accordance with NFRC 100.

2. Where required for garage doors and rolling doors, U-factor ratings shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

U-factors shall be determined by an accredited, independent laboratory, and labeled and certified by the manufacturer.

Products lacking such a labeled U-factor shall be assigned a default U-factor from Table C303.1.3(1), C303.1.3(2) or C303.1.3(4). The solar heat gain coefficient (SHGC) and visible transmittance (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table C303.1.3(3).

EXCEPTION: Units without NFRC ratings produced by a small business may be assigned default U-factors from Table C303.1.3(5) for vertical fenestration.

**C303.1.4 Insulation product rating.** The thermal resistance (R-value) of insulation shall be determined in accordance with the U.S. Federal Trade Commission R-value rule (C.F.R. Title 16, Part 460) in units of  $h \times ft^2 \times ^\circ F/Btu$  at a mean temperature of 75°F (24°C).

**C303.1.4.1 Insulated siding.** The thermal resistance (R-Value) shall be determined in accordance with ASTM C1363. Installation for testing shall be in accordance with the manufacturer's installation instructions.

**C303.1.5 Spandrel panels in glass curtain walls.** Table C303.1.5 provides default U-factors for the spandrel section of glass and other curtain wall systems. Design factors that affect performance are the type of framing, the type of spandrel panel and the R-value of insulation. Four framing conditions are considered in the table. The first is the common case where standard aluminum mullions are used. Standard mullions provide a thermal bridge through the insulation, reducing its effectiveness. The second case is for metal framing members that have a thermal break. A thermal break frame uses a urethane or other nonmetallic element to separate the metal exposed to outside conditions from the metal that is exposed to interior conditions. The third case is for structural glazing or systems where there are no exposed mullions on the exterior. The fourth case is for the condition where there is no framing or the insulation is continuous and uninterrupted by framing. The columns in the table can be used for any specified level of insulation between framing members installed in framed curtain walls or spandrel panels.

**C303.1.5.1 Window wall application.** Where "window wall" or similar assembly that is discontinuous at intermediate slab edges is used, the slab edge U-value shall be as listed in Appendix Table A103.3.7.1(3) or as determined using an approved calculation.

**C303.1.5.2 Table value assumptions.** In addition to the spandrel panel assembly, the construction assembly U-factors assume an air gap between the spandrel panel (with an R-value of 1.39) and one layer of 5/8-inch gypsum board (with an R-value of 0.56) that provides the interior finish. The gypsum board is assumed to span between the window sill and a channel at the floor. For assemblies that differ from these assumptions, custom U-factors can be calculated to account for any amount of continuous insulation or for unusual construction assemblies using Equations 3-1, 3-2 or 3-3 where appropriate. Spandrel panel U-factors for assemblies other than those covered by Table C303.1.5 or

Equations 3-1 through 3-3 may be determined using an alternate approved methodology. Equations 3-1 through 3-3 do not calculate the value of any insulation inboard of the curtain wall assembly.

**Aluminum without Thermal Break**

**(Equation 3-1)**

$$U_{\text{Overall}} = \left[ (R_{\text{gypsum}} + R_{\text{airgap}}) + \left[ \frac{1}{0.2798 + \left( \frac{1}{R_{\text{added insulation}} + \left( \frac{0.8929}{U_{\text{center of glass}}} \right)} \right)} \right] \right]$$

**Aluminum with Thermal Break**

**(Equation 3-2)**

$$U_{\text{Overall}} = \left[ (R_{\text{gypsum}} + R_{\text{airgap}}) + \left[ \frac{1}{0.1808 + \left( \frac{1}{R_{\text{added insulation}} + \left( \frac{0.8874}{U_{\text{center of glass}}} \right)} \right)} \right] \right]$$

**Structural Glazing**

**(Equation 3-3)**

$$U_{\text{Overall}} = \left[ (R_{\text{gypsum}} + R_{\text{airgap}}) + \left[ \frac{1}{0.1151 + \left( \frac{1}{R_{\text{added insulation}} + \left( \frac{0.9487}{U_{\text{center of glass}}} \right)} \right)} \right] \right]$$

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-303131 Table C303.1.3(1)—Default glazed ((fenestration)) window, glass door and skylight U-factors.**

**Table C303.1.3(1)  
Default Glazed ((Fenestration)) Window, Glass Door and Skylight U-Factors**

FRAME TYPE	<u>Window and Glass Door</u>		SKY-LIGHT
	SINGLE PANE	DOUBLE PANE	
Metal	1.20	0.80	See Table C303.1.3(4)
Metal with Thermal Break	1.10	0.65	
Nonmetal or Metal Clad	0.95	0.55	
Glazed Block	0.60		

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-303132 Table C303.1.3(2)—Default door *U*-factors.**

**Table C303.1.3(2)  
Default Opaque Door *U*-Factors  
See Appendix A, Section A107**

NEW SECTION

**WAC 51-11C-30315 Table C303.1.5—*U*-factors for spandrel panels and glass curtain walls.**

**Table C303.1.5  
*U*-Factors for Spandrel Panels and Glass Curtain Walls**

			Rated R-Value of Insulation Between Framing Members							
			None	R-4	R-7	R-10	R-15	R-20	R-25	R-30
Frame Type	Spandrel Panel		A	B	C	D	E	F	G	H
Aluminum without Thermal Break	Single glass pane, stone or metal panel	1	0.360	0.242	0.222	0.212	0.203	0.198	0.195	0.193
	Double glass with no low-e coatings	2	0.297	0.233	0.218	0.209	0.202	0.197	0.194	0.192
	Triple or low-e glass	3	0.267	0.226	0.214	0.207	0.200	0.196	0.194	0.192
Aluminum with Thermal Break	Single glass pane, stone or metal panel	4	0.350	0.211	0.186	0.173	0.162	0.155	0.151	0.149
	Double glass with no low-e coatings	5	0.278	0.200	0.180	0.170	0.160	0.154	0.151	0.148
	Triple or low-e glass	6	0.241	0.191	0.176	0.167	0.159	0.153	0.150	0.148
Structural Glazing	Single glass pane, stone or metal panel	7	0.354	0.195	0.163	0.147	0.132	0.123	0.118	0.114
	Double glass with no low-e coatings	8	0.274	0.180	0.156	0.142	0.129	0.122	0.117	0.114
	Triple or low-e glass	9	0.231	0.169	0.150	0.138	0.127	0.121	0.116	0.113
No Framing, or Insulation is Continuous	Single glass pane, stone or metal panel	10	0.360	0.148	0.102	0.078	0.056	0.044	0.036	0.031
	Double glass with no low-e coatings	11	0.297	0.136	0.097	0.075	0.054	0.043	0.035	0.030
	Triple or low-e glass	12	0.267	0.129	0.093	0.073	0.053	0.042	0.035	0.030

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-30320 Section C303.2—Installation.**

**C303.2 Installation.** Materials, systems and equipment shall be installed in accordance with the manufacturer's instructions and the *International Building Code*.

**C303.2.1 Protection of exposed foundation insulation.** Insulation applied to the exterior of basement walls, crawlspace walls and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend not less than 6 inches (153 mm) below grade.

**C303.2.2 Multiple layers of continuous insulation.** Where two or more layers of continuous insulation board are used in a construction assembly, the continuous insulation boards shall be installed in accordance with Section C303.2. Where the continuous insulation board manufacturer's instructions do not address installation of two or more layers, the edge joints between each layer of continuous insulation boards shall be staggered.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-30330 ((Section C303.3 Maintenance information.))  
Reserved.**

~~((C303.3 Maintenance information. Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.))~~

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40100 Section C401—General.**

**C401.1 Scope.** The provisions in this chapter are applicable to commercial buildings and their building sites.

**C401.2 Application.** Commercial buildings shall comply with one of the following:

1. The requirements of Sections C402, C403, C404, C405, C406, C408, C409 and C410.

2. The requirements of Section C407(~~(, C408, C409, C410, C402.5, C403.2, C404, C405.2, C405.3, C405.4, C405.6 and C405.7. The building energy consumption shall be equal to or less than 87, 90, or 93 percent of the standard reference design building, depending on the option selected per Section C407.3))~~).

3. When adopted by the local jurisdiction, the requirements of Appendix F, Outcome-Based Energy Budget, Sections C408, C409 and any specific sections in Table C407.2 as determined by the local jurisdiction. The proposed total UA of the proposed building shall be no more than 20 percent higher than the allowed total UA as defined in Section C402.1.5.

**C401.2.1 Application to existing buildings.** Work on existing buildings shall comply with Chapter 5 in addition to the applicable provisions of Chapter 4.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40210 Section C402.1—General (Prescriptive).**

**C402.1 General (~~(Prescriptive)~~).** Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis, in accordance with the compliance path described in Item 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 C402.1.3, the *U*-, *C*- and *F*-factor based method of Section C402.1.4, or the component performance alternative of Section C402.1.5.

2. Fenestration in building envelope assemblies shall comply with Section C402.4, or the component performance alternative of Section C402.1.5.

3. Air leakage of building envelope assemblies shall comply with Section C402.5.



**WAC 51-11C-40211 Section C402.1.1—Low energy buildings.**

**C402.1.1 Low energy buildings, semi-heated buildings and greenhouses.** Low energy buildings shall comply with Section C402.1.1.1. Semi-heated buildings and spaces shall comply with Section C402.1.1.2. Greenhouses shall comply with Section C402.1.1.3.

**C402.1.1.1 Low energy buildings.** The following buildings, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this code shall be exempt from all thermal envelope provision of this code:

1. Those that are heated and/or cooled with a peak design rate of energy usage less than  $3.4 \text{ Btu/h} \times \text{ft}^2$  ( $10.7 \text{ W/m}^2$ ) or  $1.0 \text{ watt/ft}^2$  ( $10.7 \text{ W/m}^2$ ) of floor area for space conditioning purposes.

2. Those that do not contain *conditioned space*.

3. ~~((Greenhouses where cooling does not include a condensing unit and that are isolated from any other conditioned space.~~

4.)) Unstaffed equipment shelters or cabinets used solely for personal wireless service facilities.

~~((C402.1.1.1))~~ **C402.1.1.2 Semi-heated buildings and spaces.** The building envelope of *semi-heated* buildings, or portions thereof, shall comply with the same requirements as that for conditioned spaces in Section C402, except as modified by this section. The total installed output capacity of mechanical space conditioning systems serving a semi-heated building or space shall comply with Section C202. Building envelope assemblies separating conditioned space from *semi-heated* space shall comply with exterior envelope insulation requirements. *Semi-heated spaces* heated by mechanical systems that do not include electric resistance heating equipment are not required to comply with the opaque wall insulation provisions of Section C402.2.3 for walls that separate *semi-heated* spaces from the exterior or low energy spaces. *Semi-heated spaces* shall be calculated separately from other conditioned spaces for compliance purposes. Opaque walls in *semi-heated* spaces shall be calculated as fully code compliant opaque walls for both the target and proposed for the Target UA calculations for Component Performance compliance per Section C402.1.5, and for the Standard Reference Design for Total Building Performance compliance per Section C407. The capacity of heat trace temperature maintenance systems complying with Section C404.7.2 that are provided for freeze protection of piping and equipment only shall not be included in the total installed output capacity of mechanical space conditioning systems.

EXCEPTION: Building or space may comply as semi-heated when served by one or more of the following system alternatives:

1. Electric infrared heating equipment for localized heating applications.

2. Heat pumps with cooling capacity permanently disabled, as preapproved by the jurisdiction.

**C402.1.1.3 Greenhouses.** Greenhouse structures or areas that comply with all of the following shall be exempt from the building envelope requirements of this code:

1. Exterior opaque envelope assemblies comply with Sections C402.2 and C402.4.4.

EXCEPTION: Low energy greenhouses that comply with Section C402.1.1.1.

2. Interior partition building thermal envelope assemblies that separate the *greenhouse* from conditioned space complying with Sections C402.2, C402.4.3 and C402.4.4.

3. Nonopaque envelope assemblies complying with the thermal envelope requirements in Table C402.1.3. The U-factor for the nonopaque roof shall be for the roof assembly or a roof that includes the assembly and an internal curtain system.

EXCEPTION: Unheated greenhouses.

4. No mechanical cooling is provided.

5. For heated greenhouses, heating is provided by a radiant heating system, a condensing natural gas-fired or condensing propane-fired heating system, or a heat pump with cooling capacity permanently disabled as preapproved by the jurisdiction.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40212 Section C402.1.2—Equipment buildings.**

**C402.1.2 Equipment buildings.** Buildings that comply with all of the following shall be exempt from the building thermal envelope provisions of this code:

1. Are separate buildings with floor area no more than 500 square feet (50 m<sup>2</sup>).

2. Are intended to house electronic equipment with installed equipment power totaling at least 7 watts per square foot (75 W/m<sup>2</sup>) and not intended for human occupancy.

3. Are served by mechanical cooling and heating systems sized in accordance with Sections C403.1.2 and C403.3.1.

4. 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).

((4-)) 5. Have an average wall and roof U-factor less than 0.200.

EXCEPTION: Where the cooling and heating system is a heat pump, the heating capacity is allowed to exceed 17,000 Btu/h provided the heat pump cooling efficiency is at least 15 percent better than the requirements in Table C403.3.2(2).

**C402.1.2.1 Standalone elevator hoistways.** Elevator hoistways that comply with all of the following shall be exempt from the building thermal envelope and envelope air barrier provisions of this code:

1. Are separate from any other conditioned spaces in the building (do not serve or open into any conditioned, semi-heated or indirectly conditioned space).

2. Have heating and/or cooling equipment sized only to serve the expected elevator loads with thermostat setpoints restricted to heating to no higher than 40°F and cooling to no lower than 95°F.

3. Have an area weighted average wall, roof and floor (where applicable) U-factor of less than or equal to 0.20. Calculations must include any floor-slab-edges that penetrate the hoistway and thus are considered part of the above-grade walls.

**WAC 51-11C-402121 Table C402.1.3—Opaque thermal envelope assembly R-value requirements.**

**Table C402.1.3**  
**Opaque Thermal Envelope Insulation**  
**Component**  
**Minimum Requirements, R-value Method<sup>a</sup>, ((g))<sup>i</sup>**

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
<b>Roofs</b>		
Insulation entirely above deck	R-38ci	R-38ci
Metal buildings <sup>b</sup>	R-25 + R-11 LS	R-25 + R-11 LS
Attic and other	R-49	R-49
<b>Walls, Above Grade</b>		
Mass <sup>h</sup>	R-9.5ci <sup>c</sup>	R-13.3ci
<u>Mass transfer deck slab edge</u>	<u>R-5</u>	<u>R-5</u>
Metal buildings	R-19ci or <u>R-13 + 13ci</u>	R-19ci or <u>R-13 + 13ci</u>
Steel framed	R-13 + R-10ci	R-19 + R-8.5ci
Wood framed and other	R-21 int or <u>R-15 + 5ci</u> <u>std</u>	<del>((R-21 int))</del> <u>R-13 + 7.5ci</u> <u>std or</u> <u>R-20 + 3.8ci</u> <u>std or R-25</u> <u>std</u>
<b>Walls, Below Grade</b>		
Below-grade wall <sup>d,h</sup>	Same as above grade	Same as above grade
<b>Floors</b>		
Mass <sup>f</sup>	R-30ci	R-30ci
Joist/framing	R-30 <sup>e</sup>	R-30 <sup>e</sup>
<b>Slab-on-Grade Floors</b>		
Unheated slabs	R-10 for 24" below	R-10 for 24" below
Heated slabs	R-10 perimeter & under entire slab	R-10 perimeter & under entire slab
<b>Opaque Doors<sup>g</sup></b>		
Nonswinging	R-4.75	R-4.75

For SI: 1 inch = 25.4 mm. ci = Continuous insulation. NR = No requirement.

LS = 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.

- a Assembly descriptions can be found in Chapter 2 and Appendix A.
- b Where using *R*-value compliance method, a thermal spacer block with minimum thickness of 1/2-inch and minimum *R*-value of R-3.5 shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.
- c Exception: Integral insulated concrete block walls complying with ASTM C90 with all cores filled and meeting both of the following:
  - 1. At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation; and
  - 2. The building thermal envelope encloses one or more of the following uses: Warehouse (storage and retail), gymnasium, auditorium, church chapel, arena, kennel, manufacturing plant, indoor swimming pool, pump station, water and waste water treatment facility, storage facility, storage area, motor vehicle service facility. Where additional uses not listed (such as office, retail, etc.) are contained within the building, the exterior walls that enclose these areas may not utilize this exception and must comply with the appropriate mass wall *R*-value from Table C402.1.3/*U*-factor from Table C402.1.4.
- d Where heated slabs are below grade, they shall comply with the insulation requirements for heated slabs.
- e Steel floor joist systems shall be insulated to  $R-38 + R-10ci$ .
- f "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.
- g Not applicable to garage doors. See Table C402.1.4.
- h Peripheral edges of intermediate concrete floors are included in the above-grade mass wall category and therefore must be insulated as above-grade mass walls unless they meet the definition of Mass Transfer Deck Slab Edge. The area of the peripheral edges of concrete floors shall be defined as the thickness of the slab multiplied by the perimeter length of the edge condition. See Table A103.3.7.2 for typical default *U*-factors for above-grade slab edges and footnote c for typical conditions of above-grade slab edges.
- i For roof, wall or floor assemblies where the proposed assembly would not be continuous insulation, an alternate nominal *R*-value compliance option for assemblies with isolated metal penetrations of otherwise continuous insulation is:

Assemblies with continuous insulation (see definition)	Alternate option for assemblies with metal penetrations, greater than 0.04% but less than 0.08%	Alternate option for assemblies with metal penetrations, greater than or equal to 0.08% but less than 0.12%
R-9.5ci	R-11.9ci	R-13ci
R-11.4ci	R-14.3ci	R-15.7ci
R-13.3ci	R-16.6ci	R-18.3ci
R-15.2ci	R-19.0ci	R-21ci
R-30ci	R-38ci	R-42ci
R-38ci	R-48ci	R-53ci
R-13 + R-7.5ci	R-13 + R-9.4ci	R-13 + R-10.3ci
R-13 + R-10ci	R-13 + R-12.5ci	R-13 + R-13.8ci
R-13 + R-12.5ci	R-13 + R-15.6ci	R-13 + R-17.2ci
R-13 + R-13ci	R-13 + R-16.3ci	R-13 + R-17.9ci
R-19 + R-8.5ci	R-19 + R-10.6ci	R-19 + R-11.7ci
R-19 + R-14ci	R-19 + R-17.5ci	R-19 + R-19.2ci
R-19 + R-16ci	R-19 + R-20ci	R-19 + R-22ci
R-20 + R-3.8ci	R-20 + R-4.8ci	R-20 + R-5.3ci
R-21 + R-5ci	R-21 + R-6.3ci	R-21 + R-6.9ci

This alternate nominal *R*-value compliance option is allowed for projects complying with all of the following:

1. The ratio of the cross-sectional area, as measured in the plane of the surface, of metal penetrations of otherwise continuous insulation to the opaque surface area of the assembly is greater than 0.0004 (0.04%), but less than 0.0012 (0.12%).
2. The metal penetrations of otherwise continuous insulation are isolated or discontinuous (e.g., brick ties or other discontinuous metal attachments, offset brackets supporting shelf angles that allow insulation to go between the shelf angle and the primary portions of the wall structure). No continuous metal elements (e.g., metal studs, z-girts, z-channels, shelf angles) penetrate the otherwise continuous portion of the insulation.

3. Building permit drawings shall contain details showing the locations and dimensions of all the metal penetrations (e.g., brick ties or other discontinuous metal attachments, offset brackets, etc.) of otherwise continuous insulation. In addition, calculations shall be provided showing the ratio of the cross-sectional area of metal penetrations of otherwise continuous insulation to the overall opaque wall area.

For other cases where the proposed assembly is not continuous insulation, see Section C402.1.4 for determination of *U*-factors for assemblies that include metal other than screws and nails.

AMENDATORY SECTION (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

**WAC 51-11C-40213 Section C402.1.3—Insulation component *R*-value method.**

**C402.1.3 Insulation component *R*-value-based method.** *Building thermal envelope* opaque assemblies shall ~~((meet))~~ comply with the requirements of Section C402.2 based on the climate zone specified in Chapter 3. For opaque portions of the *building thermal envelope* intended to comply on an insulation component *R*-value basis, the *R*-values for insulation ~~((in framing areas, where required, and for continuous insulation, where required,))~~ shall not be less than that specified in Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *R*-values from the "Group R" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *R*-values from the "All other" column of Table C402.1.3. ~~((The thermal resistance or *R*-value of the insulating material installed in, or continuously on, below grade exterior walls of the building envelope required in accordance with Table C402.1.3 shall extend to the lowest floor of the conditioned space enclosed by the below grade wall. Doors having less than 50 percent opaque glass area shall be considered opaque doors. Opaque swinging doors shall comply with the Table C402.1.4 and opaque nonswinging doors shall comply with Table C402.1.3 or C402.1.4.))~~

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40214 Section C402.1.4—Assembly *U*-factor, *C*-factor, or *F*-factor-based method.**

**C402.1.4 Assembly *U*-factor, *C*-factor, or *F*-factor-based method.** Building thermal envelope opaque assemblies shall meet the requirements of Section C402.2 based on the climate zone specified in Chapter 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 Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *U*-, *C*-, or *F*-factor from the "Group R" column of Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *U*-, *C*-, or *F*-factor from the "All other" column of Table C402.1.4. ~~((The *C*-factor for~~

~~the below-grade exterior walls of the building envelope, as required in accordance with Table C402.1.4, shall extend to the level of the lowest conditioned floor. Opaque swinging doors shall comply with Table C402.1.4 and opaque nonswinging doors shall comply with Table C402.1.3 or C402.1.4.)~~ The *U*-factors for typical construction assemblies are included in Appendix A. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Appendix A, values shall be calculated in accordance with the ASHRAE *Handbook—Fundamentals* using the framing factors listed in Appendix A where applicable and shall include the thermal bridging effects of framing materials.

**C402.1.4.1 Thermal resistance of cold-formed steel stud walls.** *U*-factors of walls with cold-formed steel studs shall be permitted to be determined in accordance with Equation 4-1:

**Equation 4-1:**

$$U = 1/[R_s + (ER)]$$

Where:

- $R_s$  = The cumulative *R-value* of the wall components along the path of heat transfer, excluding the cavity insulation and steel studs.
- $ER$  = The effective *R-value* of the cavity insulation with steel studs.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-402141 Table C402.1.4—Opaque thermal envelope requirements, *U*-factor method.**

**Table C402.1.4**  
**Opaque Thermal Envelope Requirements<sup>a, f</sup>**

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
<b>Roofs</b>		
Insulation entirely above deck	U-0.027	U-0.027
Metal buildings	U-0.031	U-0.031
Attic and other	U-0.021	U-0.021
Joist or single rafter	U-0.027	U-0.027
<b>Walls, Above Grade</b>		
Mass <sup>g</sup>	U-0.104 <sup>d</sup>	U-0.078
Mass transfer deck slab edge	U-0.20	U-0.20
Metal building	U-0.052	U-0.052
Steel framed	U-0.055	U-0.055
Wood framed and other	U-0.054	((U-0.054)) U-0.051

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
<b>Walls, Below Grade</b>		
Below-grade wall <sup>b, g</sup>	Same as above grade	Same as above grade
<b>Floors</b>		
Mass <sup>c</sup>	U-0.031	U-0.031
Joist/framing	U-0.029	U-0.029
<b>Slab-on-Grade Floors</b>		
Unheated slabs	F-0.54	F-0.54
Heated slabs <sup>c</sup>	F-0.55	F-0.55
<b>Opaque Doors</b>		
Swinging door	U-0.37	U-0.37
Nonswinging door	U-0.34	U-0.34
Garage door <14% glazing	U-0.31	U-0.31

- a Use of opaque assembly *U*-factors, *C*-factors, and *F*-factors from Appendix A is required unless otherwise allowed by Section C402.1.4.
- b Where heated slabs are below grade, they shall comply with the *F*-factor requirements for heated slabs.
- c Heated slab *F*-factors shall be determined specifically for heated slabs. Unheated slab factors shall not be used.
- d Exception: Integral insulated concrete block walls complying with ASTM C90 with all cores filled and meeting both of the following:
1. At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation; and
  2. The building thermal envelope encloses one or more of the following uses: Warehouse (storage and retail), gymnasium, auditorium, church chapel, arena, kennel, manufacturing plant, indoor swimming pool, pump station, water and waste water treatment facility, storage facility, storage area, motor vehicle service facility. Where additional uses not listed (such as office, retail, etc.) are contained within the building, the exterior walls that enclose these areas may not utilize this exception and must comply with the appropriate mass wall *R*-value from Table C402.1.3/*U*-factor from Table C402.1.4.
- e "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.
- f Opaque assembly *U*-factors based on designs tested in accordance with ASTM C1363 shall be permitted. The *R*-value of continuous insulation shall be permitted to be added or subtracted from the original test design.
- g Peripheral edges of intermediate concrete floors are included in the above-grade mass wall category and therefore must be insulated as above-grade mass walls unless they meet the definition of Mass Transfer Deck Slab Edge. The area of the peripheral edges of concrete floors shall be defined as the thickness of the slab multiplied by the perimeter length of the edge condition. See Table A103.3.7.2 for typical default *U*-factors for above-grade slab edges and footnote c for typical conditions of above-grade slab edges.

***For Section C403.1.5, Component performance alternative, see Page 277***

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40220 Section C402.2—Specific insulation requirements.**

**C402.2 Specific building thermal envelope insulation requirements ((Prescriptive)).** Insulation in building thermal envelope opaque assemblies shall comply with Sections C402.2.1 through C402.2.6 and Table C402.1.3.

Where this section refers to installing insulation levels as specified in Section C402.1.3, assemblies complying with Section C402.1.4 and buildings complying with Section C402.1.5 are allowed to install alternate levels of insulation so long as the *U*-factor of the insulated assembly is less than or equal to the *U*-factor required by the respective path.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40221 Section C402.2.1—(~~(Multiple layers of continuous insulation)~~) Roof assembly.**

**C402.2.1 (~~(Multiple layers of continuous insulation.~~ Where two or more layers of continuous insulation board are used in a construction assembly, the continuous insulation boards shall be installed in accordance with Section C303.2. If the continuous insulation board manufacturer's installation instructions do not address installation of two or more layers, the edge joints between each layer of continuous insulation boards shall be staggered.)) 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 C402.1.3, based on construction materials used in the roof assembly. Continuous insulation board shall be installed in not less than 2 layers and the edge joints between each layer of insulation shall be staggered. Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.

EXCEPTIONS:

1. Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in Table C402.1.3.
2. Where tapered insulation is used with insulation entirely above deck, those roof assemblies shall show compliance on a *U*-factor basis per Section C402.1.4. The effective *U*-factor shall be determined through the use of Tables A102.2.6(1), A102.2.6(2) and A102.2.6(3).
3. Two layers of insulation are not required where insulation tapers to the roof deck, such as at roof drains. At roof drains, the immediate 24 inch by 24 inch plan area around each roof drain has a minimum insulation requirement of *R*-13, but otherwise is permitted to be excluded from the roof insulation area-weighted calculations.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-402211 (~~(Reserved.)~~) Skylight curbs.**

**C402.2.1.1 Skylight curbs.** Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or *R*-5, 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.

**C402.2.1.2 Rooftop HVAC equipment curbs.** Structural curbs installed to support rooftop HVAC equipment are allowed to interrupt the above roof insulation. The area under the HVAC equipment inside of the equipment curb shall be insulated to a minimum of *R*-13 in all locations where there are not roof openings for ductwork. The annular space between the roof opening and the ductwork shall be sealed to maintain the building air barrier. The plan-view area of the HVAC equipment curb



shall be excluded from the prescriptive roof insulation requirements or the area-weighted component performance calculations.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40222 ((Section C402.2.2—Roof assembly.)) Reserved.**

~~((C402.2.2 Roof assembly. The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1.3, based on construction materials used in the roof assembly. Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less.~~

EXCEPTIONS: 1. Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in Table C402.1.3.  
2. Where tapered insulation is used with insulation entirely above deck, those roof assemblies shall show compliance on a *U*-factor basis per Section C402.1.4. The effective *U*-factor shall be determined through the use of Tables A102.2.6(1), A102.2.6(2) and A102.2.6(3).  
3. Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

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

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40223 Section C402.2.3—Above-grade walls.**

**C402.2.3 ((Thermal resistance of)) Above-grade walls.** The minimum thermal resistance (*R*-value) of materials installed in the wall cavity between the framing members and continuously on the walls shall be as specified in 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 (CMU) shall not be used in determining compliance with Table C402.1.3 except as otherwise noted in the table. In determining compliance with Table C402.1.4, the use of the *U*-factor of concrete masonry units with integral insulation shall be permitted.

"Mass walls" ((shall include walls)) where used as a component in the thermal envelope of a building shall comply with one of the following:

1. ~~((Weighing))~~ Weigh not less than 35 psf (170 kg/m<sup>2</sup>) of wall surface area.

2. ~~((Weighing))~~ Weigh not less than 25 psf (120 kg/m<sup>2</sup>) of wall surface area where the material weight is not more than 120 pounds per cubic foot (pcf) (1,900 kg/m<sup>3</sup>).

3. ~~((Having))~~ Have a heat capacity exceeding 7 Btu/ft<sup>2</sup> x °F (144 kJ/m<sup>2</sup> x K).

4. ~~((Having))~~ Have a heat capacity exceeding 5 Btu/ft<sup>2</sup> x °F (103 kJ/m<sup>2</sup> x K) where the material weight is not more than 120 pcf (1900 kg/m<sup>3</sup>).

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40224 Section C402.2.4—Below-grade walls.**

**C402.2.4** ~~((Thermal resistance of))~~ Below-grade walls. The ~~((minimum thermal resistance ()))~~ R-value(( )) of the insulating material installed in, or continuously on, the below-grade walls shall be ~~((as specified))~~ in accordance with Table C402.1.3. The C-factor or R-value required shall extend to the level of the lowest floor of the conditioned space enclosed by the below-grade wall.

AMENDATORY SECTION (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

**WAC 51-11C-40225 Section C402.2.5—Floors.**

**C402.2.5 Floors.** The thermal properties (component R-values or assembly U- or F-factors) of floor assemblies over outdoor air or unconditioned space shall be as specified in Table C402.1.3 or C402.1.4 based on the 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 of floor surface area;
2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

EXCEPTIONS: 1. The floor framing cavity insulation or structural slab insulation shall be permitted to be in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies where combined with insulation that meets or exceeds the minimum R-value in Table 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 air space of not more than 1 inch where it turns up and is in contact with the underside of the floor under walls associated with the *building thermal envelope*.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40227 ((Reserved.)) Airspaces.** Where the thermal properties of airspaces are used to comply with this code in accordance with Section C401.2, such airspaces 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 en-

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 a minimum air movement rate of not less than 70 mm/sec.

WAC 51-11C-40228 Section C402.2.8—Insulation of radiant heating systems.

**EXCEPTION:** Heated slabs on grade insulated in accordance with Section C402.2.6.

WAC 51-11C-40230 Section C402.4—Fenestration  
 ((~~Prescriptive~~)).

**C402.4 Fenestration (~~((Prescriptive))~~)**. Fenestration shall comply with Sections C402.4 through C402.4.4 and Table C402.4. Daylight responsive controls shall comply with this section and Section C405.2.4.1.

WAC 51-11C-402300 Table C402.4—Building envelope requirements—  
Fenestration.

(((CLIMATE ZONE	5-AND-MARINE-4	
Vertical Fenestration		
<i>U</i> -factor		

CLIMATE ZONE	5 AND MARINE 4	
Nonmetal framing (all) <sup>a</sup>	0.30	
Metal framing (fixed) <sup>b</sup>	0.38	
Metal framing (operable) <sup>c</sup>	0.40	
Metal framing (entrance doors) <sup>d</sup>	0.60	
<b>SHGC</b>		
Orientation	SEW	N
PF < 0.2	0.40	0.53
0.2 < PF < 0.5	0.48	0.58
PF > 0.5	0.64	0.64
<b>Skylights</b>		
<b>U-factor</b>	0.50	
<b>SHGC</b>	0.35))	

CLIMATE ZONE	5 AND MARINE 4	
<u><b>U-factor for Class AW windows rated in accordance with AAMA/CSA101/LS.2/A440, vertical curtain walls and site-built fenestration products<sup>a</sup></b></u>		
<u>Fixed<sup>b</sup> U-factor</u>	<u>U-0.38</u>	
<u>Operable<sup>c</sup> U-factor</u>	<u>U-0.40</u>	
<u><b>Entrance doors<sup>d</sup></b></u>		
<u>U-factor</u>	<u>U-0.60</u>	
<u><b>U-factor for all other vertical fenestration</b></u>		
<u>U-factor</u>	<u>U-0.30</u>	
<u><b>SHGC for all vertical fenestration</b></u>		
<u>Orientation<sup>e,f</sup></u>	<u>SEW</u>	<u>N</u>
<u>PF &lt; 0.2</u>	<u>0.38</u>	<u>0.51</u>
<u>0.2 ≤ PF &lt; 0.5</u>	<u>0.46</u>	<u>0.56</u>
<u>PF ≥ 0.5</u>	<u>0.61</u>	<u>0.61</u>
<u><b>Skylights</b></u>		
<u><b>U-factor</b></u>	<u>U-0.50</u>	
<u><b>SHGC</b></u>	<u>0.35</u>	

((NR = No requirement.))

<sup>a</sup> ("Nonmetal framing" includes framing materials other than metal, with or without metal reinforcing or cladding)) U-factor and SHGC shall be rated in accordance with NFRC 100.

<sup>b</sup> ("Metal framing" includes metal framing, with or without thermal break.)) "Fixed" includes curtain wall, storefront, picture windows, and other fixed windows.

<sup>c</sup> ("Metal framing" includes metal framing, with or without thermal break.)) "Operable" includes openable fenestration products other than "entrance doors."

<sup>d</sup> ("Metal framing" includes metal framing, with or without thermal break.)) "Entrance door" includes glazed swinging entrance doors. Other doors which are not entrance doors, including sliding glass doors, are considered "operable."

<sup>e</sup> "N" indicates vertical fenestration oriented within 30 degrees of true north. "SEW" indicates orientations other than "N."

<sup>f</sup> Fenestration that is entirely within the conditioned space or is between conditioned and other enclosed space is exempt from solar heat gain coefficient requirements and not included in the SHGC calculation.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40231 Section C402.4.1—Maximum area.**

**C402.4.1 Maximum area.** The total building vertical fenestration area (not including opaque doors and opaque spandrel panels) shall not exceed 30 percent of the total building gross above-grade wall area. The skylight area shall not exceed 5 percent of the total building gross roof area (skylight-to-roof ratio).

For buildings with more than one space conditioning category, compliance with the maximum allowed window-to-wall ratio and skylight-to-roof ratio shall be demonstrated separately for each space conditioning category. Interior partition ceiling, wall, fenestration and floor areas that separate space conditioning areas shall not be applied to the window-to-wall ratio and skylight-to-roof ratio calculations.

**C402.4.1.1 ((Increased)) Vertical fenestration maximum area with ((daylight responsive controls.** A maximum of 40 percent of the gross above-grade wall area shall be permitted to be vertical fenestration for the purpose of prescriptive compliance with Section C402.1.4 or for the component performance alternative in Section C402.1.5, provided all of the following requirements are met:

1. In buildings not greater than two stories above grade, no)) **high performance alternates.** For buildings that comply with Section C402.4.1.1.1 or C402.4.1.1.2, the total building vertical fenestration area is permitted to exceed 30 percent but shall not exceed 40 percent of the gross above grade wall area for the purpose of prescriptive compliance with Section C402.1.4.

When determining compliance using the component performance alternative in Section C402.1.5, the total building vertical fenestration area allowed in Equation 4-2 is 40 percent of the above grade wall area for buildings that comply with the vertical fenestration alternates described in this section.

These alternates are not permitted to be used for total building performance compliance using Section C407.

**C402.4.1.1.1 Optimized daylighting.** All of the following requirements shall be met:

1. Not less than 50 percent of the total conditioned floor area in the building is within a daylight zone that includes daylight responsive controls complying with Section C405.2.4.1.

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 C405.2.4.1 are installed in daylight zones.

4.)) Visible transmittance (VT) of all vertical fenestration in the building is greater than or equal to 1.1 times solar heat gain coefficient (SHGC), or 0.50, whichever is greater.

EXCEPTION: Fenestration that is outside the scope of NFRC 200 is not required to comply with Item ((4)) 2.

~~((C402.4.1.2 Reserved.~~

**C402.4.1.3)) C402.4.1.1.2 Increased vertical fenestration area with high-performance fenestration.** ~~((The vertical fenestration area (not including opaque doors and opaque spandrel panels) is permitted to exceed 30 percent but shall not exceed 40 percent of the gross above grade wall area, for the purpose of prescriptive compliance with Section C402.1.3 provided that each of the following conditions are met:~~

~~1. The vertical fenestration shall have)) All of the following requirements shall be met:~~

~~1. All vertical fenestration in the building shall comply with the following U-factors:~~

~~a. ((Nonmetal framing (all) = 0.28)) U-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products (fixed) = 0.34~~

~~b. ((Metal framing (fixed) = 0.34)) U-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products (operable) = 0.36~~

~~c. ((Metal framing (operable) = 0.36)) Entrance doors = 0.60~~

~~d. ((Metal framing (entrance doors) = 0.60)) U-factor for all other vertical fenestration = 0.28~~

~~2. The SHGC of the vertical fenestration shall be less than or equal to 0.35, adjusted for projection factor in compliance with C402.4.3.~~

~~An area-weighted average shall be permitted to satisfy the U-factor requirement for each fenestration product category listed in Item 1 of this section. Individual fenestration products from different fenestration product categories shall not be combined in calculating the area-weighted average U-factor.~~

~~((The compliance path described in this section is not permitted to be used for the total building performance compliance path in Section C407. The compliance path described in this section is permitted to be used for the component performance alternative in Section C402.1.5, provided that the requirements of Section C402.1.5 are met.~~

**C402.4.1.4 Increased vertical fenestration area with high-performance mechanical systems.** ~~The vertical fenestration area (not including opaque doors and opaque spandrel panels) is permitted to exceed 30 percent but shall not exceed 40 percent of the gross above-grade wall area, for the purpose of prescriptive compliance with Section C402.1.4 or for the component performance alternative in Section C402.1.5, provided that the mechanical system complies with all requirements of Section C403.6 Dedicated outdoor air systems (DOAS) without utilizing the exceptions to Section C403.6. This increased glazing fraction is not permitted to be used to establish the reference case for the Total Building Performance compliance path in Section C407.))~~

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40232 Section C402.4.2—Minimum skylight fenestration area.**

**C402.4.2 Minimum skylight fenestration area.** For ~~((single story buildings only, in an))~~ buildings with single story enclosed spaces greater than 2,500 square feet (232 m<sup>2</sup>) in floor area ~~((7))~~ that are directly under a roof ~~((with not less than 75 percent of the ceiling area with))~~ and have a ceiling height greater than 15 feet (4572 mm) ((, and used as an)) for no less than 75 percent of the ceiling area, these single-story spaces shall be provided with skylights and daylight responsive controls in accordance with Section C405.2.4. Space types required to comply with this provision include office, lobby, atrium, concourse, corridor, gymnasium/exercise center, convention center, automotive service, manufacturing, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation, ((or workshop, skylights)) and workshop. Skylights in these spaces are required to provide a total ((toplight daylight)) toplit zone area not less than ((half)) 50 percent of the floor area and shall provide one of the following:

1. A minimum ratio of skylight area to ~~((toplight daylight))~~ toplit zone area under skylights of not less than 3 percent where all skylights have a VT of at least 0.40 as determined in accordance with Section C303.1.3.

2. A minimum skylight effective aperture of at least 1 percent determined in accordance with Equation 4-5.

$$\text{Skylight Effective Aperture} = (0.85 \times \text{Skylight Area} \times \text{Skylight VT} \times \text{WF}) / ((\text{Daylight zone under skylight})) \text{ Toplit zone}$$

**(Equation 4-5)**

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 (TDD) with VT-annual ratings measured in accordance with NFRC 203.

Light well depth = Measure vertically from the underside of the lowest point of the skylight glazing to the ceiling plane under the skylight.

**EXCEPTIONS:**

1. Skylights above daylight zones of enclosed spaces are not required in:

~~((1-))~~ 1.1. Reserved.

~~((2-))~~ 1.2. Spaces where the designed *general lighting* power densities are less than 0.5 W/ft<sup>2</sup> (5.4 W/m<sup>2</sup>) and at least 10 percent lower than the lighting power allowance in Section C405.4.2.

~~((3-))~~ 1.3. Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least 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.

~~((4-))~~ 1.4. Spaces where the daylight zone under rooftop monitors is greater than 50 percent of the enclosed space floor area.

~~((5-))~~ 1.5. Spaces where the total floor area minus the ((sidelight daylight)) sidelit zone area is less than 2,500 square feet (232 m<sup>2</sup>), and where the lighting in the daylight zone is controlled in accordance with Section C405.2.3.1.

2. The skylight effective aperture, calculated in accordance with Equation 4-5, is permitted to be 0.66 percent in lieu of 1 percent if the VT-annual of the skylight or TDD, as measured by NFRC 203, is greater than 38 percent.

**C402.4.2.1 Lighting controls in daylight zones under skylights.** Daylight responsive controls complying with Section C405.2.4.1 shall be

provided to control all electric lights within (~~(daylight)~~) toplit zones.

**C402.4.2.2 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 D 1003.

EXCEPTION: Skylights 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.

**C402.4.2.3 Daylight zones.** Daylight zones referenced in Sections C402.4.1.1 through C402.4.2.2 shall comply with Section C405.2.4.2 and C405.2.4.3, as applicable. Daylight zones shall include toplit zones and sidelit zones.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40234 Section C402.4.4—Doors.**

**C402.4.4 Doors.** Opaque swinging doors shall comply with (~~(the applicable requirements for doors as specified in Tables C402.1.3 and C402.1.4 and)~~) Table C402.1.4. Opaque nonswinging doors shall comply with Table C402.1.3. Opaque doors shall be considered part of the gross area of above grade walls that are part of the *building thermal envelope*. Other doors shall comply with the provisions of Section C402.4.3 for vertical fenestration and the entire door area, including the frame, shall be considered part of the fenestration area of the building thermal envelope.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40240 Section C402.5—Air leakage-thermal envelope.**

**C402.5 Air leakage-thermal envelope (~~(Mandatory)~~).** The thermal envelope of buildings shall comply with Sections C402.5.1 through C402.5.8.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40241 Section C402.5.1—Air barriers.**

**C402.5.1 Air barriers.** A continuous air barrier shall be provided throughout the building thermal envelope. The air barriers shall be permitted to be located on the inside or outside of the building envelope, located within the assemblies composing the envelope, or any



combination thereof. The air barrier shall comply with Sections C402.5.1.1 and C402.5.1.2.

**C402.5.1.1 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 ((seals)) seams associated with penetrations shall be sealed in the same manner or taped ((~~or covered with moisture vapor permeable wrapping material~~)). Sealing materials shall be ((~~appropriate to the construction materials being sealed and 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 C402.5.8. Where similar objects are installed which 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.

**C402.5.1.2 Building test.** The completed building shall be tested and the air leakage rate of the *building envelope* shall not exceed ((~~0.40~~)) 0.25 cfm/ft<sup>2</sup> at a pressure differential of 0.3 inches water gauge (2.0 L/s • m<sup>2</sup> at 75 Pa) at the upper 95 percent confidence interval in accordance with ASTM E 779 or an equivalent method approved by the code official. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the building owner and the Code Official. ((~~If the tested rate exceeds that defined here, a visual inspection of the air barrier shall be conducted and any leaks noted shall be sealed to the extent practicable. An additional report identifying the corrective actions taken to seal air leaks shall be submitted to the building owner and the Code Official and any further requirement to meet the leakage air rate will be waived.~~))

1. Test shall be accomplished using either (1) both pressurization and depressurization or (2) pressurization alone, but not depressurization alone. The test results shall be plotted against the corrected P in accordance with Section 9.4 of ASTM E 779.

2. The test pressure range shall be from 25 Pa to 80 Pa per Section 8.10 of ASTM E 779, but the upper limit shall not be less than 50

Pa, and the difference between the upper and lower limit shall not be less than 25 Pa.

3. If the pressure exponent  $n$  is less than 0.45 or greater than 0.85 per Section 9.6.4 of ASTM E 779, the test shall be rerun with additional readings over a longer time interval.

**C402.5.1.2.1 Building test for mixed-use buildings.** Where a building is three or fewer stories above grade plane and contains both commercial and residential uses, the air barrier of the R-2 and R-3 occupancy areas of the building is permitted to be separately tested according to Section R402.4.1.2. Alternatively, it is permissible to test the air barrier of the entire building according to Section C402.5.1.2, provided that the tested air leakage rate does not exceed the rate specified in Section C402.5.1.2.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40243 Section C402.5.3—Rooms containing fuel-burning appliances.**

**C402.5.3 Rooms containing fuel-burning appliances.** Where ~~((open))~~ combustion air ~~((ducts provide combustion air to open combustion))~~ is supplied through openings in an exterior wall to a room or space containing a space conditioning fuel-burning appliance~~((s, the appliances and combustion air openings))~~, one of the following shall apply:

1. The room or space containing the appliance shall be located outside of the building thermal envelope ~~((or enclosed in a room)).~~

2. The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the building thermal envelope. Such rooms shall ~~((be sealed and insulated in accordance with the envelope requirements of))~~ comply with all of the following:

2.1. The walls, floor and ceiling that separate the enclosed room or space from the conditioned spaces shall be insulated to be at least equivalent to the insulation requirement of below grade walls as specified in Table C402.1.3 or C402.1.4 ~~((, where)).~~

2.2. The walls, floors and ceilings ~~((shall meet the minimum of the below-grade wall R-value requirement.))~~ that separate the enclosed room or space from conditioned spaces be sealed in accordance with Section C402.5.1.1.

2.3. The doors into the enclosed room or space shall be fully gasketed ~~((, and any)).~~

2.4. Water lines and ducts in the enclosed room or space shall be insulated in accordance with Section C403. ~~((The combustion))~~

2.5. Where the air duct supplying combustion air to the enclosed room or space passes through conditioned space, the duct shall be insulated ~~((, where it passes through conditioned space, to a minimum of))~~ to an R-value of not less than R-8.

EXCEPTION((S)): ~~((1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.~~

~~2.)) Fireplaces and stoves complying with Sections 901 through 905 of the International Mechanical Code, and Section 2111.13 of the International Building Code.~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40244 Section C402.5.4—Doors and access openings.**

**C402.5.4 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 shall be gasketed, weatherstripped or sealed.

EXCEPTIONS: 1. Door openings required to comply with Section ((715 or 715.4)) 716 of the *International Building Code*.  
2. Doors and door openings required to comply with UL 1784 by the *International Building Code*.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40245 Section C402.5.5—Air intakes, exhaust openings, stairways and shafts.**

**C402.5.5 Air intakes, exhaust openings, stairways and shafts.** Stairway enclosures, elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be provided with dampers in accordance with Section ((C403.2.4.3)) C403.7.9.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40246 Section C402.5.6—Loading dock weatherseals.**

**C402.5.6 Loading dock weatherseals.** Cargo door((s)) openings and loading dock door((s)) openings shall be equipped with weatherseals ((to)) that restrict infiltration ((when)) and provide direct contact along the top and sides of vehicles that are parked in the doorway.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40247 Section C402.5.7—Vestibules.**

**C402.5.7 Vestibules.** All 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. For the purposes of this section, "building entrances" shall include exit-only doors in buildings where separate doors for entering and exiting are provided.

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. The building lobby is not considered a vestibule.

EXCEPTION: Vestibules are not required for the following:

1. Doors not intended to be used as building entrances.
2. Unfinished ground-level space greater than 3,000 square feet (298 m<sup>2</sup>) if a note is included on the permit documents at each exterior entrance to the space stating "Vestibule required at time of tenant build-out if entrance serves a space greater than 3,000 square feet in area."
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors between ((a)) an enclosed space smaller than 3,000 square feet (298 m<sup>2</sup>) in area and the exterior of the building or the building entrance lobby, where those doors do not comprise one of the primary building entrance paths to the remainder of the building. The space must be enclosed and separated without transfer air paths from the primary building entrance paths. If there are doors between the space and the primary entrance path, then the doors shall be equipped with self-closing devices so the space acts as a vestibule for the primary building entrance.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. In buildings less than 3 stories above grade or in spaces that do not directly connect with the building elevator lobby, 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 C408.2.3.
8. Building entrances in buildings that are less than four stories above grade and less than 10,000 ft<sup>2</sup> in area.
9. Elevator doors in parking garages provided that the elevators have an enclosed lobby at each level of the garage.
10. Entrances to semi-heated spaces.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

## **WAC 51-11C-40310 Section C403.1—General.**

**C403.1 General.** Mechanical systems and equipment serving heating, cooling, ventilating, and other needs shall comply with ~~((Section C403.2 and shall comply with Sections C403.3 and C403.4 based on the equipment and systems provided))~~ this section.

EXCEPTIONS:

1. Energy using equipment used by a manufacturing, industrial or commercial process other than for conditioning spaces or maintaining comfort and amenities for the occupants and not otherwise regulated by ~~((C403.2.3, Tables C403.2.3))~~ Section C403.3.2, Tables C403.3.2 (1) through ((10)) (12) inclusive, ((C403.2.4.5, C403.2.4.6, C403.2.7, C403.2.9, C403.5.4)) Sections C403.7.8, C403.9.5, C403.10.3, C403.11.2, C403.11.3, C404.2, Table C404.2, C405.8 and C410. ((Data center)) Computer room HVAC equipment is not covered by this exception.
2. Data center systems are exempt from Sections C403.4 and C403.5.

**C403.1.1 HVAC total system performance ratio (HVAC TSPR).** For systems serving office, retail, library, and education occupancies subject to the requirements of Section C403.3.5 without exceptions, the HVAC total system performance ratio (HVAC TSPR) of the proposed design HVAC system shall be more than or equal to the HVAC TSPR of the standard reference design as calculated according to Appendix D, Calculation of HVAC Total System Performance Ratio.

EXCEPTIONS:

1. Buildings with conditioned floor area less than 5,000 square feet.
2. HVAC systems using district heating water, chilled water or steam.
3. HVAC systems not included in Table D601.10.1.
4. 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.
5. HVAC systems served by heating water plants that include air to water or water to water heat pumps.
6. Underfloor air distribution HVAC systems.
7. Space conditioning systems that do not include *mechanical cooling*.
8. Alterations to existing buildings that do not substantially replace the entire HVAC system.
9. HVAC systems meeting all the requirements of the *standard reference design* HVAC system in Table D602.11, Standard Reference Design HVAC Systems.

**C403.1.2 Calculation of heating and cooling loads.** Design loads associated with heating, ventilating and air conditioning of the building shall be determined in accordance with the procedures described in ANSI/ASHRAE/ACCA Standard 183 or by an approved equivalent computational

procedure, using the design parameters specified in Chapter 3. Heating and cooling loads shall be adjusted to account for load reductions that are achieved where energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE HVAC Systems and Equipment Handbook by an approved equivalent computational procedure.

**C403.1.3 Data centers.** Data center systems shall comply with Sections 6 and 8 of ASHRAE Standard 90.4 with the following changes:

1. Replace design MLC in ASHRAE Standard 90.4 Table 6.2.1.1 "Maximum Design Mechanical Load Component (Design MLC)" with the following per the applicable climate zone:

Zone 4C Design MLC = 0.22      Zone 5B Design MLC = 0.24

2. Replace annualized MLC values of Table 6.2.1.2 "Maximum Annualized Mechanical Load Component (Annualized MLC)" in ASHRAE Standard 90.4 with the following per applicable climate zone:

Zone 4C Annual MLC = 0.18      Zone 5B Annual MLC = 0.17

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40320 Section C403.2—(~~Provisions applicable to all mechanical~~) System(s) design.**

**C403.2 (~~Provisions applicable to all mechanical systems (Mandatory).~~) System design.** Mechanical systems ((and equipment serving the building heating, cooling or ventilating needs)) shall be designed to comply with Sections C403.2.1 ((through C403.2.13)) and C403.2.2. Where elements of a building's mechanical systems are addressed in Sections C403.3 through C403.11, such elements shall comply with the applicable provisions of those sections.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40321 Section C403.2.1—(~~Calculation of heating and cooling loads~~) Zone isolation.**

**C403.2.1 (~~Calculation of heating and cooling loads.~~** Design loads associated with heating, ventilating and air conditioning of the building shall be determined in accordance with the procedures described in ANSI/ASHRAE/ACCA Standard 183 or by an approved equivalent computational procedure, using the design parameters specified in Chapter 3. Heating and cooling loads shall be adjusted to account for load reductions that are achieved where energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE HVAC Systems and Equipment Handbook by an approved equivalent computational procedure.))  
**Zone isolation required.** HVAC systems serving zones that are intended to operate or be occupied nonsimultaneously shall be divided into isolation areas. Zones may be grouped into a single isolation area provided it does not exceed 25,000 square feet (2323 m<sup>2</sup>) of conditioned

floor area nor include more than one floor. Each isolation area shall be equipped with isolation devices and controls configured to automatically shut off the supply of conditioned air and outdoor air to and exhaust air from the isolation area. Each isolation area shall be controlled independently by a device meeting the requirements of Section C403.4.2.2. Central systems and plants shall be provided with controls and devices that will allow system and equipment operation for any length of time while serving only the smallest isolation area served by the system or plant.

**EXCEPTIONS:**

1. Exhaust air and outdoor air connections to isolation areas where the fan system to which they connect is not greater than 5,000 cfm (2360 L/s).
2. Exhaust airflow from a single isolation area of less than 10 percent of the design airflow of the exhaust system to which it connects.
3. Isolation areas intended to operate continuously or intended to be inoperative only when all other isolation areas in a zone are inoperative.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40322 Section C403.2.2—(~~(Equipment and systems sizing)~~) Ventilation and exhaust.**

**C403.2.2 (~~(Equipment and system sizing.~~** The output capacity of heating and cooling equipment shall be no greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.2.1. 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.

**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.))

**Ventilation and exhaust.**

**C403.2.2.1 Ventilation.** Ventilation, either natural or mechanical, shall be provided in accordance with Chapter 4 of the *International Mechanical Code*. Where mechanical ventilation is provided, the system shall be configured to provide no greater than 150 percent of the minimum outdoor air required by Chapter 4 of the *International Mechanical Code* or other applicable code or standard, whichever is greater.

**EXCEPTIONS:**

1. The mechanical system may supply outdoor air at rates higher than the limit above when it is used for particulate or VOC dilution, economizer, night flushing, dehumidification, pressurization, exhaust make-up, or other process air delivery. Outdoor air shall be reduced to the minimum ventilation rates when not required for the preceding uses.
2. Air systems supplying Group R-1, R-2 or I-2 occupancies.
3. Alterations that replace less than half of the total heating and cooling capacity of the system.
4. Systems with energy recovery complying with the requirements of Section C403.7.6.1 that utilize sensible only active chilled beams for space cooling without any additional zonal fan power. Active chilled beams shall be permitted to utilize the increased outdoor airflow to increase space sensible capacity and to maintain space latent cooling loads without additional controls to reduce the outdoor airflow to each zone.

**C403.2.2.2 Exhaust.** Exhaust shall be provided in accordance with Chapters 4 and 5 of the *International Mechanical Code*. Where exhaust is provided, the system shall be configured to provide no greater than 150 percent of the minimum exhaust air required by Chapters 4 and 5 of the *International Mechanical Code* or other applicable code or standard, whichever is greater.

**EXCEPTIONS:**

1. The mechanical system may exhaust air at rates higher than the limit above when it is used for particulate or VOC dilution, economizer, night flushing, dehumidification, pressure equalization, relief, or other process exhaust air requirements. Outdoor air and exhaust air shall be reduced to the minimum ventilation rates when not required for the preceding uses.
2. Domestic range hood exhaust in Group R occupancies.
3. Exhaust from Group I occupancies.

**WAC 51-11C-40323 Section C403.2.3—(~~HVAC equipment performance requirements~~) Variable flow capacity.**

**C403.2.3 (~~HVAC equipment performance requirements.~~** Equipment shall meet the minimum efficiency requirements of Tables C403.2.3(1), C403.2.3(2), C403.2.3(3), C403.2.3(4), C403.2.3(5), C403.2.3(6), C403.2.3(7), C403.2.3(8) and C403.2.3(9) when tested and rated in accordance with the applicable test procedure. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirements of Table C403.2.3(10). The efficiency shall be verified through certification and listed under an approved certification program or, if no certification program exists, 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.

Gas-fired and oil-fired forced air furnaces with input ratings  $\geq 225,000$  Btu/h (65 kW) and all unit heaters shall also have an intermittent ignition or interrupted device (IID), and have either mechanical draft (including power venting) or a flue damper. A vent damper is an acceptable alternative to a flue damper for furnaces where combustion air is drawn from the conditioned space. All furnaces with input ratings  $\geq 225,000$  Btu/h (65 kW), including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating.

Chilled water plants and buildings with more than 500 tons total capacity shall not have more than 100 tons provided by air-cooled chillers.

EXCEPTIONS:

1. Where the designer demonstrates that the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled equipment.
2. Air-cooled chillers with minimum efficiencies at least 10 percent higher than those listed in Table C403.2.3(7).
3. Replacement of existing equipment.

**C403.2.3.1 ~~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 adjusted using Equations 4-7 and 4-8.

$$FL_{adj} = FL/K_{adj}$$

~~(Equation 4-7)~~

$$PLV_{adj} = IPLV/K_{adj}$$

~~(Equation 4-8)~~

Where:

$$K_{adj} = A \times B$$

$$\begin{aligned}
 FL &= \text{Full-load kW/ton values as specified in Table C403.2.3(7)} \\
 FL_{adj} &= \text{Maximum full-load kW/ton rating, adjusted for nonstandard conditions} \\
 IPLV &= \text{Value as specified in Table C403.2.3(7)} \\
 PLV_{adj} &= \text{Maximum NPLV rating, adjusted for nonstandard conditions} \\
 A &= 0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times LIFT + 3.9302 \\
 B &= 0.0015 \times L_{vg}^{Evap} (^\circ F) + 0.934 \\
 LIFT &= L_{vg}^{Cond} - L_{vg}^{Evap} \\
 L_{vg}^{Cond} &= \text{Full-load condenser leaving fluid temperature (}^\circ F\text{)} \\
 L_{vg}^{Evap} &= \text{Full-load evaporator leaving temperature (}^\circ F\text{)}
 \end{aligned}$$

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°F.
2. Maximum condenser leaving temperature: 115°F.
3. LIFT is not less than 20°F (11.1°C) and not greater than 80°F (44.4°C).

**C403.2.3.2 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 C403.2.3(7) when tested or certified with water at standard rating conditions, in accordance with the referenced test procedure.

**C403.2.3.3 Packaged electric heating and cooling equipment.** Packaged electric equipment providing both heating and cooling with a total cooling capacity greater than 6,000 Btu/h shall be a heat pump.

EXCEPTION: Unstaffed equipment shelters or cabinets used solely for personal wireless service facilities.

**C403.2.3.4 Humidification.** If an air economizer is required on a cooling system for which humidification equipment is to be provided to maintain minimum indoor humidity levels, then the humidifier shall be of the adiabatic type (direct evaporative media or fog atomization type).

EXCEPTIONS:

1. Health care facilities licensed by the state where chapter 246-320 or 246-330 WAC requires steam injection humidifiers in duct work downstream of final filters.
2. Systems with water economizer.
3. 100% outside air systems with no provisions for air recirculation to the central supply fan.
4. Nonadiabatic humidifiers cumulatively serving no more than 10% of a building's air economizer capacity as measured in cfm. This refers to the system cfm serving rooms with stand-alone or duct-mounted humidifiers.))

**Variable flow capacity.** For fan and pump motors 7.5 hp and greater including motors in or serving custom and packaged air handlers serving variable air volume fan systems, constant volume fans, heating and cooling hydronic pumping systems, pool and service water pumping systems, domestic water pressure-booster systems, cooling tower fan, and other pump or fan motors where variable flows are required, there shall be:

1. Variable speed drives; or



2. Other controls and devices that will result in fan and pump motor demand of no more than 30 percent of design wattage at 50 percent of design air volume for fans when static pressure set point equals 1/3 the total design static pressure, and 50 percent of design water flow for pumps, based on manufacturer's certified test data. Variable inlet vanes, throttling valves (dampers), scroll dampers or bypass circuits shall not be allowed.

**EXCEPTION:**

Variable speed devices are not required for motors that serve:

1. Fans or pumps in packaged equipment where variable speed drives are not available as a factory option from the equipment manufacturer.

2. Fans or pumps that are required to operate only for emergency fire-life-safety events (e.g., stairwell pressurization fans, elevator pressurization fans, fire pumps, etc.).

AMENDATORY SECTION (Amending WSR 17-10-062, filed 5/2/17, effective 6/2/17)

**WAC 51-11C-403231 Table ((C403.2.3)) C403.3.2(1)—Minimum efficiency requirements—Electrically operated unitary air conditioners and condensing units.**

**Table ((C403.2.3)) C403.3.2(1)A  
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 <sup>A</sup>
Air conditioners, air cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System	13.0 SEER	AHRI 210/240
			Single Package	14.0 SEER	
Through-the-wall (air cooled)	≤ 30,000 Btu/h <sup>b</sup>	All	Split system	12.0 SEER	
			Single Package	12.0 SEER	
Small duct high velocity, air cooled	< 65,000 Btu/h <sup>b</sup>	All	Split system	11.0 SEER	
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	AHRI 210/240
		All other	Split System and Single Package	11.0 EER 12.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 12.4 IEER	
		All other	Split System and Single Package	10.8 EER 12.2 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 11.6 IEER	
		All other	Split System and Single Package	9.8 EER 11.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 11.2 IEER	
		All other	Split System and Single Package	9.5 EER 11.6 IEER	

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure <sup>A</sup>
Air conditioners, water cooled	< 65,000 Btu/h <sup>b</sup>	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)	Split System and Single Package	12.1 EER 13.9 IEER	AHRI 210/240
		All other	Split System and Single Package	11.9 EER 13.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.5 EER 13.9 IEER	
		All other	Split System and Single Package	12.3 EER 13.7 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.4 EER 13.6 IEER	
		All other	Split System and Single Package	12.2 EER 13.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.2 EER 13.5 IEER	
		All other	Split System and Single Package	12.0 EER 13.3 IEER	
Air conditioners, evaporatively cooled	< 65,000 Btu/h <sup>b</sup>	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)	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 340/360
		All other	Split System and Single Package	11.9 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.0 EER 12.2 IEER	
		All other	Split System and Single Package	11.8 EER 12.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.9 EER 12.1 IEER	
		All other	Split System and Single Package	11.7 EER 11.9 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.7 EER 11.9 IEER	
		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	
Condensing units, evaporatively cooled	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	

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

a Chapter ((6)) 12 of the referenced standard contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

**Table ((C403.2.3)) C403.3.2(1)B**  
**Minimum Efficiency Requirements—Electrically Operated Variable Refrigerant Flow Air Conditioners**

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 Multi-Split System	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or none)	VRF Multi-Split System	11.2 EER ((13.1 IEER (before 1/1/2017))) 15.5 IEER (((as of 1/1/2017)))	

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or none)	VRF Multi-Split System	11.0 EER ((12.9 IEER (before 1/1/2017))) 14.9 IEER (((as of 1/1/2017)))	
	≥ 240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.0 EER ((11.6 IEER (before 1/1/2017))) 13.9 IEER (((as of 1/1/2017)))	

**Table ((C403.2.3)) C403.3.2(1)C**  
**Minimum Efficiency Requirements—Electrically Operated Variable Re-**  
**frigerant 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 Multi-Split System	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or none)	VRF Multi-Split System	11.0 EER ((12.9 IEER (before 1/1/2017))) 14.6 IEER (((as of 1/1/2017)))	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or none)	VRF Multi-Split System with Heat Recovery	10.8 EER ((12.7 IEER (before 1/1/2017))) 14.4 IEER (((as of 1/1/2017)))	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or none)	VRF Multi-Split System	10.6 EER ((12.3 IEER (before 1/1/2017))) 13.9 IEER (((as of 1/1/2017)))	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or none)	VRF Multi-Split System with Heat Recovery	10.4 EER ((12.1 IEER (before 1/1/2017))) 13.7 IEER (((as of 1/1/2017)))	
	≥ 240,000 Btu/h	Electric Resistance (or none)	VRF Multi-Split System	9.5 EER ((11.0 IEER (before 1/1/2017))) 12.7 IEER (((as of 1/1/2017)))	

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure
	$\geq 240,000$ Btu/h	Electric Resistance (or none)	VRF Multi-Split System with Heat Recovery	9.3 EER <del>((10.8 IEER (before 1/1/2017)))</del> 12.5 IEER <del>((as of 1/1/2017)))</del>	
VRF Water Source (cooling mode)	$< 65,000$ Btu/h	All	VRF Multi-Split System <i>86°F entering water</i>	12.0 EER <u>16.0 IEER</u>	AHRI 1230
	$< 65,000$ Btu/h	All	VRF Multi-Split System with Heat Recovery <i>86°F entering water</i>	11.8 EER <u>15.8 IEER</u>	
	$\geq 65,000$ Btu/h and $< 135,000$ Btu/h	All	VRF Multi-Split System <i>86°F entering water</i>	12.0 EER <u>16.0 IEER</u>	
	$\geq 65,000$ Btu/h and $< 135,000$ Btu/h	All	VRF Multi-Split System with Heat Recovery <i>86°F entering water</i>	11.8 EER <u>15.8 IEER</u>	
	$\geq 135,000$ Btu/h and $< 240,000$ Btu/h	All	VRF Multi-Split System <i>86°F entering water</i>	10.0 EER <u>14.0 IEER</u>	
	$\geq 135,000$ Btu/h and $< 240,000$ Btu/h	All	VRF Multi-Split System with Heat Recovery <i>86°F entering water</i>	9.8 EER <u>13.8 IEER</u>	
	<u><math>\geq 240,000</math> Btu/h</u>	<u>All</u>	<u>VRF Multi-Split System</u> <i>86°F entering water</i>	<u>12.0 IEER</u>	
	<u><math>\geq 240,000</math> Btu/h</u>	<u>All</u>	<u>VRF Multi-Split System with Heat Recovery</u> <i>86°F entering water</i>	<u>11.8 IEER</u>	
VRF Groundwater Source (cooling mode)	$< 135,000$ Btu/h	All	VRF Multi-Split System <i>59°F entering water</i>	16.2 EER	AHRI 1230
	$< 135,000$ Btu/h	All	VRF Multi-Split System with Heat Recovery <i>59°F entering water</i>	16.0 EER	
	$\geq 135,000$ Btu/h	All	VRF Multi-Split System <i>59°F entering water</i>	13.8 EER	
	$\geq 135,000$ Btu/h	All	VRF Multi-Split System with Heat Recovery <i>59°F entering water</i>	13.6 EER	
VRF Ground Source (cooling mode)	$< 135,000$ Btu/h	All	VRF Multi-Split System <i>77°F entering water</i>	13.4 EER	AHRI 1230
	$< 135,000$ Btu/h	All	VRF Multi-Split System with Heat Recovery <i>77°F entering water</i>	13.2 EER	

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure
	$\geq 135,000$ Btu/h	All	VRF Multi-Split System <i>77°F entering water</i>	11.0 EER	
	$\geq 135,000$ Btu/h	All	VRF Multi-Split System with Heat Recovery <i>77°F entering water</i>	10.8 EER	
VRF Air Cooled (heating mode)	$< 65,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System	7.7 HSPF	AHRI 1230
	$\geq 65,000$ Btu/h and $< 135,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>47°F db/43°F wb outdoor air</i> <i>17°F db/15°F wb outdoor air</i>	3.3 COP 2.25 COP	
	$\geq 135,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>47°F db/43°F wb outdoor air</i> <i>17°F db/15°F wb outdoor air</i>	3.2 COP 2.05 COP	
VRF Water Source (heating mode)	$< 135,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>68°F entering water</i>	<del>((4.2))</del> <u>4.3</u> COP	AHRI 1230
	$\geq 135,000$ Btu/h and $\leq 240,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>68°F entering water</i>	<del>((3.9))</del> <u>4.0</u> COP	
	$\geq 240,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>68°F entering water</i>	<u>3.9</u> COP	
VRF Groundwater Source (heating mode)	$< 135,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>50°F entering water</i>	3.6 COP	AHRI 1230
	$\geq 135,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>50°F entering water</i>	3.3 COP	
VRF Ground Source (heating mode)	$< 135,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>32°F entering water</i>	3.1 COP	AHRI 1230
	$\geq 135,000$ Btu/h (cooling capacity)	—	VRF Multi-Split System <i>32°F entering water</i>	2.8 COP	

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403232 Table ((C403.2.3)) C403.3.2(2)—Minimum efficiency requirements—Electrically operated unitary and applied heat pumps.**

**Table ((C403.2.3)) C403.3.2(2)  
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 <sup>a</sup>
Air cooled (cooling mode)	< 65,000 Btu/h <sup>b</sup>	All	Split System	14.0 SEER	AHRI 210/240
			Single Packaged	14.0 SEER	
Through-the-wall, air cooled (cooling mode)	≤ 30,000 Btu/h <sup>b</sup>	All	Split System	12.0 SEER	
			Single Packaged	12.0 SEER	
Small duct high velocity, air cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System	11.0 SEER	
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	AHRI 340/360
		All Other	Split System and Single Package	10.8 EER 12.0 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.6 EER 11.6 IEER	
		All Other	Split System and Single Package	10.4 EER 11.4 IEER	
	≥ 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 10.6 IEER	
		All Other	Split System and Single Package	9.3 EER 10.4 IEER	
<u>Water ((source)) to air, water loop</u> (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	
<u>Water to air, ground water ((source))</u> (cooling mode)	< 135,000 Btu/h	All	59°F entering water	18.0 EER	
<u>((Ground-water source)) Brine to air, ground loop</u> (cooling mode)	< 135,000 Btu/h	All	77°F entering water	14.1 EER	
<u>((Water-source)) Water to water, water loop</u> (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	ISO 13256-2
<u>Water to water, ground water</u> (cooling mode)	≤ 135,000 Btu/h	All	59°F entering water	16.3 EER	
<u>((Ground-water source)) Brine to water, ground loop</u> (cooling mode)	< 135,000 Btu/h	All	77°F entering fluid	12.1 EER	
Air cooled (heating mode)	< 65,000 Btu/h <sup>b</sup>	—	Split System	8.2 HSPF	AHRI 210/240
		—	Single Package	8.0 HSPF	
Through-the-wall, (air cooled, heating mode)	≤ 30,000 Btu/h <sup>b</sup> (cooling capacity)	—	Split System	7.4 HSPF	
		—	Single Package	7.4 HSPF	
Small-duct high velocity (air cooled, heating mode)	< 65,000 Btu/h <sup>b</sup>	—	Split System	6.8 HSPF	
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb Outdoor Air	3.3 COP	AHRI 340/360
			17°F db/15°F wb Outdoor Air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb Outdoor Air	3.2 COP	
			17°F db/15°F wb Outdoor Air	2.05 COP	
<u>Water ((source)) to air, water loop</u> (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	4.3 COP	ISO 13256-1
<u>Water to air, ground water ((source))</u> (heating mode)	< 135,000 Btu/h (cooling capacity)	—	50°F entering water	3.7 COP	
<u>((Ground-source)) Brine to air, ground loop</u> (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	3.2 COP	
<u>((Water-source)) Water to water, water loop</u> (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	3.7 COP	ISO 13256-2
		—	50°F entering water	3.1 COP	

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure <sup>a</sup>
((Ground source)) Brine to water, ground loop (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	2.5 COP	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

- a Chapter ((6)) 12 of the referenced standard contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
- b Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403233 Table ((C403.2.3)) C403.3.2(3)—Minimum efficiency requirements—Electrically operated PTAC, PTHP, SPVAC, SPVHP, room air conditioners.**

**Table ((C403.2.3)) C403.3.2(3)**

**Minimum Efficiency Requirements—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**

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency		Test Procedure <sup>a</sup>
PTAC (cooling mode) new construction	All Capacities	95°F db outdoor air		14.0 - (0.300 × Cap/1000) EER	AHRI 310/380
PTAC (cooling mode) replacements <sup>b</sup>	All Capacities	95°F db outdoor air		10.9 - (0.213 × Cap/1000) EER	
PTHP (cooling mode) new construction	All Capacities	95°F db outdoor air		14.0 - (0.300 × Cap/1000) EER	
PTHP (cooling mode) replacements <sup>b</sup>	All Capacities	95°F db outdoor air		10.8 - (0.213 × Cap/1000) EER	
PTHP (heating mode) new construction	All Capacities	—		3.7 - (0.052 × Cap/1000) COP	
PTHP (heating mode) replacements <sup>b</sup>	All Capacities	—		2.9 - (0.026 × Cap/1000) COP	
SPVAC (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb outdoor air		((10.0)) 11.0 EER	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb outdoor air		((10.0)) 11.0 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb outdoor air		((10.0)) 11.0 EER	
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb outdoor air		((10.0)) 11.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb outdoor air		((10.0)) 11.0 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb outdoor air		((10.0)) 11.0 EER	
SPVHP (heating mode)	<65,000 Btu/h	47°F db/43°F wb outdoor air		((3.0)) 3.3 COP	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/43°F wb outdoor air		((3.0)) 3.3 COP	
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/43°F wb outdoor air		((3.0)) 3.3 COP	
Room air conditioners, with louvered sides	< 6,000 Btu/h	—		((9.7 SEER)) 11.0 CEER	ANSI/AHA-MRAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h	—		((9.7 SEER)) 11.0 CEER	

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency		Test Procedure <sup>a</sup>
	$\geq 8,000$ Btu/h and $< 14,000$ Btu/h	—		<del>((9.8 EER))</del> <u>10.9 CEER</u>	
	$\geq 14,000$ Btu/h and $< 20,000$ Btu/h	—		<del>((9.7 SEER))</del> <u>10.7 CEER</u>	
	$\geq 20,000$ Btu/h and $< 25,000$ Btu/h	==		<u>9.4 CEER</u>	
	$\geq ((20,000))$ 25,000 Btu/h	—		<del>((8.5 EER))</del> <u>9.0 CEER</u>	
Room air conditioners, without louvered sides	<del>((&lt; 8,000 Btu/h))</del> $< 6,000$ Btu/h	—		<del>((9.0 EER))</del> <u>10.0 CEER</u>	
	$\geq 6,000$ Btu/h and $< 8,000$ Btu/h	==		<u>10.0 CEER</u>	
	$\geq 8,000$ Btu/h and $< 11,000$ Btu/h	==		<u>9.6 CEER</u>	
	$\geq ((8,000))$ 11,000 Btu/h and $< ((20,000))$ 14,000 Btu/h	—		<del>((8.5 EER))</del> <u>9.5 CEER</u>	
	$\geq 14,000$ Btu/h and $< 20,000$ Btu/h	==		<u>9.3 CEER</u>	
	$\geq 20,000$ Btu/h	—		<del>((8.5 EER))</del> <u>9.4 CEER</u>	
Room air-conditioner heat pumps with louvered sides	$< 20,000$ Btu/h	—		<del>((9.0 EER))</del> <u>9.8 CEER</u>	
	$\geq 20,000$ Btu/h	—		<del>((8.5 EER))</del> <u>9.3 CEER</u>	
Room air-conditioner heat pumps without louvered sides	$< 14,000$ Btu/h	—		<del>((8.5 EER))</del> <u>9.3 CEER</u>	
	$\geq 14,000$ Btu/h	—		<del>((8.0 EER))</del> <u>8.7 CEER</u>	
Room air conditioner casement only	All capacities	—		<del>((8.7 EER))</del> <u>9.5 CEER</u>	
Room air conditioner casement-slider	All capacities	—		<del>((9.5 EER))</del> <u>10.4 CEER</u>	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

"Cap" = The rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculations.

- a Chapter ((6)) 12 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- b Replacement unit shall be factory labeled as follows: "MANUFACTURED FOR NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW STANDARD PROJECTS" or "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 inches (406 mm) in height and less than 42 inches (1067 mm) in width.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-403234 Table ((C403.2.3)) C403.3.2(4)—Minimum efficiency requirements—Warm air furnaces and unit heaters.**

**Table ((403.2.3)) 403.3.2(4)**

**Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters, Minimum Efficiency Requirements**

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency <sup>d, e</sup>	Test Procedure <sup>a</sup>
Warm air furnaces, gas fired	$< 225,000$ Btu/h	—	<del>((78))</del> 80% AFUE or 80% $E_t^c$	DOE 10 C.F.R. Part 430 or ANSI Z21.47
	$\geq 225,000$ Btu/h	Maximum capacity <sup>c</sup>	80% $E_t^f$	ANSI Z21.47



Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency <sup>d, e</sup>	Test Procedure <sup>a</sup>
Warm air furnaces, oil fired	< 225,000 Btu/h	—	((78)) 83% AFUE or 80% $E_t^c$	DOE 10 C.F.R. Part 430 or UL 727
	≥ 225,000 Btu/h	Maximum capacity <sup>b</sup>	81% $E_t^g$	UL 727
Warm air duct furnaces, gas fired	All capacities	Maximum capacity <sup>b</sup>	80% $E_c$	ANSI Z83.8
Warm air unit heaters, gas fired	All capacities	Maximum capacity <sup>b</sup>	80% $E_c$	ANSI Z83.8
Warm air unit heaters, oil fired	All capacities	Maximum capacity <sup>b</sup>	80% $E_c$	UL 731

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

<sup>a</sup> Chapter ((6)) 12 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

<sup>b</sup> Minimum and maximum ratings as provided for and allowed by the unit's controls.

<sup>c</sup> Combination units not covered by the National Appliance Energy Conservation Act of 1987 (NAECA) (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h [19 kW]) shall comply with either rating.

<sup>d</sup>  $E_t$  = Thermal efficiency. See test procedure for detailed discussion.

<sup>e</sup>  $E_c$  = Combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

<sup>f</sup>  $E_c$  = Combustion efficiency. Units must also include an IID, have jackets 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.

<sup>g</sup>  $E_t$  = Thermal efficiency. Units must also include an 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.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403235 Table ((C403.2.3)) C403.3.2(5)—Minimum efficiency requirements—Gas- and oil-fired boilers.**

**Table ((C403.2.3)) C403.3.2(5)  
Minimum Efficiency Requirements—Gas- and Oil-Fired Boilers**

Equipment Type <sup>a</sup>	Subcategory or Rating Condition	Size Category (Input)	Minimum Efficiency	Test Procedure
Boilers, hot water	Gas-fired	< 300,000 Btu/h <sup>d, e</sup>	82% AFUE	10 C.F.R. Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	80% $E_t$	10 C.F.R. Part 431
		> 2,500,000 Btu/h <sup>a</sup>	82% $E_c$	
	Oil-fired <sup>c</sup>	< 300,000 Btu/h <sup>e</sup>	84% AFUE	10 C.F.R. Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	82% $E_t$	10 C.F.R. Part 431
		> 2,500,000 Btu/h <sup>a</sup>	84% $E_c$	
Boilers, steam	Gas-fired	< 300,000 Btu/h <sup>d</sup>	80% AFUE	10 C.F.R. Part 430
	Gas-fired - All, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	79% $E_t$	10 C.F.R. Part 431
		> 2,500,000 Btu/h <sup>a</sup>	79% $E_t$	
	Gas-fired-natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	((77)) 79% $E_t$	
		> 2,500,000 Btu/h <sup>a</sup>	((77)) 79% $E_t$	
	Oil-fired <sup>c</sup>	< 300,000 Btu/h	82% AFUE	10 C.F.R. Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	81% $E_t$	10 C.F.R. Part 431
		> 2,500,000 Btu/h <sup>a</sup>	81% $E_t$	

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

$E_c$  = Combustion efficiency (100 percent less flue losses).

$E_t$  = Thermal efficiency. See referenced standard document for detailed information.

- a 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 efficiency requirements for boilers cover all capacities of packaged boilers.
- b Maximum capacity minimum and maximum ratings as provided for and allowed by the unit's controls.
- c Includes oil-fired (residual).
- d Boilers shall not be equipped with a constant burning ignition pilot.
- e 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.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-403236 Table ((C403.2.3)) C403.3.2(6)—Reserved.**

**Table ((C403.2.3)) C403.3.2(6)  
Reserved**

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403237 Table ((C403.2.3)) C403.3.2(7)—Minimum efficiency requirements—Water chilling packages.**

**Table ((C403.2.3)) C403.3.2(7)  
Minimum Efficiency Requirements—Water Chilling Packages<sup>a</sup>**

Equipment Type	Size Category	Units	((As of 1/1/2015 <sup>b</sup> ))				Test Procedure <sup>c</sup>
			Path A		Path B		
			Full Load	IPLV	Full Load	IPLV	
Air-cooled chillers	< 150 tons	EER	≥ 10.100	≥ 13.700	≥ 9.700	≥ 15.800	AHRI 550/590
	≥ 150 tons	EER	≥ 10.100	≥ 14.000	≥ 9.700	≥ 16.100	
Air cooled without condenser, electrically operated	All capacities	EER	Air-cooled chillers without condensers shall be rated with matching condensers and comply with the air-cooled chiller efficiency requirements				
((Water cooled, electrically operated, reciprocating	All capacities	kW/ton	Reciprocating units shall comply with water cooled positive displacement efficiency requirements))				
Water cooled, electrically operated, positive displacement	< 75 tons	kW/ton	≤ 0.750	≤ 0.600	≤ 0.780	≤ 0.500	
	≥ 75 tons and < 150 tons	kW/ton	≤ 0.720	≤ 0.560	≤ 0.750	≤ 0.490	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.660	≤ 0.540	≤ 0.680	≤ 0.440	
	≥ 300 tons and < 600 tons	kW/ton	≤ 0.610	≤ 0.520	≤ 0.625	≤ 0.410	
	≥ 600 tons	kW/ton	≤ 0.560	≤ 0.500	≤ 0.585	≤ 0.380	

Equipment Type	Size Category	Units	((As of 1/1/2015 <sup>b</sup> ))				Test Procedure <sup>c</sup>
			Path A		Path B		
			Full Load	IPLV	Full Load	IPLV	
Water cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.610	≤ 0.550	≤ 0.695	≤ 0.440	AHRI 560
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.610	≤ 0.550	≤ 0.695	≤ 0.400	
	≥ 300 tons and < 400 tons	kW/ton	≤ 0.560	≤ 0.520	≤ 0.595	≤ 0.390	
	≥ 400 tons	kW/ton	≤ 0.560	≤ 0.500	≤ 0.585	≤ 0.380	
Air cooled, absorption single effect	All capacities	COP	≥ 0.600	NR	NA	NA	
Water cooled, absorption single effect	All capacities	COP	≥ 0.700	NR	NA	NA	
Absorption double effect, indirect fired	All capacities	COP	≥ 1.000	≥ 1.050	NA	NA	
Absorption double effect, direct fired	All capacities	COP	≥ 1.000	≥ 1.000	NA	NA	

For SI: 1 ton = 3517 W, 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

NA = Not applicable, not to be used for compliance;

NR = No requirement.

- a The centrifugal chiller equipment requirements, after adjustment in accordance with Section ((C403.2.3.1)) C403.3.2.2 or Section ((C403.2.3.2)) C403.3.2.3, do not apply to chillers used in low-temperature applications where the design leaving fluid temperature is less than 36°F. The requirements do not apply to positive displacement chillers with leaving fluid temperatures less than or equal to 32°F. The requirements do not apply to absorption chillers with design leaving fluid temperatures less than 40°F.
- b Compliance with this standard can be obtained by meeting the minimum requirements of Path A or B. However, both the full load and IPLV shall be met to fulfill the requirements of Path A or B.
- c Chapter ((6)) 12 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

AMENDATORY SECTION (Amending WSR 17-10-062, filed 5/2/17, effective 6/2/17)

**WAC 51-11C-403238 Table ((C403.2.3)) C403.3.2(8)—Minimum efficiency requirements—Heat rejection equipment.**

**Table ((C403.2.3)) C403.3.2(8)  
Minimum Efficiency Requirements—Heat Rejection Equipment**

Equipment Type <sup>a</sup>	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required <sup>b,c,d,g,h</sup>	Test Procedure <sup>e,f</sup>
Propeller or axial fan open circuit cooling towers	All	95°F Entering Water 85°F Leaving Water 75°F Entering wb	≥ ((38.2)) 40.2 gpm/hp	CTI ATC-105 and CTI STD-201 <u>RS</u>
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 <u>RS</u>
Propeller or axial fan closed circuit cooling towers	All	102°F Entering Water 90°F Leaving Water 75°F Entering wb	≥ ((14.0)) 16.1 gpm/hp	CTI ATC-105S and CTI STD-201 <u>RS</u>
Centrifugal 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 <u>RS</u>
Propeller or axial fan evaporative condensers	All	R-507A Test Fluid 165°F Entering Gas Temperature 105°F Condensing Temperature 75°F Entering wb	≥ 157,000 Btu/h • hp	CTI ATC-106

Equipment Type <sup>a</sup>	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required <sup>b,c,d,g,h</sup>	Test Procedure <sup>e,f</sup>
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-507A Test Fluid 165°F Entering Gas Temperature 105°F Condensing Temperature 75°F Entering wb	≥ 135,000 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 R-22 Test Fluid 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, °F;  
wb = wet-bulb temperature, °F.

- a 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 wet and dry heat exchange sections.
- (a) 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 Table 403.2.3(8)~~)) divided by the fan nameplate rated motor power.
- c For purposes of this table, closed circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition ((~~listed in Table 403.2.3(8)~~)) divided by the sum of the fan nameplate rated motor power and the spray pump nameplate rated motor power.
- d For purposes of this table, air cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.
- e Chapter ((6)) 12 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- f Where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program, or, where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, but the product is not listed in the existing certification program, the ratings shall be verified by an independent laboratory test report.
- g 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.
- h 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.
- i Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in this table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed above with R-507A as the test fluid.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403239 Table ((C403.2.3)) C403.3.2(9) and Table ((C403.2.3)) C403.3.2(10)—Minimum efficiency requirements.**

**Table ((C403.2.3)) C403.3.2(9)  
Minimum Efficiency Requirements—Air Conditioners and Condensing Units  
Serving Computer Rooms**

((Equipment Type	Net Sensible Cooling Capacity <sup>a</sup>	Minimum SCOP-127 <sup>b</sup> Efficiency Downflow units/Upflow units	Test Procedure
Air conditioners, air-cooled	< 65,000 Btu/h (< 19 kW)	2.20/2.09	ANSI/ASHRAE 127
	≥ 65,000 Btu/h and < 240,000 Btu/h (19 kW and < 70 kW)	2.10/1.99	
	≥ 240,000 Btu/h (≥ 70 kW)	1.90/1.79	

<b>((Equipment Type</b>	<b>Net Sensible Cooling Capacity<sup>a</sup></b>	<b>Minimum SCOP-127<sup>b</sup> Efficiency Downflow units/Upflow units</b>	<b>Test Procedure</b>
Air conditioners, water-cooled	< 65,000 Btu/h (< 19 kW)	2.60/2.49	ANSI/ASHRAE 127
	≥ 65,000 Btu/h and < 240,000 Btu/h (≥ 19 kW and < 70 kW)	2.50/2.39	
	≥ 240,000 Btu/h (≥ 70 kW)	2.40/2.29	
Air conditioners, water-cooled with fluid economizer	< 65,000 Btu/h (< 19 kW)	2.55/2.44	ANSI/ASHRAE 127
	≥ 65,000 Btu/h and < 240,000 Btu/h (≥ 19 kW and < 70 kW)	2.45/2.34	
	≥ 240,000 Btu/h (≥ 70 kW)	2.35/2.24	
Air conditioners, glycol-cooled (rated at 40% propylene glycol)	< 65,000 Btu/h (< 19 kW)	2.50/2.39	ANSI/ASHRAE 127
	≥ 65,000 Btu/h and < 240,000 Btu/h (≥ 19 kW and < 70 kW)	2.15/2.04	
	≥ 240,000 Btu/h (≥ 70 kW)	2.10/1.99	
Air conditioners, glycol-cooled (rated at 40% propylene glycol) with fluid economizer	< 65,000 Btu/h (< 19 kW)	2.45/2.34	ANSI/ASHRAE 127
	≥ 65,000 Btu/h and < 240,000 Btu/h (≥ 19 kW and < 70 kW)	2.10/1.99	
	≥ 240,000 Btu/h (≥ 70 kW)	2.05/1.94	

- a Net sensible cooling capacity: The total gross cooling capacity less the latent cooling less the energy to the air movement system. (Total Gross – Latent – Fan Power.)
- b Sensible coefficient of performance (SCOP-127): A ratio calculated by dividing the net sensible cooling capacity in watts by the total power input in watts (excluding reheaters and humidifiers) at conditions defined in ASHRAE Standard 127. The net sensible cooling capacity is the gross sensible capacity minus the energy dissipated into the cooled space by the fan system.)

Equipment Type	Net Sensible Cooling Capacity	Standard Model	Minimum Net Sensible COP <sup>c</sup>			Test Procedure
			Return Air Dry-Bulb Temperature/Dew-Point Temperature			
			Class 1	Class 2	Class 3	
			75°F/52°F	85°F/52°F	95°F/52°F	
Air cooled	< 65,000 Btu/h	Downflow unit	2.09	2.30	2.45	AHRI 1360
		Upflow unit - Ducted		2.10		
		Upflow unit - Unducted				
		Horizontal-flow unit				
	≥ 65,000 Btu/h and < 240,000 Btu/h	Downflow unit	1.99	2.20	2.35	
		Upflow unit - Ducted		2.05		
		Upflow unit - Unducted				
		Horizontal-flow unit				
	≥ 240,000 Btu/h	Downflow unit	1.79	2.00	2.15	
Upflow unit - Ducted		1.85				
Upflow unit - Unducted						
Horizontal-flow unit						

Equipment Type	Net Sensible Cooling Capacity	Standard Model	Minimum Net Sensible COP <sup>c</sup>			Test Procedure
			Return Air Dry-Bulb Temperature/Dew-Point Temperature			
			Class 1	Class 2	Class 3	
			75°F/52°F	85°F/52°F	95°F/52°F	
Water cooled	< 65,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	2.25	2.50 2.30	2.70	AHRI 1360
	≥ 65,000 Btu/h and < 240,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	2.15	2.40 2.20	2.60	
	≥ 240,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	2.05	2.25 2.10	2.45	
Water cooled with fluid economizer	< 65,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	2.20	2.45 2.25	2.60	AHRI 1360
	≥ 65,000 Btu/h and < 240,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	2.10	2.35 2.15	2.55	
	≥ 240,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	2.00	2.20 2.05	2.40	
Glycol cooled	< 65,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	2.00	2.30 2.10	2.40	AHRI 1360
	≥ 65,000 Btu/h and < 240,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	1.85	2.05 1.85	2.15	
	≥ 240,000 Btu/h	Downflow unit Upflow unit - Ducted Upflow unit - Unducted Horizontal-flow unit	1.75	1.95 1.80	2.10	

Equipment Type	Net Sensible Cooling Capacity	Standard Model	Minimum Net Sensible COP <sup>c</sup>			Test Procedure
			Return Air Dry-Bulb Temperature/Dew-Point Temperature			
			Class 1	Class 2	Class 3	
			75°F/52°F	85°F/52°F	95°F/52°F	
Glycol cooled with fluid economizer	< 65,000 Btu/h	Downflow unit	2.00	2.25	2.35	AHRI 1360
		Upflow unit - Ducted		2.10		
		Upflow unit - Unducted				
		Horizontal-flow unit				
	≥ 65,000 Btu/h and < 240,000 Btu/h	Downflow unit	1.75	1.95	2.10	
		Upflow unit - Ducted		1.80		
		Upflow unit - Unducted				
		Horizontal-flow unit				
	≥ 240,000 Btu/h	Downflow unit	1.70	1.90	2.10	
		Upflow unit - Ducted		1.80		
		Upflow unit - Unducted				
		Horizontal-flow unit				

**Table ((C403.2.3)) C403.3.2(10)**  
**Minimum Efficiency Requirements—**  
**Heat Transfer Equipment**

Equipment Type	Subcategory	Minimum Efficiency	Test Procedure <sup>a</sup>
Liquid-to-liquid heat exchangers	Plate type	NR	AHRI 400

NR = No requirement.

<sup>a</sup> Chapter ((6)) 12 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

**Table C403.3.2(11)**  
**Minimum Efficiency Requirements: Electrically Operated DX-DOAS Units, Single-package and Remote Condenser, Without Energy Recovery**

<b>EQUIPMENT TYPE</b>	<b>SUBCATEGORY OR RATING CONDITION</b>	<b>MINIMUM EFFICIENCY</b>	<b>TEST PROCEDURE</b>
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 (heating 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	

**Table C403.3.2(12)**

**Minimum Efficiency Requirements: Electrically Operated DX-DOAS Units,  
Single-package and Remote Condenser, with Energy Recovery**

<b><u>EQUIPMENT TYPE</u></b>	<b><u>SUBCATEGORY OR RATING CONDITION</u></b>	<b><u>MINIMUM EFFICIENCY</u></b>	<b><u>TEST PROCEDURE</u></b>
<u>Air cooled (dehumidification mode)</u>		<u>5.2 ISMRE</u>	<u>AHRI 920</u>
<u>Air source heat pumps (dehumidification mode)</u>		<u>5.2 ISMRE</u>	<u>AHRI 920</u>
<u>Water cooled (dehumidification mode)</u>	<u>Cooling tower condenser water</u>	<u>5.3 ISMRE</u>	<u>AHRI 920</u>
	<u>Chilled water</u>	<u>6.6 ISMRE</u>	
<u>Air source heat pump (heating mode)</u>		<u>3.3 ISCOP</u>	<u>AHRI 920</u>
<u>Water source heat pump (dehumidification mode)</u>	<u>Ground source, closed loop</u>	<u>5.2 ISMRE</u>	<u>AHRI 920</u>
	<u>Ground-water source</u>	<u>5.8 ISMRE</u>	
	<u>Water source</u>	<u>4.8 ISMRE</u>	
<u>Water source heat pump (heating mode)</u>	<u>Ground source, closed loop</u>	<u>3.8 ISCOP</u>	<u>AHRI 920</u>
	<u>Ground-water source</u>	<u>4.0 ISCOP</u>	
	<u>Water source</u>	<u>4.8 ISCOP</u>	

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40324 ((Section C403.2.4 HVAC system controls.)) Re-served.**

~~((C403.2.4 HVAC system controls. HVAC systems shall be provided with controls as defined in this section and shall be capable of and configured to implement all required control functions in this code.))~~

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-403241 ((Section C403.2.4.1 Thermostatic controls.)) Reserved.**

~~((C403.2.4.1 Thermostatic controls. The supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls capable of responding to temperature within the zone. Controls in the same zone or in neighboring zones connected by openings larger than 10 percent of the floor area of either zone shall not allow for simultaneous heating and cooling. At a minimum, each floor of a building shall be considered as a separate zone. Controls on systems required to have economizers and serving single zones shall have multiple cooling stage capability and activate the economizer when appropriate as the first stage of cooling. See Section C403.3.1 for further economizer requirements. Where humidification or dehumidification or both is provided, at least one humidity control device shall be provided for each humidity control system.))~~



EXCEPTIONS: 1. Independent perimeter systems that are designed to offset only building envelope heat losses or gains or both serving one or more perimeter *zones* also served by an interior system provided:  
1.1. The perimeter system includes at least one thermostatic control *zone* for each building exposure having exterior walls facing only one orientation (within  $\pm 45$  degrees) ( $0.8$  rad) for more than 50 contiguous feet (15,240 mm);  
1.2. The perimeter system heating and cooling supply is controlled by a thermostat located within the *zones* served by the system; and  
1.3. Controls are configured to prevent the perimeter system from operating in a different heating or cooling mode from the other equipment within the *zones* or from neighboring *zones* connected by openings larger than 10 percent of the floor area of either *zone*.  
2. Any interior *zone* open to a perimeter *zone* shall have setpoints and deadbands coordinated to that cooling in the interior *zone* shall not operate while the perimeter *zone* is in heating until the interior *zone* temperature is  $5^{\circ}\text{F}$  ( $2.8^{\circ}\text{C}$ ) higher than the perimeter *zone* temperature, unless the interior and perimeter *zones* are separated by a partition whose permanent openings are smaller than 10 percent of the perimeter *zone* floor area.

~~C403.2.4.1.1 Heat pump supplementary heat.~~ Unitary air cooled heat pumps shall include microprocessor controls that minimize supplemental heat usage during start-up, set-up, and defrost conditions. These controls shall anticipate need for heat and use compression heating as the first stage of heat. Controls shall indicate when supplemental heating is being used through visual means (e.g., LED indicators). Heat pumps equipped with supplementary heaters shall be installed with controls that prevent supplemental heater operation above  $40^{\circ}\text{F}$ .

EXCEPTION: Packaged terminal heat pumps (PTHPs) of less than 2 tons (24,000 Btu/hr) cooling capacity provided with controls that prevent supplementary heater operation above  $40^{\circ}\text{F}$ .

~~C403.2.4.1.2 Deadband.~~ Where used to control both heating and cooling, *zone* thermostatic controls shall be configured to provide a temperature range or deadband of at least  $5^{\circ}\text{F}$  ( $2.8^{\circ}\text{C}$ ) within which the supply of heating and cooling energy to the *zone* is shut off or reduced to a minimum.

EXCEPTIONS: 1. Thermostats requiring manual changeover between heating and cooling modes.  
2. Occupancies or applications requiring precision in indoor temperature control as approved by the code official.

~~C403.2.4.1.3 Setpoint overlap restriction.~~ Where a *zone* has a separate heating and a separate cooling thermostatic control located within the *zone*, a limit switch, mechanical stop or direct digital control system with software programming shall be configured to prevent the heating set point from exceeding the cooling setpoint and to maintain a deadband in accordance with Section C403.2.4.1.2.) )

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403242 ((Section C403.2.4.2 Off-hour controls.)) Re-served.**

~~((C403.2.4.2 Off-hour controls.~~ For all occupancies other than Group R, each *zone* shall be provided with thermostatic setback controls that are controlled by either an automatic time clock or programmable control system.

EXCEPTIONS: 1. *Zones* that will be operated continuously.  
2. *Zones* with a full HVAC load demand not exceeding 6,800 Btu/h (2 kW) and having a readily accessible manual shutoff switch.

~~C403.2.4.2.1 Thermostatic setback.~~ Thermostatic setback controls shall be configured to set back or temporarily operate the system to maintain *zone* temperatures down to  $55^{\circ}\text{F}$  ( $13^{\circ}\text{C}$ ) or up to  $85^{\circ}\text{F}$  ( $29^{\circ}\text{C}$ ).

~~C403.2.4.2.2 Automatic setback and shutdown.~~ Automatic time clock or programmable controls shall be capable of starting and stopping the system for seven different daily schedules per week and retaining their programming and time setting during a loss of power for at least 10 hours. Additionally, the controls shall have a manual override that allows temporary operation of the system for up to 2 hours; a manually

operated timer configured to operate the system for up to 2 hours; or an occupancy sensor.

**~~C403.2.4.2.3 Automatic start capabilities.~~** Automatic start controls shall be provided for each HVAC system. The controls shall be capable of automatically adjusting the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403243 ((Section C403.2.4.3 Shutoff dampers.)) Re-served.**

~~((C403.2.4.3 Shutoff dampers. Outdoor air supply, exhaust openings and relief outlets and stairway and shaft vents shall be provided with Class I motorized dampers.~~

~~Return air openings used for airside economizer operation shall be equipped with Class I motorized dampers.~~

~~Class 1 dampers shall have a maximum leakage rate of 4 cfm/ft<sup>2</sup> (20.3 L/s x m<sup>2</sup>) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D and shall be labeled by an approved agency for such purpose.~~

EXCEPTION: Motorized dampers on return air openings in unitary packaged equipment that have the minimum leakage rate available from the manufacturer shall be deemed to comply.

~~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 the *International Mechanical Code* 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.~~

EXCEPTIONS: 1. Gravity (nonmotorized) dampers shall be permitted to be used as follows:  
1.1. Relief dampers serving systems less than 5,000 cfm total supply shall be permitted in buildings less than three stories in height.  
1.2. Gravity (nonmotorized) dampers in Group R occupancies where the design outdoor air intake or exhaust capacity does not exceed 400 cfm (189 L/s).  
2. Combustion air intakes.

~~Gravity (nonmotorized) dampers shall have an air leakage rate not greater than 20 cfm/ft<sup>2</sup> (101.6 L/s x m<sup>2</sup>) where not less than 24 inches (610 mm) in either dimension and 40 cfm/ft<sup>2</sup> (203.2 L/s x m<sup>2</sup>) 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. Gravity dampers for ventilation air intakes shall be protected from direct exposure to wind.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403244 ((Section C403.2.4.4 Zone isolation.)) Reserved.**

~~((C403.2.4.4 Zone isolation. HVAC systems serving zones that are over 25,000 square feet (2323 m<sup>2</sup>) in floor area or that span more than one floor and are designed to operate or be occupied nonsimultaneously shall be divided into isolation areas. Each isolation area shall be equipped with isolation devices and controls configured to automatically shut off the supply of conditioned air and outdoor air to and exhaust air from the isolation area. Each isolation area shall be controlled independently by a device meeting the requirements of Section C403.2.4.2.2. Central systems and plants shall be provided with controls and devices that will allow system and equipment operation for any length of time while serving only the smallest isolation area served by the system or plant.~~

EXCEPTIONS: 1. Exhaust air and outdoor air connections to isolation areas where the fan system to which they connect is not greater than 5,000 cfm (2360 L/s).  
2. Exhaust airflow from a single isolation area of less than 10 percent of the design airflow of the exhaust system to which it connects.  
3. Isolation areas intended to operate continuously or intended to be inoperative only when all other isolation areas in a zone are inoperative.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403245 ((Section C403.2.4.5 Snowmelt and freeze protection controls.)) Reserved.**

~~((C403.2.4.5 Snow and ice-melt system controls. Snow and ice-melting systems, supplied through energy service to the building, shall include automatic controls configured to shut off the system when the pavement temperature is above 50°F (10°C) and no precipitation is falling and an automatic or manual control that is configured to shut off when the outdoor temperature is above 40°F (4°C) so that the potential for snow or ice accumulation is negligible.~~

~~**C403.2.4.6 Freeze protection system controls.** Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, shall include automatic controls configured to shut off the systems when outdoor air temperatures are above 40°F (4°C) or when the conditions of the protected fluid will prevent freezing.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403246 ((Section C403.2.4.7 Economizer fault detection and Section C403.2.4.8 Combustion heating equipment controls.)) Reserved.**

~~((C403.2.4.7 Economizer fault detection and diagnostics (FDD). Air-cooled unitary direct-expansion units with a cooling capacity of 54,000 Btu/h or greater listed in Tables C403.2.3(1) through C403.2.3(3) that are equipped with an economizer in accordance with Section C403.3 shall include a fault detection and diagnostics (FDD) 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. Temperature sensors shall have an accuracy of  $\pm 2^{\circ}\text{F}$  ( $1.1^{\circ}\text{C}$ ) over the range of  $40^{\circ}\text{F}$  to  $80^{\circ}\text{F}$  ( $4^{\circ}\text{C}$  to  $26.7^{\circ}\text{C}$ ).~~

~~3. Refrigerant pressure sensors, where used, shall have an accuracy of  $\pm 3$  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 accessible by day-to-day operating or service personnel or annunciated locally on zone thermostats.~~

~~7. The FDD 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.~~

~~**C403.2.4.8 Combustion heating equipment controls.** Combustion heating equipment with a capacity over 225,000 Btu/h shall have modulating or staged combustion control.~~

EXCEPTIONS: 1. Boilers.  
2. Radiant heaters.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403247 ((Sections C403.2.4.9 through C403.2.4.11 Group R controls.)) Reserved.**

~~((C403.2.4.9 Group R-1 hotel/motel guest rooms. For hotel and motel guest rooms, a minimum of one of the following control technologies shall be required in hotels/motels with over 50 guest rooms such that the space temperature would automatically setback (winter) or set up~~

~~(summer) by no less than 5°F (3°C) when the occupant is not in the room:~~

~~1. Controls that are activated by the room occupant via the primary room access method — Key, card, deadbolt, etc.~~

~~2. Occupancy sensor controls that are activated by the occupant's presence in the room.~~

**C403.2.4.10 Group R-2 and R-3 dwelling units.** The primary space conditioning system within each dwelling unit shall be provided with at least one programmable thermostat for the regulation of space temperature. The thermostat shall allow for, at a minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback periods per day.

Each additional system provided within the dwelling unit shall be provided with at least one adjustable thermostat for the regulation of temperature.

EXCEPTIONS: 1. Systems controlled by an occupant sensor that is configured to shut the system off when no occupant is sensed for a period of up to 30 minutes.  
2. Systems controlled solely by a manually operated timer configured to operate the system for no more than two hours.  
3. Ductless heat pumps.

Each thermostat shall be capable of being set by adjustment or selection of sensors and configured as follows: When used to control heating only: 55°F to 75°F; when used to control cooling only: 70°F to 85°F; all other: 55°F to 85°F with an adjustable deadband of not less than 10°F.

**C403.2.4.11 Group R-2 sleeping units.** The primary space conditioning system within each sleeping unit shall be provided with at least one programmable thermostat for the regulation of space temperature. The thermostat shall allow for, at a minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback periods per day.

Each additional system provided within the sleeping unit shall be provided with at least one adjustable thermostat for the regulation of temperature.

EXCEPTIONS: 1. Systems controlled by an occupant sensor that is configured to shut the system off when no occupant is sensed for a period of up to 30 minutes.  
2. Systems controlled solely by a manually operated timer configured to operate the system for no more than two hours.  
3. Zones with a full HVAC load demand not exceeding 3,400 Btu/h (1 kW) and having a readily accessible manual shutoff switch.  
4. Ductless heat pumps.

Each thermostat shall be capable of being set by adjustment or selection of sensors and configured as follows: When used to control heating only: 55°F to 75°F; when used to control cooling only: 70°F to 85°F; all other: 55°F to 85°F with an adjustable deadband of not less than 10°F.)

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403248 ((Section C403.2.4.12 Direct digital control systems.)) Reserved.**

**((C403.2.4.12 Direct digital control systems.** Direct digital control (DDC) shall be required as specified in Sections C403.2.4.12.1 through C403.2.4.12.3.

**C403.2.4.12.1 DDC applications.** DDC shall be provided in the applications and qualifications listed in Table C403.2.4.12.1.

**C403.2.4.12.2 DDC controls.** Where DDC is required by Section C403.2.4.12.1, the DDC system shall be capable of all of the following, as required to provide the system and zone control logic required in Sections C403.2, C403.3, and C403.4:

1. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling.

2. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers.

**C403.2.4.12.3 DDC display.** Where DDC is required by Section C403.2.12.1 for new buildings, the DDC system shall be capable of trending and graphically displaying input and output points.

**Table C403.2.4.12.1  
DDC Applications and Qualifications**

<b>Building Status</b>	<b>Application</b>	<b>Qualifications</b>
New building	Air-handling system and all zones served by the system	All air-handling systems in buildings with building cooling capacity greater than 780,000 Btu/h
	Air-handling system and all zones served by the system	Individual systems supplying more than three zones and with fan system bhp of 10 hp and larger
	Chilled-water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300,000 Btu/h and larger
	Hot-water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300,000 Btu/h and larger
Alteration or addition	Zone terminal unit such as VAV box	Where existing zones served by the same air-handling, chilled-water, or hot-water system have DDC
	Air-handling system or fan coil	Where existing air-handling system(s) and fan coil(s) served by the same chilled- or hot-water plant have DDC
	New air-handling system and all new zones served by the system	Individual systems with fan system bhp of 10 hp and larger and supplying more than three zones and more than 75% of zones are new
	New or upgraded chilled-water plant	Where all chillers are new and plant design cooling capacity is 300,000 Btu/h and larger
	New or upgraded hot-water plant	Where all boilers are new and plant design heating capacity is 300,000 Btu/h and larger))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403249 ((Section C403.2.5 Hot water boiler controls.)) Reserved.**

**((C403.2.5 Hot water boiler outdoor temperature setback control.** Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40325 ((Section C403.2.6 Ventilation.)) Reserved.**

~~((C403.2.6 Ventilation. Ventilation, either natural or mechanical, shall be provided in accordance with Chapter 4 of the *International Mechanical Code*. Where mechanical ventilation is provided, the system shall be configured to provide no greater than 150 percent of the minimum outdoor air required by Chapter 4 of the *International Mechanical Code* or other applicable code or standard, whichever is greater.~~

**EXCEPTIONS:**

1. The mechanical system may supply outdoor air at rates higher than the limit above when it is used for particulate or VOC dilution; economizer, night flushing, dehumidification, pressurization, exhaust make-up, or other process air delivery. Outdoor air shall be reduced to the minimum ventilation rates when not required for the preceding uses.
2. Air systems supplying Group R-1, R-2 or I-2 occupancies.
3. Alterations that replace less than half of the total heating and cooling capacity of the system.
4. Systems with energy recovery complying with the requirements of Section C403.5.1.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403252 ((Section C403.2.6.2 Demand control ventilation.)) Reserved.**

~~((C403.2.6.2 Demand controlled ventilation. Demand control ventilation (DCV) shall be provided for spaces larger than 500 square feet (50 m<sup>2</sup>) and with an occupant load greater than or equal to 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) 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; or
3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

**EXCEPTION:**

Demand control ventilation is not required for systems and spaces as follows:

1. Systems with energy recovery complying with Section C403.5.1.
2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.
3. System with a design outdoor airflow less than 750 cfm (354 L/s).
4. Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1,200 cfm (566 L/s).
5. Ventilation provided for process loads only.
6. Spaces with one of the following occupancy categories (as defined by the *International Mechanical Code*): Correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alley seating.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403253 ((Section C403.2.6.3 Occupancy sensors.)) Reserved.**

~~((C403.2.6.3 Occupancy sensors. Classrooms, gyms, auditoriums and conference rooms larger than 500 square feet of floor area shall have occupancy sensor control that will either close outside air dampers or turn off serving equipment when the space is unoccupied except where equipped with another means to automatically reduce outside air intake below design rates when spaces are partially occupied.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403254 ((Section C403.2.6.4 Loading dock and parking garage ventilation system controls.)) Reserved.**

~~((C403.2.6.4 Enclosed loading dock and parking garage exhaust ventilation system control. Mechanical ventilation systems for enclosed loading docks and parking garages shall be designed to exhaust the airflow rates (maximum and minimum) determined in accordance with the International Mechanical Code.~~

~~Ventilation systems shall be equipped with a control device that operates the system automatically by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Controllers shall be configured to shut off fans or modulate fan speed to 50 percent or less of design capacity, or intermittently operate fans less than 20 percent of the occupied time or as required to maintain acceptable contaminant levels in accordance with the International Mechanical Code provisions.~~

~~Gas sensor controllers used to activate the exhaust ventilation system shall stage or modulate fan speed upon detection of specified gas levels. All equipment used in sensor controlled systems shall be designed for the specific use and installed in accordance with the manufacturer's recommendations. The system shall be arranged to operate automatically by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Garages and loading docks shall be equipped with a controller and a full array of carbon monoxide (CO) sensors set to maintain levels of carbon monoxide below 35 parts per million (ppm). Additionally, a full array of nitrogen dioxide detectors shall be connected to the controller set to maintain the nitrogen dioxide level below the OSHA standard for eight hour exposure. Spacing and location of the sensors shall be installed in accordance with manufacturer recommendations.~~

**C403.2.6.4.1 System activation devices for enclosed loading docks.** ~~Ventilation systems for enclosed loading docks shall be activated by one of the following:~~

~~1. Gas sensors installed in accordance with the International Mechanical Code; or~~

~~2. Occupant detection sensors used to activate the system that detects entry into the loading area along both the vehicle and pedestrian pathways.~~

**C403.2.6.4.2 System activation devices for enclosed parking garages.** ~~Ventilation systems for enclosed parking garages shall be activated by gas sensors.~~

EXCEPTION: ~~A parking garage ventilation system having a total design capacity under 8,000 cfm may use occupant sensors.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40326 ((Section C403.2.7 Exhaust systems.)) Reserved.**



**( (C403.2.7 Exhaust systems.**

**C403.2.7.1 Kitchen exhaust systems.** Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10 percent of the hood exhaust airflow rate. Conditioned supply air delivered to any space shall not exceed the greater of the following:

1. The ventilation rate required to meet the space heating or cooling load.

2. The hood exhaust flow minus the available transfer air from adjacent space where available transfer air is considered 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 2,000 cfm 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 C403.2.7.1 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 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 energy recovery devices with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent 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.

**EXCEPTIONS:**

1. Where not less than 75 percent of all the replacement air is transfer air that would otherwise be exhausted.
2. Certified grease extractor hoods that require a face velocity no greater than 60 fpm.

**Table C403.2.7.1  
Maximum Net Exhaust Flow Rate,  
CFM Per Linear Foot of Hood Length**

TYPE OF HOOD	LIGHT-DUTY EQUIPMENT	MEDIUM-DUTY EQUIPMENT	HEAVY-DUTY EQUIPMENT	EXTRA-HEAVY-DUTY EQUIPMENT
Wall-mounted canopy	140	210	280	385
Single island	280	350	420	490
Double island (per side)	175	210	280	385
Eyebrow	175	175	NA	NA
Backshelf/pass-over	210	210	280	NA

For SI: 1 cfm = 0.4719 L/s; 1 foot = 305 mm  
NA = Not allowed

**C403.2.7.2 Laboratory exhaust systems.** Buildings with laboratory exhaust systems having a total exhaust rate greater than 5,000 cfm (2360 L/s) shall include heat recovery systems to precondition makeup air from laboratory exhaust. The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 25°F (13.9°C). A provision shall be made to bypass or control

~~the heat recovery system to permit air economizer operation as required by Section C403.3.~~

**EXCEPTIONS:**

1. Variable air volume laboratory exhaust and room supply systems configured to reduce exhaust and make-up air volume to 50 percent or less of design values; or
2. Direct make-up (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2°F (1.1°C) below room set point, cooled to no cooler than 3°F (1.7°C) above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control; or
3. Combined energy reduction method: VAV exhaust and room supply system configured to reduce exhaust and makeup air volumes and a heat recovery system to precondition makeup air from laboratory exhaust that when combined will produce the same energy reduction as achieved by a heat recovery system with a 50 percent sensible recovery effectiveness as required above. For calculation purposes, the heat recovery component can be assumed to include the maximum design supply airflow rate at design conditions. The combined energy reduction ( $Q_{ER}$ ) shall meet the following:

$$\begin{aligned} Q_{ER} &\geq Q_{MIN} \\ Q_{MIN} &= CFM_S \cdot (T_R - T_O) \cdot 1.1 \cdot 0.6 \\ Q_{ER} &= CFM_S \cdot (T_R - T_O) \cdot 1.1(A + B)/100 \end{aligned}$$

Where:

- |           |   |  |
|-----------|---|--|
| $Q_{MIN}$ | = | Energy recovery at 60 percent sensible effectiveness (Btu/h)   |
| $Q_{ER}$  | = | Combined energy reduction (Btu/h)  |
| $CFM_S$   | = | The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute |
| $T_R$     | = | Space return air dry bulb at winter design conditions  |
| $T_O$     | = | Outdoor air dry bulb at winter design conditions   |
| A         | = | Percentage that the exhaust and makeup air volumes can be reduced from design conditions                   |
| B         | = | Percentage sensible heat recovery effectiveness))  |

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40327 ((Section C403.2.8 Duct and plenum insulation and sealing.)) Reserved.**

**((C403.2.8 Duct and plenum insulation and sealing.**

**C403.2.8.1** ~~Ducts, shafts and plenums conveying outdoor air from the exterior of the building to the mechanical system shall meet all air leakage and building envelope insulation requirements of Section C402, plus building envelope vapor control requirements from the *International Building Code*, extending continuously from the building exterior to an automatic shutoff damper or heating or cooling equipment. For the purposes of building envelope insulation requirements, duct surfaces shall meet the requirements for metal framed walls per Table C402.1.4. Duct surfaces included as part of the building envelope shall not be used in the calculation of maximum glazing area as described in Section C402.4.1.~~

**EXCEPTIONS:**

1. Outside air ducts serving individual supply air units with less than 2,800 cfm of total supply air capacity, provided these are insulated to R-7.
2. Unheated equipment rooms with combustion air louvers, provided they are isolated from conditioned space at sides, top and bottom of the room with R-11 nominal insulation.

**C403.2.8.2** ~~All other supply and return air ducts and plenums shall be insulated with a minimum of R-6 insulation where located in uncondi-~~

tioned spaces and where located outside the building with a minimum of R-8 insulation in Climate Zone 4 and R-12 insulation in Climate Zone 5. Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by minimum insulation value as required for exterior walls by Section C402.1.3.

EXCEPTIONS: 1. Where located within equipment.  
2. Where the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F (8°C).

Where located within conditioned space, supply ducts which convey supply air at temperatures less than 55°F or greater than 105°F shall be insulated with a minimum of R-3.3 insulation.

EXCEPTION: Ductwork exposed to view within a zone that serves that zone is not required to be insulated.

All ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply with Section 603.9 of the *International Mechanical Code*.

**C403.2.8.3 Duct construction.** Ductwork shall be constructed and erected in accordance with the *International Mechanical Code*.

**C403.2.8.3.1 Low-pressure duct systems.** All 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.) (500 Pa) shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus embedded fabric systems or tapes installed in accordance with the manufacturer's installation instructions. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

EXCEPTION: Continuously welded and locking-type longitudinal joints and seams on ducts operating at static pressures less than 2 inches water gauge (w.g.) (500 Pa) pressure classification.

**C403.2.8.3.2 Medium-pressure duct systems.** All ducts and plenums designed to operate at a static pressure greater than 2 inches water gauge (w.g.) (500 Pa) but less than 3 inches w.g. (750 Pa) shall be insulated and sealed in accordance with Section C403.2.7. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

**C403.2.8.3.3 High-pressure duct systems.** Ducts designed to operate at static pressures in excess of 3 inches water gauge (w.g.) (750 Pa) shall be insulated and sealed in accordance with Section C403.2.8. 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 4-9.

**(Equation 4-9)**

$$CL = F/P^{0.65}$$

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 at least 25 percent of the duct area have been tested and that all tested sections meet the requirements of this section.) )

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40328 ((Section C403.2.9 Piping insulation.)) Reserved.**

~~((C403.2.9 Piping insulation. All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.2.9.~~

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 840, respectively.
3. Piping that conveys fluids that have a design operating temperature range between 60°F (15°C) and 105°F (41°C).
4. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.
5. Strainers, control valves, and balancing valves associated with piping 1 inch (25 mm) or less in diameter.
6. Direct buried piping that conveys fluids at or below 60°F (15°C).

~~**C403.2.9.1 Protection of piping insulation.** Piping insulation exposed to weather shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesives tape shall not be permitted.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403281 ((Table C403.2.9 Minimum pipe insulation thickness.)) Reserved.**

~~((Table C403.2.9  
Minimum Pipe Insulation Thickness (thickness in inches)<sup>a</sup>~~

Fluid Operating Temperature Range and Usage (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (inches)				
	Conductivity Btu • in. / (h • ft <sup>2</sup> • °F) <sup>b</sup>	Mean Rating Temperature, °F	< 1	1 to < 1-1/2	1-1/2 to < 4	4 to < 8	≥ 8
> 350	0.32 – 0.34	250	4.5	5.0	5.0	5.0	5.0
251 – 350	0.29 – 0.32	200	3.0	4.0	4.5	4.5	4.5
201 – 250	0.27 – 0.30	150	2.5	2.5	2.5	3.0	3.0
141 – 200	0.25 – 0.29	125	1.5	1.5	2.0	2.0	2.0
105 – 140	0.21 – 0.28	100	1.0	1.0	1.5	1.5	1.5
40 – 60	0.21 – 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 – 0.26	75	0.5	1.0	1.0	1.0	1.5

<sup>a</sup> For piping smaller than 1-1/2 inch (38 mm) and located in partitions within *conditioned spaces*, reduction of these thicknesses by 1 inch (25 mm) shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch (25 mm).

<sup>b</sup> For insulation outside the stated conductivity range, the minimum thickness (*T*) shall be determined as follows:

$$T = r \{ (1 + t/r)^{K/k} - 1 \}$$

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<sup>2</sup> × °F) and

*k* = The upper value of the conductivity range listed in the table for the applicable fluid temperature.

<sup>c</sup> 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 (25 mm).))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40329** (~~(Section C403.2.10 Mechanical system commissioning and completion requirements.)~~) Reserved.

(~~(C403.2.10 Mechanical systems commissioning and completion requirements. Mechanical systems shall be commissioned and completed in accordance with Section C408.)~~)

AMENDATORY SECTION (Amending WSR 17-10-062, filed 5/2/17, effective 6/2/17)

**WAC 51-11C-403291** (~~(Section C403.2.11 Air system design and control.)~~) Reserved.

(~~(C403.2.11 Air system design and control. Each HVAC system having a total fan system motor nameplate horsepower (hp) exceeding 5 horsepower (hp) (3.7 kW) shall comply with the provisions of Sections C403.2.11.1 through C403.2.11.3.~~

~~The air flow requirements of Section C403.2.11.5 shall apply to all fan motors. Group R occupancy exhaust fans shall also comply with Section C403.2.11.4.~~

~~**C403.2.11.1 Allowable fan motor horsepower.** Each HVAC system at fan system design conditions shall not exceed the allowable fan system motor nameplate hp (Option 1) or fan system bhp (Option 2) as shown in Table C403.2.11.1(1). This includes supply fans, exhaust fans, return/relief fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single zone variable-air-volume systems shall comply with the constant volume fan power limitation.~~

EXCEPTIONS:      1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.  
                         2. Individual exhaust fans with motor nameplate horsepower of 1 hp or less are exempt from allowable fan motor horsepower requirements.

~~**C403.2.11.2 Motor nameplate horsepower.** For each fan, the selected fan motor shall be no larger than the first available motor size greater than the brake horsepower (bhp). The fan brake horsepower (bhp) shall be indicated on the design documents to allow for compliance verification by the code official.~~

EXCEPTIONS:      1. For fans less than 6 bhp (4413 W), where the first available motor larger than the brake horsepower has a nameplate rating within 50 percent of the bhp, selection of the next larger nameplate motor size is allowed.  
                         2. For fans 6 bhp (4413 W) and larger, where the first available motor larger than the bhp has a nameplate rating within 30 percent of the bhp, selection of the next larger nameplate motor size is allowed.  
                         3. For fans used only in approved life safety applications such as smoke evacuation.

~~**C403.2.11.3 Fan efficiency.** Fans shall have a fan efficiency grade (FEG) of 67 or higher based on manufacturers' certified data, as defined by AMCA 205. 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.~~

EXCEPTION:      The following fans are not required to have a fan efficiency grade:  
                         1. Fans of 5 hp (3.7 kW) or less as follows:  
                         1.1. Single fan with a motor nameplate horsepower of 5 hp (3.7 kW) or less, unless Exception 1.2. applies.  
                         1.2. Multiple fans in series or parallel that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less and are operated as the functional equivalent of a single fan.  
                         2. Fans that are part of equipment covered under Section C403.2.3.

3. 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. Fans that are intended to operate only during emergency conditions.

**~~C403.2.11.4 Group R occupancy exhaust fan efficacy.~~** The Group R occupancies of the building shall be provided with ventilation that meets the requirements of the *International Mechanical Code*, as applicable, or with other approved means of ventilation. Mechanical ventilation system fans with 400 cfm or less in capacity shall meet the efficacy requirements of Table C403.2.11.4.

EXCEPTIONS:

1. Group R heat recovery ventilator and energy recovery ventilator fans that are less than 400 cfm.
2. Where whole house ventilation fans are integrated with forced-air systems that are tested and listed HVAC equipment, they shall be powered by an electronically commutated motor where required by Section C405.8.
3. Domestic clothes dryer booster fans, domestic range hood exhaust fans, and domestic range booster fans that operate intermittently.

**~~C403.2.11.5 Fan airflow control.~~** Each cooling system listed in Table C403.2.11.5 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 no 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 airside economizer in accordance with Section C403.3 shall have not fewer than two speeds of 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 the *International Mechanical Code* at low speed exceeds the air that would be delivered at the minimum speed defined in this section, the minimum speed shall be selected to provide the required ventilation air.)

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403292 ((Tables for Section C403.2.11.)) Reserved.**

**((Table C403.2.11.1(1)  
Fan Power Limitation**

	Limit	Constant Volume	Variable Volume
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	$hp \leq CFM_S \times 0.0011$	$hp \leq CFM_S \times 0.0015$
Option 2: Fan system bhp	Allowable fan system bhp	$bhp \leq CFM_S \times 0.00094 + A$	$bhp \leq CFM_S \times 0.0013 + A$

For SI: 1 cfm = 0.471 L/s, 1 bhp = 735.5 W, 1 hp = 745.5 W.

Where:

- CFM<sub>S</sub> = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.
- hp = The maximum combined motor nameplate horsepower.
- bhp = The maximum combined fan brake horsepower.
- $A = \text{Sum of } [PD \times CFM_D / 4131]$

Where:

- $PD$  = Each applicable pressure drop adjustment from Table C403.2.10.1(2) in. w.e.
- CFM<sub>D</sub> = The design airflow through each applicable device from Table C403.2.10.1(2) in cubic feet per minute.

**Table C403.2.11.1(2)**  
**Fan Power Limitation Pressure Drop Adjustment**

Device	Adjustment
<b>Credits</b>	
Fully ducted return and/or exhaust air systems	0.5 inch w.e. (2.15 inches w.e. for laboratory and vivarium systems)
Return and/or exhaust air flow control devices	0.5 inch w.e.
Exhaust filters, scrubbers, or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate filtration credit: MERV 9 – 12	0.5 inch w.e.
Particulate filtration credit: MERV 13 – 15	0.9 inch w.e.
Particulate filtration credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2x clean filter pressure drop at fan system design condition
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition
Biosafety cabinet	Pressure drop of device at fan system design condition
Energy recovery device, other than coil runaround loop	(2.2 × energy recovery effectiveness) — 0.5 inch w.e. for each airstream
Coil runaround loop	0.6 inch w.e. for each airstream
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design conditions
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.15 inch w.e.
Exhaust system serving fume hoods	0.35 inch w.e.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 inch w.e./100 feet of vertical duct exceeding 75 feet

Device	Adjustment
<b>Credits</b>	
<b>Deductions</b>	
Systems without central cooling device	-0.6 inch w.e
Systems without central heating device	-0.3 inch w.e.
Systems with central electric resistance heat	-0.2 inch w.e.

For SI: 1 inch w.e.=249 Pa, 1 inch=25.4 mm.  
w.e.= water column.

**Table C403.2.11.4**  
**Mechanical Ventilation System Fan Efficacy**

Fan Location	Air Flow Rate Minimum (cfm)	Minimum Efficacy (cfm/watt)	Air Flow Rate Maximum (cfm)
Exhaust fan: Bathroom, utility room, whole house	40	1.4 cfm/watt	<90
Exhaust fan: Bathroom, utility room, whole house	90	2.8 cfm/watt	Any

**Table C403.2.11.5**  
**Fan Control**

Cooling System Type	Fan Motor Size	Mechanical Cooling Capacity
DX cooling	Any	≥ 65,000 Btu/h
Chilled water and evaporative cooling	≥ 5 hp	Any
	≥ 1/4 hp	Any))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403293 ((Section C403.2.12 Heating outside a building.)) Reserved.**

~~((C403.2.12 Heating outside a building. Systems installed to provide heat outside a building shall be radiant systems.~~

~~Such heating systems shall be controlled by an occupancy sensing device or a timer switch, so that the system is automatically deenergized when no occupants are present.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403294 ((Section C403.2.13 System criteria.)) Reserved.**



~~((C403.2.13 Variable flow capability. For fan and pump motors 7.5 hp and greater including motors in or serving custom and packaged air handlers serving variable air volume fan systems, constant volume fans, heating and cooling hydronic pumping systems, pool and service water pumping systems, domestic water pressure boosting systems, cooling tower fan, and other pump or fan motors where variable flows are required, there shall be:~~

- ~~1. Variable speed drives; or~~
- ~~2. Other controls and devices that will result in fan and pump motor demand of no more than 30 percent of design wattage at 50 percent of design air volume for fans when static pressure set point equals 1/3 the total design static pressure, and 50 percent of design water flow for pumps, based on manufacturer's certified test data. Variable inlet vanes, throttling valves (dampers), scroll dampers or bypass circuits shall not be allowed.~~

EXCEPTION: Variable speed devices are not required for motors that serve:  
1. Fans or pumps in packaged equipment where variable speed drives are not available as a factory option from the equipment manufacturer.  
2. Fans or pumps that are required to operate only for emergency fire-life-safety events (e.g., stairwell pressurization fans, elevator pressurization fans, fire pumps, etc.).

~~C403.2.13.1 Heat rejection equipment. The requirements of this section apply to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, open cooling towers, closed-circuit cooling towers, and evaporative condensers.~~

EXCEPTION: Heat rejection devices included as an integral part of equipment listed in Tables C403.2.3(1) through C403.2.3(3).

~~Heat rejection equipment shall have a minimum efficiency performance not less than values specified in Table C403.2.3(8). These requirements apply to all propeller, axial fan and centrifugal fan cooling towers. Table C403.2.3(8) specifies requirements for air-cooled condensers that are within rating conditions specified within the table.~~

~~C403.2.13.1.1 Variable flow controls. Cooling tower fans 7.5 hp and greater shall have control devices that vary flow by controlling the leaving fluid temperature or condenser temperature/pressure of the heat rejection device.~~

~~C403.2.13.1.2 Limitation on centrifugal fan cooling towers. Open cooling towers with a combined rated capacity of 1,100 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall meet the energy efficiency requirement for axial fan open circuit cooling towers.~~

EXCEPTION: Open circuit cooling towers that are ducted (inlet or discharge) or have external sound attenuation that requires external static pressure capability.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-403295 ((Section C403.2.14 Electric motor efficiency.)) Reserved.**

~~((C403.2.14 Electric motor efficiency. Electric motors, including fractional hp motors, shall comply with the provisions of Section C405.8.))~~

**WAC 51-11C-40330 Section C403.3—((Economizers)) Equipment selection.**

**C403.3 ((Economizers (Prescriptive)).** ~~Air economizers shall be provided on all new systems including those serving computer server rooms, electronic equipment, radio equipment, and telephone switchgear. Economizers shall comply with Sections C403.3.1 through C403.3.4.~~

- EXCEPTIONS:
1. Systems complying with Section C403.6 Dedicated outdoor air systems (DOAS) with year-round cooling loads from lights and equipment of less than 5 watts per square foot.
  2. Unitary or packaged systems serving one zone with dehumidification that affect other systems so as to increase the overall building energy consumption. New humidification equipment shall comply with Section C403.2.3.4.
  3. Unitary or packaged systems serving one zone where the cooling efficiency meets or exceeds the efficiency requirements in Table C403.3.
  4. Water-cooled refrigeration equipment serving chilled beams and chilled ceiling space cooling systems only which are provided with a water economizer meeting the requirements of Section C403.3.4.
  5. Systems complying with all of the following criteria:
    - 5.1. Consist of multiple water source heat pumps connected to a common water loop;
    - 5.2. Have a minimum of 60 percent air economizer;
    - 5.3. Have water source heat pumps with an EER at least 15 percent higher for cooling and a COP at least 15 percent higher for heating than that specified in Section C403.2.3;
    - 5.4. Where provided, have a central boiler or furnace efficiency of 90 percent minimum for units up to 199,000 Btu/h; and
    - 5.5. Provide heat recovery with a minimum 50 percent heat recovery effectiveness as defined in Section C403.5 to preheat the outside air supply.
  6. For Group R occupancies, cooling units installed outdoors or in a mechanical room adjacent to outdoors with a total cooling capacity less than 20,000 Btu/h and other cooling units with a total cooling capacity less than 54,000 Btu/h provided that these are high-efficiency cooling equipment with IEER, SEER, and EER values more than 15 percent higher than minimum efficiencies listed in Tables C403.2.3 (1) through (3), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify for this exception. For split systems, compliance is based on the cooling capacity of individual fan coil units.
  7. Variable refrigerant flow (VRF) systems, multiple-zone split-system heat pumps, consisting of multiple, individually metered indoor units with multi-speed fan motors, served on a single common refrigeration circuit with an exterior reverse-cycle heat pump with variable speed compressor(s) and variable speed condenser fan(s). These systems shall also be capable of providing simultaneous heating and cooling operation, where recovered energy from the indoor units operating in one mode can be transferred to one or more indoor units operating in the other mode, and shall serve at least 20 percent internal (no perimeter wall within 12') and 20 percent perimeter zones (as determined by conditioned floor area) and the outdoor unit shall be at least 65,000 Btu/h in total capacity. Systems utilizing this exception shall have 50 percent heat recovery effectiveness as defined by Section C403.5 on the outside air. For the purposes of this exception, dedicated server rooms, electronic equipment rooms or telecom switch rooms are not considered perimeter zones.
  8. Equipment used to cool *Controlled Plant Growth Environments* provided these are high-efficiency cooling equipment with SEER, EER and IEER values a minimum of 20 percent greater than the values listed in Tables C403.2.3 (1), (3) and (7).
  9. Equipment used to cool any spaces with year-round cooling loads from lights and equipment of greater than 5 watts per square foot, where it can be demonstrated through calculations, to the satisfaction of the *code official*, that the heat rejection load of the equipment will be recovered and used for on-site space heating or service water heating demands such that the energy use of the building is decreased in comparison to a baseline of the same equipment provided with an air economizer complying with Section C403.3.
  10. Equipment used to cool any dedicated server room, electronic equipment room or telecom switch room provided the system complies with Option a, b or c in the table below. The total capacity of all systems without economizers shall not exceed 240,000 Btu/h per building or 10 percent of its air economizer capacity, whichever is greater. This exception shall not be used for Total Building Performance.

	Equipment Type	Higher-Equipment Efficiency	Part-Load-Control	Economizer
Option-a	Tables C403.2.3(1) and C403.2.3(2) <sup>a</sup>	+15% <sup>b</sup>	Required over 85,000 Btu/h <sup>c</sup>	None-Required
Option-b	Tables C403.2.3(1) and C403.2.3(2) <sup>a</sup>	+5% <sup>d</sup>	Required over 85,000 Btu/h <sup>c</sup>	Waterside Economizer <sup>e</sup>
Option-c	ASHRAE Standard 127 <sup>f</sup>	+0% <sup>g</sup>	Required over 85,000 Btu/h <sup>c</sup>	Waterside Economizer <sup>e</sup>

Notes for Exception 10:

<sup>a</sup>For a system where all of the cooling equipment is subject to the AHRI standards listed in Tables C403.2.3(1) and C403.2.3(2), the system shall comply with all of the following (note that if the system contains any cooling equipment that exceeds the capacity limits in Table C403.2.3(1) or C403.2.3(2), or if the system contains any cooling equipment that is not included in Table C403.2.3(1) or C403.2.3(2), then the system is not allowed to use this option):

<sup>b</sup>The cooling equipment shall have an EER value and an IPLV value that is a minimum of 15 percent greater than the value listed in Tables C403.2.3(1) and C403.2.3(2).

<sup>c</sup>For units with a total cooling capacity over 85,000 Btu/h, the system shall utilize part-load capacity control schemes that are able to modulate to a part-load capacity of 50 percent of the load or less that results in the compressor operating at the same or higher EER at part loads than at full load (e.g., minimum of two stages of compressor unloading such as cylinder unloading, two-stage scrolls, dual tandem scrolls, but hot gas bypass is not credited as a compressor unloading system).

<sup>d</sup>The cooling equipment shall have an EER value and an IPLV value that is a minimum of 5 percent greater than the value listed in Tables C403.2.3(1) and C403.2.3(2).

<sup>c</sup>The system shall include a water economizer in lieu of air economizer. Water economizers shall meet the requirements of C403.3.1 and C403.3.2 and be capable of providing the total concurrent cooling load served by the connected terminal equipment lacking airside economizer, at outside air temperatures of 50°F dry-bulb/45°F wet-bulb and below. For this calculation, all factors including solar and internal load shall be the same as those used for peak load calculations, except for the outside temperatures. The equipment shall be served by a dedicated condenser water system unless a nondedicated condenser water system exists that can provide appropriate water temperatures during hours when waterside economizer cooling is available.

<sup>f</sup>For a system where all cooling equipment is subject to ASHRAE Standard 127.

<sup>g</sup>The cooling equipment subject to the ASHRAE Standard 127 shall have an EER value and an IPLV value that is equal or greater than the value listed in Tables C403.2.3(1) and C403.2.3(2) when determined in accordance with the rating conditions ASHRAE Standard 127 (i.e., not the rating conditions in AHRI Standard 210/240 or 340/360). This information shall be provided by an independent third party.

**Table C403.3  
Equipment Efficiency Performance  
Exception for Economizers**

Climate Zones	Efficiency Improvement <sup>a</sup>
4C	64%
5B	59%

<sup>a</sup> If a unit is rated with an IPLV, IEER or SEER then to eliminate the required air or water economizer, the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full load metric like EER or COP cooling, then these must be increased by the percentage shown.))

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

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40331 Section C403.3.1—(~~Integrated economizer control~~) Equipment and system sizing.**

**C403.3.1 (~~Integrated economizer control.~~** Economizer systems 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 shall not be capable of creating a false load in the mechanical cooling system by limiting or disabling the economizer or any other means, such as hot gas bypass, 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 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 with cooling capacity 65,000 Btu/h (19 kW) or greater of rated capacity shall comply with the following:

2.1. DX units that control the capacity of the mechanical cooling directly based on occupied space temperature shall have not fewer than two stages of mechanical cooling capacity.

2.2. Other DX units, including those that control space temperature by modulating the airflow to the space, shall be in accordance with Table C403.3.1.

**Table C403.3.1**  
**DX Cooling Stage Requirements for Modulating Airflow Units**

RATING CAPACITY	MINIMUM NUMBER OF MECHANICAL COOLING STAGES	MINIMUM COMPRESSOR DISPLACEMENT <sup>a</sup>
≥65,000 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.

<sup>a</sup>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.)

**Equipment and system 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 C403.1.2. 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.

**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.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40332 Section C403.3.2—((Economizer heating system impact)) HVAC equipment performance requirements.**

**C403.3.2 ((Economizer heating system impact.** HVAC system design and economizer controls shall be such that economizer operation does not increase building heating energy use during normal operation.

**EXCEPTION:** Economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature.))

**HVAC equipment performance requirements.** Equipment shall meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2(12) 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(10). The efficiency shall be verified through certification and listed under an *approved* certification program or, if no certification program exists, 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.

Gas-fired and oil-fired forced air furnaces with input ratings ≥ 225,000 Btu/h (65 kW) and all unit heaters shall also have an intermittent ignition or interrupted device (IID), and have either mechanical draft (including power venting) or a flue damper. A vent damper is an acceptable alternative to a flue damper for furnaces where combustion air is drawn from the conditioned space. All furnaces with input ratings ≥ 225,000 Btu/h (65 kW), including electric furnaces, that are

not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating.

**C403.3.2.1 Chillers.** Chilled water plants and buildings with more than 500 tons total capacity shall not have more than 100 tons provided by air-cooled chillers.

EXCEPTIONS:

1. Where the designer demonstrates that the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled equipment.
2. Air-cooled chillers with minimum efficiencies at least 10 percent higher than those listed in Table C403.3.2(7).
3. Replacement of existing air-cooled chiller equipment.
4. Air-to-water heat pump units that are configured to provide both heating and cooling and that are rated in accordance with AHRI 550/590. Where the air-to-water heat pumps are designed for a maximum supply leaving water temperature of less than 140°F, the efficiency rating will be calculated and reported at the maximum unit leaving water temperature for this test condition.

**C403.3.2.2 Water-cooled centrifugal chilling package.** 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 adjusted using Equations 4-7 and 4-8.

$$FL_{adj} = FL/K_{adj}$$

**(Equation 4-7)**

$$PLV_{adj} = IPLV/K_{adj}$$

**(Equation 4-8)**

Where:

$$K_{adj} = A \times B$$

$$FL = \text{Full-load kW/ton values as specified in Table C403.3.2(7)}$$

$$FL_{adj} = \text{Maximum full-load kW/ton rating, adjusted for nonstandard conditions}$$

$$IPLV = \text{Value as specified in Table C403.3.2(7)}$$

$$PLV_{adj} = \text{Maximum NPLV rating, adjusted for nonstandard conditions}$$

$$A = \frac{0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times LIFT + 3.9302}{1}$$

$$B = \frac{0.0015 \times L_{vg}^{Evap} (^\circ F) + 0.934}{1}$$

$$LIFT = L_{vg}^{Cond} - L_{vg}^{Evap}$$

$$L_{vg}^{Cond} = \text{Full-load condenser leaving fluid temperature (}^\circ F\text{)}$$

$$L_{vg}^{Evap} = \text{Full-load evaporator leaving temperature (}^\circ F\text{)}$$

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°F.
2. Maximum condenser leaving temperature: 115°F.
3. LIFT is not less than 20°F (11.1°C) and not greater than 80°F (44.4°C).

**C403.3.2.3 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.

**C403.3.2.4 Packaged electric heating and cooling equipment.** Packaged electric equipment providing both heating and cooling with a total cooling capacity greater than 6,000 Btu/h shall be a heat pump.

EXCEPTION: Unstaffed equipment shelters or cabinets used solely for personal wireless service facilities.

**C403.3.2.5 Humidification.** If an air economizer is required on a cooling system for which humidification equipment is to be provided to maintain minimum indoor humidity levels, then the humidifier shall be of the adiabatic type (direct evaporative media or fog atomization type).

EXCEPTIONS: 1. Health care facilities licensed by the state where chapter 246-320 or 246-330 WAC requires steam injection humidifiers in duct work downstream of final filters.  
2. Systems with water economizer.  
3. 100 percent outside air systems with no provisions for air recirculation to the central supply fan.  
4. Nonadiabatic humidifiers cumulatively serving no more than 10 percent of a building's air economizer capacity as measured in cfm.  
This refers to the system cfm serving rooms with stand alone or duct mounted humidifiers.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40333 Section C403.3.3—((Air economizers)) Hot gas bypass.**

**C403.3.3 ((Air economizers.** ~~Air economizers shall comply with Sections C403.3.3.1 through C403.3.3.5.~~

**C403.3.3.1 Design capacity.** ~~Air economizer systems shall be configured to modulate outdoor air and return air dampers to provide up to 100 percent of the design supply air quantity as outdoor air for cooling.~~

**C403.3.3.2 Control signal.** ~~Economizer controls and dampers shall be configured to sequence the dampers with the mechanical cooling equipment and shall not be controlled by only mixed air temperature. Air economizers on systems with cooling capacity greater than 65,000 Btu/h shall be configured to provide partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.~~

EXCEPTION: The use of mixed air temperature limit control shall be permitted for systems that are both controlled from space temperature (such as single zone systems) and having cooling capacity less than 65,000 Btu/h.

**C403.3.3.3 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 no longer reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table C403.3.3.3. High-limit shutoff control settings for these control types shall be those specified in Table C403.3.3.3.~~

**Table C403.3.3.3**  
**High-limit Shutoff Control Setting for Air Economizers<sup>b</sup>**

Device Type	Climate Zone	Required High Limit (economizer off when):	
		Equation	Description
Fixed dry-bulb	4C, 5B	$T_{OA} > 75^{\circ}\text{F}$	Outdoor air temperature exceeds 75°F

Device Type	Climate Zone	Required High Limit (economizer off when):	
		Equation	Description
Differential dry-bulb	4C, 5B	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy with fixed dry-bulb temperatures	All	$h_{OA} > 28 \text{ Btu/lb}^a$ or $T_{OA} > 75^\circ\text{F}$	Outdoor air enthalpy exceeds 28 Btu/lb of dry air <sup>a</sup> or outdoor air temperature exceeds 75°F
Differential enthalpy with fixed dry-bulb temperature	All	$h_{OA} > h_{RA}$ or $T_{OA} > 75^\circ\text{F}$	Outdoor air enthalpy exceeds return air enthalpy or outdoor air temperature exceeds 75°F

For SI:  $^\circ\text{C} = (^\circ\text{F} - 32) \times 5/9$ , 1 Btu/lb = 2.33 kJ/kg.

<sup>a</sup>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.

<sup>b</sup>Devices with selectable setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.

**C403.3.3.4 Relief of excess outdoor air.** Systems shall be capable of relieving excess outdoor air during air economizer operation to prevent over-pressurizing the building. The relief air outlet shall be located to avoid recirculation into the building.

**C403.3.3.5 Economizer dampers.** Return, exhaust/relief and outdoor air dampers used in economizers shall comply with Section C403.2.4.3.))  
**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 C403.5.1.

**Table C403.3.3**  
**Maximum Hot Gas Bypass Capacity**

Rated Capacity	Maximum Hot Gas Bypass Capacity (% of total capacity)
$\leq 240,000 \text{ Btu/h}$	50
$\geq 240,000 \text{ Btu/h}$	25

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

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40334 Section C403.3.4—((Water-side economizers)) Boiler turndown.**

**C403.3.4 ((Water-side economizers.** Water-side economizers shall comply with Sections C403.3.4.1 and C403.3.4.2.

**C403.3.4.1 Design capacity.** Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to 100 percent of the expected system cooling load at outdoor air temperatures of 50°F dry-bulb (10°C dry-bulb)/45°F wet-bulb (7.2°C wet-bulb) and below.

**EXCEPTION:** Systems where dehumidification requirements cannot be met using outdoor air temperatures of 50°F dry-bulb (10°C dry-bulb)/45°F wet-bulb (7.2°C wet-bulb) and where 100 percent of the expected system cooling load at 45°F dry-bulb (7.2°C dry-bulb)/40°F wet-bulb (4.5°C wet-bulb) is met with evaporative water economizers.

**C403.3.4.2 Maximum pressure drop.** ~~Precooling coils and water-to-water heat exchangers used as part of a water economizer system shall either have a waterside pressure drop of less than 15 feet (4572 mm) of water or a secondary loop shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling (noneconomizer) mode.))~~ **Boiler turndown.** Boiler systems with design input of greater than 1,000,000 Btu/h (293 kW) shall comply with the turndown ratio specified in Table C403.3.4.

The system turndown requirement shall be met through the use of multiple single input boilers, one or more modulating boilers or a combination of single input and modulating boilers.

**Table C403.3.4**  
**Boiler Turndown**

<b>Boiler System Design Input (Btu/h)</b>	<b>Minimum Turndown Ratio</b>
<u>≥ 1,000,000 and less than or equal to 5,000,000</u>	<u>3 to 1</u>
<u>&gt; 5,000,000 and less than or equal to 10,000,000</u>	<u>4 to 1</u>
<u>&gt; 10,000,000</u>	<u>5 to 1</u>

NEW SECTION

**WAC 51-11C-40335 Section C403.3.5—Dedicated outdoor air systems.**

**C403.3.5 Dedicated outdoor air systems (DOAS).** For buildings with occupancies as shown in Table C403.3.5, outdoor air shall be provided to each occupied space by a dedicated outdoor air system (DOAS) which delivers 100 percent outdoor air without requiring operation of the heating and cooling system fans for ventilation air delivery.

EXCEPTIONS: 1. Occupied spaces that are not ventilated by a mechanical ventilation system and are only ventilated by a natural ventilation system per Section 402 of the *International Mechanical Code*.  
2. High efficiency variable air volume (VAV) systems complying with Section C403.6.10 for occupancy classifications other than Groups A-1, A-2 and A-3 as specified in Table C403.3.5, and high efficiency VAV systems comply with Section C403.12 for occupancy classification Groups A-1, A-2 and A-3 as specified in Table C403.3.5. This exception shall not be used as a substitution for a DOAS per Section C406.6.

**Table C403.3.5**  
**Occupancy Classifications Requiring DOAS**

<b>Occupancy Classification<sup>a</sup></b>	<b>Inclusions</b>	<b>Exempted</b>
A-1	All occupancies not specifically exempted	Television and radio studios
A-2	Casinos (gaming area)	All other A-2 occupancies
A-3	Lecture halls, community halls, exhibition halls, gymnasiums, courtrooms, libraries, places of religious worship	All other A-3 occupancies
A-4, A-5		All occupancies excluded
B	All occupancies not specifically exempted	Food processing establishments including commercial kitchens, restaurants, cafeterias; laboratories for testing and research; data processing facilities and telephone exchanges; air traffic control towers; animal hospitals, kennels, pounds; ambulatory care facilities



Occupancy Classification <sup>a</sup>	Inclusions	Exempted
F, H, I, R, S, U		All occupancies excluded
E, M	All occupancies included	

a. Occupancy classification from the *International Building Code* Chapter 3.

**C403.3.5.1 Energy recovery ventilation with DOAS.** The DOAS shall include *energy recovery ventilation*. The energy recovery system shall have a 60 percent minimum sensible recovery effectiveness or have 50 percent enthalpy recovery effectiveness in accordance with Section C403.7.6.1. For DOAS having a total fan system motor nameplate hp less than 5 hp, total combined fan power shall not exceed 1 W/cfm of outdoor air. For DOAS having a total fan system motor hp greater than or equal to 5 hp, refer to fan power limitations of Section C403.8.1. This fan power restriction applies to each dedicated outdoor air unit in the permitted project, but does not include the fan power associated with the zonal heating/cooling equipment. The airflow rate thresholds for energy recovery requirements in Tables C403.7.6.1(1) and C403.7.6.1(2) do not apply.

EXCEPTIONS:

1. Occupied spaces with all of the following characteristics: Complying with Section C403.7.6.1, served by equipment less than 5000 cfm, with an average occupant load greater than 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) that include demand control ventilation configured to reduce outdoor air by at least 50 percent below design minimum ventilation rates when the actual occupancy of the space served by the system is less than the design occupancy.
2. Systems installed for the sole purpose of providing makeup air for systems exhausting toxic, flammable, paint, or corrosive fumes or dust, dryer exhaust, or commercial kitchen hoods used for collecting and removing grease vapors and smoke.

**C403.3.5.2 Heating/cooling system fan controls.** Heating and cooling equipment fans, heating and cooling circulation pumps, and terminal unit fans shall cycle off and terminal unit primary cooling air shall be shut off when there is no call for heating or cooling in the zone.

EXCEPTION: Fans used for heating and cooling using less than 0.12 watts per cfm may operate when space temperatures are within the setpoint deadband (Section C403.4.1.2) to provide destratification and air mixing in the space.

**C403.3.5.3 Decoupled DOAS supply air.** The DOAS supply air shall be delivered directly to the occupied space or downstream of the terminal heating and/or cooling coils.

EXCEPTIONS:

1. Active chilled beam systems.
2. Sensible only cooling terminal units with pressure independent variable airflow regulating devices limiting the DOAS supply air to the greater of latent load or minimum ventilation requirements.
3. Terminal heating and/or cooling units that comply with the low fan power allowance requirements in the exception of Section C403.3.5.2.

**C403.3.5.4 Impracticality.** Where the code official determines that full compliance with all the requirements of Sections C403.3.5.1 and C403.3.5.2 would be impractical, it is permissible to provide an approved alternate means of compliance that achieves a comparable level of energy efficiency. For the purposes of this section, impractical means that an HVAC system complying with Section C403.3.5 cannot effectively be utilized due to an unusual use or configuration of the building.

## NEW SECTION

**WAC 51-11C-40336 Section C403.3.6—Ventilation for Group R-2 occupancy.**

**C403.3.6 Ventilation for Group R-2 occupancy.** For all Group R-2 dwelling and sleeping units, a balanced ventilation system with heat recovery system with minimum 60 percent sensible recovery effectiveness

shall provide outdoor air directly to all habitable space. The ventilation system shall allow for the design flow rates to be tested and verified at each habitable space as part of the commissioning process in accordance with Section C408.2.2.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40340 Section C403.4—(~~Hydronic and multiple-zone~~) HVAC system(~~(s)~~) controls.**

**C403.4 (~~Hydronic and multiple-zone~~) HVAC system controls (~~and equipment (prescriptive)~~.** ~~Hydronic and multiple zone HVAC system controls and equipment shall comply with this section.~~

~~For buildings with a total equipment cooling capacity of 300 tons and above, the equipment shall comply with one of the following:~~

~~1. No one unit shall have a cooling capacity of more than 2/3 of the total installed cooling equipment capacity;~~

~~2. The equipment shall have a variable speed drive; or~~

~~3. The equipment shall have multiple compressors)). HVAC systems shall be provided with controls in accordance with Sections C403.4.1 through C403.4.11 and shall be capable of and configured to implement all required control functions in this code.~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40341 (~~(Reserved-)~~) Section C403.4.1—Thermostatic controls.**

**C403.4.1 Thermostatic controls.** The supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls capable of responding to temperature within the zone. Controls in the same zone or in neighboring zones connected by openings larger than 10 percent of the floor area of either zone shall not allow for simultaneous heating and cooling. At a minimum, each floor of a building shall be considered as a separate zone. Controls on systems required to have economizers and serving single zones shall have multiple cooling stage capability and activate the economizer when appropriate as the first stage of cooling. See Section C403.5 for further economizer requirements. Where humidification or dehumidification or both is provided, at least one humidity control device shall be provided for each humidity control system.

EXCEPTIONS:

1. Independent perimeter systems that are designed to offset only building envelope heat losses or gains or both serving one or more perimeter zones also served by an interior system provided:

1.1. The perimeter system includes at least one thermostatic control zone for each building exposure having exterior walls facing only one orientation (within +/-45 degrees) (0.8 rad) for more than 50 contiguous feet (15,240 mm);

1.2. The perimeter system heating and cooling supply is controlled by a thermostat located within the zones served by the system; and

1.3. Controls are configured to prevent the perimeter system from operating in a different heating or cooling mode from the other equipment within the zones or from neighboring zones connected by openings larger than 10 percent of the floor area of either zone.  
2. Any interior zone open to a perimeter zone shall have setpoints and deadbands coordinated so that cooling in the interior zone shall not operate while the perimeter zone is in heating until the interior zone temperature is 5°F (2.8°C) higher than the perimeter zone temperature, unless the interior and perimeter zones are separated by a partition whose permanent openings are smaller than 10 percent of the perimeter zone floor area.

3. Dedicated outdoor air units that provide ventilation air, make-up air or replacement air for exhaust systems are permitted to be controlled based on supply air temperature. The supply air temperature shall be controlled to a maximum of 65°F (18.3°C) in heating and a minimum of 72°F (22°C) in cooling unless the supply air temperature is being reset based on the status of cooling or heating in the zones served or it being reset based on outdoor air temperature.

**C403.4.1.1 Heat pump supplementary heat.** Unitary air cooled heat pumps shall include microprocessor controls that minimize supplemental heat usage during start-up, set-up, and defrost conditions. These controls shall anticipate need for heat and use compression heating as the first stage of heat. Controls shall indicate when supplemental heating is being used through visual means (e.g., LED indicators). Heat pumps equipped with supplementary heaters shall be installed with controls that prevent supplemental heater operation above 40°F (4.4°C).

**EXCEPTION:** Packaged terminal heat pumps (PTHPs) of less than 2 tons (24,000 Btu/hr) cooling capacity provided with controls that prevent supplementary heater operation above 40°F (4.4°C).

**C403.4.1.2 Deadband.** Where used to control both heating and cooling, zone thermostatic controls shall be configured to provide a temperature range or deadband of at least 5°F (2.8°C) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

**EXCEPTIONS:** 1. Thermostats requiring manual changeover between heating and cooling modes.  
2. Occupancies or applications requiring precision in indoor temperature control as approved by the code official.

**C403.4.1.3 Setpoint overlap restriction.** Where a zone has a separate heating and a separate cooling thermostatic control located within the zone, a limit switch, mechanical stop or direct digital control system with software programming shall be configured to prevent the heating setpoint from exceeding the cooling setpoint and to maintain a deadband in accordance with Section C403.4.1.2.

**C403.4.1.4 Heated or cooled vestibules.** 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 45°F (7°C). Vestibule heating and cooling systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 60°F (16°C) and cooling to a temperature not less than 85°F (29°C).

**EXCEPTIONS:** 1. Control of heating or cooling provided by transfer air that would otherwise be exhausted.  
2. Vestibule heating only systems are permitted to be controlled without an outdoor air temperature lockout when controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 45°F (7°C) where required for freeze protection of piping and sprinkler heads located in the vestibule.

**C403.4.1.5 Hot water boiler outdoor temperature setback control.** Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.

**C403.4.1.6 Door switches for HVAC system thermostatic control.** Doors that open to the outdoors from a conditioned space must have controls configured to do the following once doors have been open for 5 minutes:

1. Disable the mechanical heating to the zone or reset the space heating temperature setpoint to 55°F or less within 5 minutes of the door open enable signal.

2. Disable the mechanical cooling to the zone or reset the space cooling temperature setpoint to 85°F or more within 5 minutes of the door open enable signal.

**EXCEPTIONS:** 1. Building entrances with vestibules.  
2. Alterations to existing buildings.  
3. Loading docks.

**WAC 51-11C-40342 Section ((C403.4.1—Fan)) C403.4.2—Off-hour controls.**

~~((C403.4.1 Multiple-zone system fan control. Controls shall be provided for fans in accordance with Sections C403.4.1.1 through C403.4.1.2.~~

~~**C403.4.1.1 Static pressure sensor location.** Static pressure sensors used to control VAV fans shall be located such that the controller setpoint is no greater than 1.2 inches w.c. (2099 Pa). Where this results in one or more sensors being located downstream of major duct splits, not less than one sensor shall be located on each major branch to ensure that static pressure can be maintained in each branch.~~

~~EXCEPTION: Systems complying with Section C403.4.1.2.~~

~~**C403.4.1.2 Set points for direct digital control.** For systems with direct digital control of individual zones reporting to the central control panel, the static pressure setpoint shall be reset based on the zone requiring the most pressure. In such cases, the set point is reset lower until one zone damper is nearly wide open. The direct digital controls shall be capable of monitoring zone damper positions or shall have an alternative method of indicating the need for static pressure that is configured to provide all of the following:~~

- ~~1. Automatically detecting any zone that excessively drives the reset logic.~~
  - ~~2. Generating an alarm to the system operational location.~~
  - ~~3. Allowing an operator to readily remove one or more zones from the reset algorithm.)~~
- ~~**C403.4.2 Off-hour controls.** For all occupancies other than Group R, each zone shall be provided with thermostatic setback controls that are controlled by either an automatic time clock or programmable control system.~~

~~EXCEPTIONS:~~

- ~~1. Zones that will be operated continuously.~~
- ~~2. Zones with a full HVAC load demand not exceeding 6,800 Btu/h (2 kW) and having a manual shutoff switch located with ready access.~~

~~**C403.4.2.1 Thermostatic setback.** Thermostatic setback controls shall be configured to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C).~~

~~**C403.4.2.2 Automatic setback and shutdown.** Automatic time clock or programmable controls shall be capable of starting and stopping the system for seven different daily schedules per week and retaining their programming and time setting during a loss of power for at least 10 hours. Additionally, the controls shall have a manual override that allows temporary operation of the system for up to 2 hours; a manually operated timer configured to operate the system for up to 2 hours; or an occupancy sensor.~~

~~**C403.4.2.3 Automatic start and stop.** Automatic start and stop 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. The automatic stop controls shall be configured to reduce the HVAC system's heating temperature setpoint and increase the cooling temperature setpoint by at least 2°F (1.1°C) before scheduled unoccupied periods based upon~~

the thermal lag and acceptable drift in space temperature that is within comfort limits. At a minimum, the controls shall be a function of the space temperature, occupied and unoccupied temperatures, and the amount of time prior to scheduled occupancy.

**C403.4.2.4 Exhaust system off-hour controls.** For all occupancies other than Group R, exhaust systems serving spaces within the conditioned envelope shall be controlled by either an automatic time clock, thermostatic controls or programmable control system to operate on the same schedule as the HVAC systems providing their make-up air.

EXCEPTIONS:

1. Exhaust systems requiring continuous operation.
2. Exhaust systems that are controlled by occupancy sensor control configured with automatic on and automatic shutoff within 15 minutes after occupants have left the space.

**C403.4.2.5 Transfer and destratification fan system off-hour controls.** For all occupancies other than Group R, transfer fan or mixing fan systems serving spaces within the conditioned envelope shall be controlled by either an automatic time clock, thermostatic controls or programmable control system to operate on the same schedule as the associated HVAC systems.

EXCEPTION: Transfer fan and destratification fan systems that are controlled by occupancy sensor control configured with manual on and automatic shutoff within 15 minutes after occupants have left the space.

AMENDATORY SECTION (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

**WAC 51-11C-40343 Section ((C403.4.2)) C403.4.3—Hydronic systems controls.**

**((C403.4.2)) C403.4.3 Hydronic systems controls.** The heating of fluids that have been previously mechanically cooled and the cooling of fluids that have been previously mechanically heated shall be limited in accordance with Sections ((C403.4.2.1)) C403.4.3.1 through ((C403.4.2.3)) C403.4.3.3. Hydronic heating systems comprised of multiple-packaged boilers and designed to deliver conditioned water or steam into a common distribution system shall include automatic controls configured to sequence operation of the boilers. Hydronic heating systems comprised of a single boiler and greater than 500,000 Btu/h (146,550 W) input design capacity shall include either a multi-staged or modulating burner.

**((C403.4.2.1)) C403.4.3.1 Three-pipe system.** Hydronic systems that use a common return system for both hot water and chilled water are prohibited.

**((C403.4.2.2)) C403.4.3.2 Two-pipe changeover system.** Systems that use a common distribution system to supply both heated and chilled water shall be designed to allow a dead band between changeover from one mode to the other of at least 15°F (8.3°C) outside air temperatures; be designed to and provided with controls that will allow operation in one mode for at least 4 hours before changing over to the other mode; and be provided with controls that allow heating and cooling supply temperatures at the changeover point to be no more than 30°F (16.7°C) apart.

**((C403.4.2.3)) C403.4.3.3 Hydronic (water loop) heat pump systems.** Hydronic heat pump systems shall comply with Sections ((C403.4.2.3.1)) C403.4.3.3.1 through ((C403.4.2.3.3)) C403.4.3.3.3.

**((C403.4.2.3.1)) C403.4.3.3.1 Temperature dead band.** Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are configured to provide a heat pump water supply temperature dead band of at least 20°F (11.1°C) between initiation of heat rejection and heat addition by the central devices.

EXCEPTION: Where a system loop temperature optimization controller is installed and can determine the most efficient operating temperature based on real time conditions of demand and capacity, dead bands of less than 20°F (11°C) shall be permitted.

**((C403.4.2.3.2)) C403.4.3.3.2 Heat rejection.** ~~((Heat rejection equipment shall comply with Sections C403.4.2.3.2.1 and C403.4.2.3.2.2.))~~  
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, an automatic valve shall be installed to bypass the flow of water around the closed-circuit cooling tower, except for the minimum flow necessary for freeze protection. Flow controls for freeze protection shall not allow water through the closed-circuit cooling tower when outdoor temperatures are above the freezing point of the glycol/water solution, i.e., 32°F (0°C) for 100 percent water applications and 18°F (-7.8°C) for 20 percent by mass propylene glycol solution.

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 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.

**((C403.4.2.3.2.1 Climate Zone 4. For Climate Zone 4:**

~~1. If a closed-circuit cooling tower is used directly in the heat pump loop, either an automatic valve shall be installed to bypass all but a minimal flow of water around the tower, or lower leakage positive closure dampers shall be provided.~~

~~2. If an open-circuit tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the tower.~~

~~3. If an open- or closed-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the cooling tower from the heat pump loop, then heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.~~

**C403.4.2.3.2.2 Climate Zone 5.** For Climate Zone 5, if an open- or closed-circuit cooling tower is used, then a separate heat exchanger shall be provided to isolate the cooling tower from the heat pump loop, and heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop and providing an automatic valve to stop the flow of fluid.

**C403.4.2.3.3)) C403.4.3.3.3 Isolation valve.** Each hydronic heat pump on the hydronic system having a total pump system power exceeding 10 horsepower (hp) (7.5 kW) shall have a two-way (but not three-way) valve. For the purposes of this section, pump system power is the sum of the nominal power demand (i.e., nameplate horsepower at nominal motor efficiency) of motors of all pumps that are required to operate at design conditions to supply fluid from the heating or cooling source to all heat transfer devices (e.g., coils, heat exchanger) and return it to the source. This converts the system into a variable flow system

and, as such, the primary circulation pumps shall comply with the variable flow requirements in Section (C403.4.2.6.

**C403.4.2.4 Part load controls.** Hydronic systems greater than or equal to 300,000 Btu/h (88 kW) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that are configured to:

1. Automatically reset the supply-water temperatures in response to varying building heating and cooling demand using coil valve position, zone-return water temperature or outdoor air temperature. The temperature shall be reset by not less than 25 percent of the design supply-to-return water temperature difference.

EXCEPTION: Hydronic systems serving hydronic heat pumps.

2. Automatically vary fluid flow for hydronic systems with a combined motor capacity of 3 hp or larger with three or more control valves or other devices by reducing the system design flow rate by not less than 50 percent by designed 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 chilled-water systems and heat rejection loops serving water-cooled unitary air conditioners with a combined motor capacity of 3 hp or larger by reducing pump design flow by not less than 50 percent utilizing adjustable speed drives on pumps, or multiple-staged pumps where not less than one-half of the total pump horsepower is capable of being automatically turned off. Pump flow shall be controlled to maintain one control valve nearly wide open or to satisfy the minimum differential pressure.

EXCEPTIONS: 1. Supply-water temperature reset for chilled-water systems supplied by off-site district chilled water or chilled water from ice storage systems.  
2. Minimum flow rates other than 50 percent as required by the equipment manufacturer for proper operation of equipment where using flow-bypass or end-of-line 3-way valves.  
3. Variable pump flow 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.

**C403.4.2.5 Boiler turndown.** Boiler systems with design input of greater than 1,000,000 Btu/h (293 kW) shall comply with the turndown ratio specified in Table C403.4.2.5.

The system turndown requirement shall be met through the use of multiple single input boilers, one or more modulating boilers or a combination of single input and modulating boilers.

**Table C403.4.2.5  
Boiler Turndown**

Boiler System Design Input (Btu/h)	Minimum Turndown Ratio
≥ 1,000,000 and less than or equal to 5,000,000	3 to 1
> 5,000,000 and less than or equal to 10,000,000	4 to 1
> 10,000,000	5 to 1

**C403.4.2.6 Pump isolation.** Chilled water plants including more than one chiller shall be capable of and configured to reduce flow automatically through the chiller plant when a chiller is shut down and automatically shut off flow to chillers that are shut down. Chillers piped in series for the purpose of increased temperature differential shall be considered as one chiller.

EXCEPTION: Chillers that are piped in series for the purpose of increased temperature differential.

Boiler plants including more than one boiler shall be capable of and configured to reduce flow automatically through the boiler plant when a boiler is shut down.

**~~C403.4.2.7 Variable flow controls.~~** Individual pumps required by this code to have variable speed control shall be controlled in one of the following manners:

1. For systems having a combined pump motor horsepower less than or equal to 20 hp (15 kW) and without direct digital control of individual coils, pump speed shall be a function of either:

1.1. Required differential pressure; or

1.2. Reset directly based on zone hydronic demand, or other zone load indicators; or

1.3. Reset directly based on pump power and pump differential pressure.

2. For systems having a combined pump motor horsepower that exceeds 20 hp (15 kW) or smaller systems with direct digital control, pump speed shall be a function of either:

2.1. The static pressure set point as reset based on the valve requiring the most pressure; or

2.2. Directly controlled based on zone hydronic demand))

C403.4.5.

AMENDATORY SECTION (Amending WSR 17-10-062, filed 5/2/17, effective 6/2/17)

**WAC 51-11C-40344 Section ((C403.4.3 Heat rejection equipment))**

**C403.4.4—Part load controls.**

~~((C403.4.3 Heat rejection equipment. Heat rejection equipment such as air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers and evaporative condensers used for comfort cooling applications shall comply with this section.~~

EXCEPTION: Heat rejection devices where energy usage is included in the equipment efficiency ratings listed in Tables C403.2.3(1)A, C403.2.3(1)B, C403.2.3(1)C, C403.2.3(2), C403.2.3(3), C403.2.3(7) and C403.2.3(9).

**~~C403.4.3.1 Fan speed control.~~** The fan speed shall be controlled as provided in Sections C403.4.3.1.1 and C403.4.3.1.2.

**~~C403.4.3.1.1 Fan motors not less than 7.5 hp.~~** Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

**~~C403.4.3.1.2 Multiple-cell heat rejection equipment.~~** Multiple-cell heat rejection equipment with variable speed fan drives shall be controlled in both of the following manners:

1. To operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components.

2. So all fans can operate at the same fan speed required for the instantaneous cooling duty, as opposed to staged (on/off) operation. Minimum fan speed shall be the minimum allowable speed of the fan drive system in accordance with the manufacturer's recommendations.

**~~C403.4.3.2 Limitation on centrifugal fan open-circuit cooling towers.~~** Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1,100 gpm (4164 L/m) or greater at 95°F (35°C) condenser wa-



ter 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 C403.2.3(8).

EXCEPTION: Centrifugal open-circuit cooling towers that are designed with inlet or discharge ducts or require external sound attenuation.

**C403.4.3.3 Tower flow turndown.** Open-circuit cooling towers used on water-cooled chiller systems that are configured with multiple- or variable-speed condenser water pumps shall be designed so that all open circuit cooling tower cells can be run in parallel with the larger of the flow that is produced by the smallest pump at its minimum expected flow rate or at 50 percent of the design flow for the cell.))

**C403.4.4 Part load controls.** Hydronic systems greater than or equal to 300,000 Btu/h (88 kW) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that are configured to:

1. Automatically reset the supply-water temperatures in response to varying building heating and cooling demand using coil valve position, zone-return water temperature or outdoor air temperature. The temperature shall be reset by not less than 25 percent of the design supply-to-return water temperature difference.

EXCEPTION: Hydronic systems serving hydronic heat pumps.

2. Automatically vary fluid flow for hydronic systems with a combined pump motor capacity of 2 hp 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 2 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 motors having the same or greater nominal output power indicated in Table C403.4.4 based on the climate zone and system served.

4. Where 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 or to satisfy the minimum differential pressure.

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. Variable speed drives are not required on heating water pumps where more than 50 percent of annual heat is generated by an electric boiler.

**Table C403.4.4**  
**Variable Speed Drive (VSD) Requirements for Demand-Controlled Pumps**

<u>Climate Zones 4c, 5b</u>	<u>VSD Required for Motors with Rated Output of at Least</u>
<u>Heating water pumps</u>	<u>≥7.5 hp</u>
<u>Chilled water and heat rejection loop pumps</u>	<u>≥10 hp</u>

AMENDATORY SECTION (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

**WAC 51-11C-40345 Section ((C403.4.4 Requirements for mechanical systems serving multiple zones)) C403.4.5—Pump isolation.**

~~((C403.4.4 Requirements for mechanical systems serving multiple zones. Sections C403.4.4.1 through C403.4.4.4 shall apply to mechanical systems serving multiple zones. Supply air systems serving multiple zones shall be VAV systems which, during periods of occupancy, are designed and configured to reduce primary air supply to each zone to one of the following before reheating, recooling or mixing takes place:~~

- ~~1. Thirty percent of the maximum supply air to each zone.~~
- ~~2. Three hundred cfm (142 L/s) or less where the maximum flow rate is less than 10 percent of the total fan system supply airflow rate.~~
- ~~3. The minimum ventilation requirements of Chapter 4 of the *International Mechanical Code*.~~
- ~~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 rates to comply with applicable codes or accreditation standards such as pressure relationships or minimum air change rates.~~

**EXCEPTION:**

The following define where individual *zones* or where entire air distribution systems are exempted from the requirement for VAV control:

1. *Zones* or supply air systems where at least 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered or site-solar energy source.
2. *Zones* where special humidity levels are required to satisfy process needs.
3. *Zones* with a peak supply air quantity of 300 cfm (142 L/s) or less and where the flow rate is less than 10 percent of the total fan system supply airflow rate.
4. *Zones* without DDC for which the volume of air that is reheated, recoolled or remixed is less than the larger of the following:
  - 4.1. 30 percent of the zone design peak supply rate.
  - 4.2. The outdoor airflow rate required to meet the ventilation requirements of Chapter 4 of the *International Mechanical Code* for the zone.
  - 4.3. Any higher rate that can be demonstrated, to the satisfaction of the code official, to reduce overall system annual energy usage by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system.
  - 4.4. The airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
5. *Zones* with DDC that comply with all of the following:
  - 5.1. The airflow rate in dead band between heating and cooling does not exceed the larger of the following:
    - 5.1.1. 20 percent of the zone design peak supply rate.
    - 5.1.2. The outdoor airflow rate required to meet the ventilation requirements of Chapter 4 of the *International Mechanical Code* for the zone.
    - 5.1.3. Any higher rate that can be demonstrated, to the satisfaction of the code official, to reduce overall system annual energy usage by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system.
    - 5.1.4. The airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
  - 5.2. The airflow rate that is reheated, recoolled, or mixed shall be less than 50 percent of the zone design peak supply rate.
  - 5.3. The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the dead-band flow rate.
  - 5.4. The second stage of heating consists of modulating the airflow rate from the dead-band flow rate up to the heating maximum flow rate.
6. *Zones* or supply air systems with thermostatic and humidistatic controls capable of operating in sequence the supply of heating and cooling energy to the *zones* and which are configured to 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.

**~~C403.4.4.1 Single duct variable air volume (VAV) systems, terminal devices.~~** Single duct VAV systems shall use terminal devices capable of and configured to reduce the supply of primary supply air before reheating or recooling takes place.

**~~C403.4.4.2 Dual duct and mixing VAV systems, terminal devices.~~** Systems that have one warm air duct and one cool air duct shall use terminal devices which are capable of and configured to reduce the flow from one duct to a minimum before mixing of air from the other duct takes place.

**~~C403.4.4.3 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 configured to reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency ( $E_v$ ) as defined by the *International Mechanical Code*.

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 having exhaust air energy recovery complying with Section C403.5.
3. Systems where total design exhaust airflow is more than 70 percent of total design outdoor air intake flow requirements.

**~~C403.4.4.4 Supply-air temperature reset controls.~~** Multiple zone HVAC systems shall include controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperature. The controls shall be capable of resetting the supply air temperature at least 25 percent of the difference between the design supply-air temperature and the design room 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.
3. Zones with peak supply air quantities of 300 cfm (142 L/s) or less.)

**C403.4.5 Pump isolation.** Chilled water plants including more than one chiller shall be capable of and configured to reduce flow automatically through the chiller plant when a chiller is shut down and automatically shut off flow to chillers that are shut down. Chillers piped in series for the purpose of increased temperature differential shall be considered as one chiller.

EXCEPTION: Chillers that are piped in series for the purpose of increased temperature differential.

Boiler systems including more than one boiler shall be capable of and configured to reduce flow automatically through the boiler system when a boiler is shut down.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40346 ((Reserved.)) Section C403.4.6—Variable flow controls.**

**C403.4.6 Variable flow controls.** Individual pumps required by this code to have variable speed control shall be controlled in one of the following manners:

1. For systems having a combined pump motor horsepower less than or equal to 20 hp (15 kW) and without direct digital control of individual coils, pump speed shall be a function of either:
  - 1.1. Required differential pressure; or

1.2. Reset directly based on zone hydronic demand, or other zone load indicators; or

1.3. Reset directly based on pump power and pump differential pressure.

1.4. Reset directly by an integral controller based on the relationship between variable speed controller frequency and power.

2. For systems having a combined pump motor horsepower that exceeds 20 hp (15 kW) or smaller systems with direct digital control, pump speed shall be a function of either:

2.1. The static pressure set point as reset based on the valve requiring the most pressure; or

2.2. Directly controlled based on zone hydronic demand.

2.3. Reset directly by an integral controller based on the relationship between variable speed controller frequency and power.

AMENDATORY SECTION (Amending WSR 17-10-062, filed 5/2/17, effective 6/2/17)

**WAC 51-11C-40347 Section ((C403.4.6—Hot gas bypass limitation))  
C403.4.7—Combustion heating equipment controls.**

~~((C403.4.6 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 C403.4.6, as limited by Section C403.3.1.~~

**Table C403.4.6  
Maximum Hot Gas Bypass Capacity**

<b>Rated Capacity</b>	<b>Maximum Hot Gas Bypass Capacity (% of total capacity)</b>
$\leq 240,000$ Btu/h	50
$> 240,000$ Btu/h	25

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

**C403.4.7 Combustion heating equipment controls.** Combustion heating equipment with a capacity over 225,000 Btu/h shall have modulating or staged combustion control.

EXCEPTIONS:  
1. Boilers.  
2. Radiant heaters.

**C403.4.7.1 Combustion decorative vented appliance, combustion fire-place and fire pit controls.** Combustion decorative vented appliances, combustion fireplaces and fire pits shall be equipped with local controls to limit operation to a maximum duration of one hour without override hold capability or shall be controlled by occupancy sensor control configured with manual on and automatic shutoff within 15 minutes after occupants have left the space.

## NEW SECTION

**WAC 51-11C-40348 Sections C403.4.8 through C403.4.10—Group R requirements.**

**C403.4.8 Group R-1 hotel/motel guestrooms.** See Section C403.7.4.

**C403.4.9 Group R-2 and R-3 dwelling units.** The primary space conditioning system within each dwelling unit shall be provided with at least one programmable thermostat for the regulation of space temperature. The thermostat shall allow for, at a minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback periods per day.

Each additional system provided within the dwelling unit shall be provided with at least one adjustable thermostat for the regulation of temperature.

EXCEPTIONS:

1. Systems controlled by an occupant sensor that is configured to shut the system off when no occupant is sensed for a period of up to 30 minutes.
2. Systems controlled solely by a manually operated timer configured to operate the system for no more than 2 hours.
3. Ductless heat pumps.

Each thermostat shall be capable of being set by adjustment or selection of sensors and configured as follows:

1. When used to control heating only: 55°F to 75°F.
2. When used to control cooling only: 70°F to 85°F.
3. All other: 55°F to 85°F with an adjustable deadband configured to at least 5°F in accordance with Section C403.4.1.2.

**C403.4.10 Group R-2 sleeping units.** The primary space conditioning system within each sleeping unit shall be provided with at least one programmable thermostat for the regulation of space temperature. The thermostat shall allow for, at a minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback periods per day.

Each additional system provided within the sleeping unit shall be provided with at least one adjustable thermostat for the regulation of temperature.

EXCEPTIONS:

1. Systems controlled by an occupant sensor that is configured to shut the system off when no occupant is sensed for a period of up to 30 minutes.
2. Systems controlled solely by a manually operated timer configured to operate the system for no more than 2 hours.
3. Zones with a full HVAC load demand not exceeding 3,400 Btu/h (1 kW) and having a manual shutoff switch located with *ready access*.
4. Ductless heat pumps.

Each thermostat shall be capable of being set by adjustment or selection of sensors and configured as follows:

1. When used to control heating only: 55°F to 75°F.
2. When used to control cooling only: 70°F to 85°F.
3. All other: 55°F to 85°F with an adjustable deadband configured to at least 5°F in accordance with Section C403.4.1.2.

## NEW SECTION

**WAC 51-11C-40349 Section C403.4.11—DDC systems.**

**C403.4.11 Direct digital control systems.** Direct digital control (DDC) shall be required as specified in Sections C403.4.11.1 through C403.4.11.3.

**C403.4.11.1 DDC applications.** DDC shall be provided in the applications and qualifications listed in Table C403.4.11.1.

**C403.4.11.2 DDC controls.** Where DDC is required by Section C403.4.11.1, the DDC system shall be capable of all of the following, as required to provide the system and zone control logic required in Sections C403.2, C403.5, C403.6.8 and C403.4.3:

1. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling.

2. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers.

**C403.4.11.3 DDC display.** Where DDC is required by Section C403.4.11.1 for new buildings, the DDC system shall be capable of trending and graphically displaying input and output points.

**Table C403.4.11.1  
DDC Applications and Qualifications**

Building Status	Application	Qualifications
New building	Air-handling system and all zones served by the system	All air-handling systems in buildings with building cooling capacity greater than 780,000 Btu/h
	Air-handling system and all zones served by the system	Individual systems supplying more than three zones and with fan system bhp of 10 hp and larger
	Chilled-water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300,000 Btu/h and larger
	Hot-water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300,000 Btu/h and larger
Alteration or addition	Zone terminal unit such as VAV box	Where existing zones served by the same air-handling, chilled-water, or hot-water system have DDC
	Air-handling system or fan coil	Where existing air-handling system(s) and fan coil(s) served by the same chilled- or hot-water plant have DDC
	New air-handling system and all new zones served by the system	Individual systems with fan system bhp of 10 hp and larger and supplying more than three zones and more than 75 percent of zones are new
	New or upgraded chilled-water plant	Where all chillers are new and plant design cooling capacity is 300,000 Btu/h and larger
	New or upgraded hot-water plant	Where all boilers are new and plant design heating capacity is 300,000 Btu/h and larger

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40350 Section C403.5—((Energy recovery)) Economizers.**

**C403.5 ((Energy recovery.**

**C403.5.1 ~~Energy recovery ventilation systems.~~** Any system with minimum outside air requirements at design conditions greater than 5,000 cfm or any system where the system's supply airflow rate exceeds the value listed in Tables C403.5.1(1) and C403.5.1(2), based on the climate zone and percentage of outdoor airflow rate at design conditions, shall include an energy recovery system. Table C403.5.1(1) shall be

used for all ventilation systems that operate less than 8,000 hours per year, and Table C403.5.1(2) shall be used for all ventilation systems that operate 8,000 hours or more per year. The energy recovery system shall have the capability to provide a change in the enthalpy of the outdoor air supply 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 which permit operation of the economizer as required by Section C403.3. Where a single room or space is supplied by multiple units, the aggregate ventilation (cfm) of those units shall be used in applying this requirement. The return/exhaust air stream temperature for heat recovery device selection shall be 70°F (21°C) at 30 percent relative humidity, or as calculated by the registered design professional.

**EXCEPTION:**

An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are restricted per Section 514 of the *International Mechanical Code* to sensible energy, recovery shall comply with one of the following:

1.1. Kitchen exhaust systems where they comply with Section C403.2.7.1.

1.2. Laboratory fume hood systems where they comply with Exception 2 of Section C403.5.1.

1.3. Other sensible energy recovery systems with the capability to provide a change in dry-bulb temperature of the outdoor air supply of not less than 50 percent of the difference between the outdoor air and the return air dry-bulb temperatures, at design conditions.

2. Laboratory fume hood systems that include at least one of the following features and also comply with Section C403.2.7.2:

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 at least 75 percent of the exhaust rate, heated no warmer than 2°F (1.1°C) above room setpoint, cooled to no cooler than 3°F (1.7°C) below room setpoint, 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 are not cooled.

4. Where more than 60 percent of the outdoor air heating energy is provided from site-recovered or site solar energy.

5. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.

6. Cooling energy recovery in Climate Zones 3C, 4C, 5B, 5C, 6B, 7 and 8.

7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.

8. Multiple-zone systems where the supply airflow rate is less than the values specified in Tables C403.5.1 (1) and (2), for the corresponding percent of outdoor air. Where a value of NR is listed, energy recovery shall not be required.

9. Systems serving Group R dwelling or sleeping units where the largest source of air exhausted at a single location at the building exterior is less than 25 percent of the design outdoor air flow rate.

**Table C403.5.1(1)**

**Energy Recovery Requirement**

**(Ventilation systems operating less than 8,000 hours per year)**

Percent (%) Outdoor Air at Full Design Airflow Rate								
Climate zone	≥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)								
4C, 5B	NR	NR	NR	NR	NR	NR	≥5000	≥5000

NR = Not required.

**Table C403.5.1(2)**

**Energy Recovery Requirement**

**(Ventilation systems operating not less than 8,000 hours per year)**

Percent (%) Outdoor Air at Full Design Airflow Rate								
Climate zone	≥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)								
4C	NR	≥19500	≥9000	≥5000	≥4000	≥3000	≥1500	≥0
5B	≥2500	≥2000	≥1000	≥500	≥0	≥0	≥0	≥0

NR = Not required.

**C403.5.2 Condensate systems.** On-site steam heating systems shall have condensate water heat recovery. On-site includes a system that is located within or adjacent to one or more buildings within the boundary of a contiguous area or campus under one ownership and which serves one or more of those buildings.

~~Buildings using steam generated off-site with steam heating systems which do not have condensate water recovery shall have condensate water heat recovery.~~

~~**C403.5.3 Condenser heat recovery.** Facilities having food service, meat or deli departments and having 500,000 Btu/h or greater of remote refrigeration condensers shall have condenser waste heat recovery from freezers and coolers and shall use the waste heat for service water heating, space heating or for dehumidification reheat. Facilities having a gross conditioned floor area of 40,000 ft<sup>2</sup> or greater and 1,000,000 Btu/h or greater of remote refrigeration shall have condenser waste heat recovery from freezers and coolers and shall use the waste heat for service water heating, and either for space heating or for dehumidification reheat for maintaining low space humidity.~~

~~**C403.5.4 Heat recovery for service water heating.** Condenser heat recovery shall be installed for heating or reheating of service hot water provided the facility operates 24 hours a day, the total installed heat capacity of water cooled systems exceeds 1,500,000 Btu/hr of heat rejection, and the design service water heating load exceeds 250,000 Btu/hr.~~

~~The required heat recovery system shall have the capacity to provide the smaller of:~~

- ~~1. Sixty percent of the peak heat rejection load at design conditions; or~~
- ~~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.))~~

**Economizers.** Air economizers shall be provided on all new cooling systems including those serving computer server rooms, electronic equipment, radio equipment, and telephone switchgear. Economizers shall comply with Sections C403.5.1 through C403.5.5.

EXCEPTIONS:

1. Cooling systems not installed outdoors nor in a mechanical room adjacent to outdoors and installed in conjunction with DOAS complying with Section C403.3.5 and serving only spaces with year-round cooling loads from lights and equipment of less than 5 watts per square foot.
2. Unitary or packaged systems serving one zone with dehumidification that affect other systems so as to increase the overall building energy consumption. New humidification equipment shall comply with Section C403.3.2.5.
3. Unitary or packaged systems serving one zone where the cooling efficiency meets or exceeds the efficiency requirements in Table C403.5.
4. Equipment serving chilled beams and chilled ceiling space cooling systems only which are provided with a water economizer meeting the requirements of Section C403.5.4.
5. For Group R occupancies, cooling units installed outdoors or in a mechanical room adjacent to outdoors with a total cooling capacity less than 20,000 Btu/h and other cooling units with a total cooling capacity less than 54,000 Btu/h provided that these are high-efficiency cooling equipment with IEER, CEER, SEER, and EER values more than 15 percent higher than minimum efficiencies listed in Tables C403.3.2 (1) through (3), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify for this exception. For split systems, compliance is based on the cooling capacity of individual fan coil units.
6. Equipment used to cool *Controlled Plant Growth Environments* provided these are high-efficiency cooling equipment with SEER, EER and IEER values a minimum of 20 percent greater than the values listed in Tables C403.3.2 (1), (3) and (7).
7. Equipment serving a space with year-round cooling loads from lights and equipment of 5 watts per square foot or greater complying with the following criteria:
  - 7.1. Equipment serving the space utilizes chilled water as the cooling source; and
  - 7.2. The chilled water plant includes a condenser heat recovery system that meets the requirements of Section C403.9.5 or the building and water-cooled system meets the following requirements:
    - 7.2.1. A minimum of 90 percent (capacity-weighted) of the building space heat is provided by hydronic heating water.
    - 7.2.2. Chilled water plant includes a heat recovery chiller or water-to-water heat pump capable of rejecting heat from the chilled water system to the hydronic heating equipment capacity.
8. Water-cooled equipment served by systems meeting the requirements of Section C403.9.8 Condenser heat recovery.
9. Equipment used to cool any dedicated server room, electronic equipment room or telecom switch room provided the system complies with option a, b, or c in the table below. The total cooling capacity of all fan systems without economizers shall not exceed 240,000 Btu/h per building or 10 percent of its air economizer capacity, whichever is greater. This exception shall not be used for total building performance.



	<b><u>Equipment Type</u></b>	<b><u>Higher Equipment Efficiency</u></b>	<b><u>Part-Load Control</u></b>	<b><u>Economizer</u></b>
<b><u>Option a</u></b>	Tables C403.3.2(1) and C403.3.2(2) <sup>a</sup>	+15% <sup>b</sup>	Required over 85,000 Btu/h <sup>c</sup>	None Required
<b><u>Option b</u></b>	Tables C403.3.2(1) and C403.3.2(2) <sup>a</sup>	+5% <sup>d</sup>	Required over 85,000 Btu/h <sup>c</sup>	Waterside Economizer <sup>e</sup>
<b><u>Option c</u></b>	ASHRAE Standard 127 <sup>f</sup>	+0% <sup>g</sup>	Required over 85,000 Btu/h <sup>c</sup>	Waterside Economizer <sup>e</sup>

**Notes for Exception 9:**

<sup>a</sup>For a system where all of the cooling equipment is subject to the AHRI standards listed in Tables C403.3.2(1) and C403.3.2(2), the system shall comply with all of the following (note that if the system contains any cooling equipment that exceeds the capacity limits in Table C403.3.2(1) or C403.3.2(2), or if the system contains any cooling equipment that is not included in Table C403.3.2(1) or C403.3.2(2), then the system is not allowed to use this option).

<sup>b</sup>The cooling equipment shall have an EER value and an IPLV value that is a minimum of 15 percent greater than the value listed in Tables C403.3.2(1) and C403.3.2(2).

<sup>c</sup>For units with a total cooling capacity over 85,000 Btu/h, the system shall utilize part-load capacity control schemes that are able to modulate to a part-load capacity of 50 percent of the load or less that results in the compressor operating at the same or higher EER at part loads than at full load (e.g., minimum of two-stages of compressor unloading such as cylinder unloading, two-stage scrolls, dual tandem scrolls, but hot gas bypass is not credited as a compressor unloading system).

<sup>d</sup>The cooling equipment shall have an EER value and an IPLV value that is a minimum of 5 percent greater than the value listed in Tables C403.3.2(1) and C403.3.2(2).

<sup>e</sup>The system shall include a water economizer in lieu of air economizer. Water economizers shall meet the requirements of C403.5.1 and C403.5.2 and be capable of providing the total concurrent cooling load served by the connected terminal equipment lacking airside economizer, at outside air temperatures of 50°F dry-bulb/45°F wet-bulb and below. For this calculation, all factors including solar and internal load shall be the same as those used for peak load calculations, except for the outside temperatures. The equipment shall be served by a dedicated condenser water system unless a nondedicated condenser water system exists that can provide appropriate water temperatures during hours when waterside economizer cooling is available.

<sup>f</sup>For a system where all cooling equipment is subject to ASHRAE Standard 127.

<sup>g</sup>The cooling equipment subject to the ASHRAE Standard 127 shall have an EER value and an IPLV value that is equal to or greater than the value listed in Tables C403.3.2(1) and C403.3.2(2) when determined in accordance with the rating conditions ASHRAE Standard 127 (i.e., not the rating conditions in AHRI Standard 210/240 or 340/360). This information shall be provided by an independent third party.

**Table C403.5**  
**Equipment Efficiency Performance**  
**Exception for Economizers**

<b><u>Climate Zones</u></b>	<b><u>Efficiency Improvement<sup>a</sup></u></b>
<b><u>4C</u></b>	<b><u>64%</u></b>
<b><u>5B</u></b>	<b><u>59%</u></b>

<sup>a</sup>If a unit is rated with an IPLV, IEER or SEER then to eliminate the required air or water economizer, the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full load metric like EER or COP cooling, then these must be increased by the percentage shown.

**NEW SECTION**

**WAC 51-11C-40351 Section C403.5.1—Integrated economizer control.**

**C403.5.1 Integrated economizer control.** Economizer systems 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 shall not be capable of creating a false load in the mechanical cooling system by limiting or disabling the economizer or any other means, such as hot gas bypass, 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 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 with cooling capacity 65,000 Btu/h (19 kW) or greater of rated capacity shall comply with the following:

2.1. DX units that control the capacity of the mechanical cooling directly based on occupied space temperature shall have not fewer than two stages of mechanical cooling capacity.

2.2. Other DX units, including those that control space temperature by modulating the airflow to the space, shall be in accordance with Table C403.5.1.

**Table C403.5.1**  
**DX Cooling Stage Requirements for Modulating Airflow Units**

Rating Capacity	Minimum Number of Mechanical Cooling Stages	Minimum Compressor Displacement <sup>a</sup>
≥ 65,000 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.

<sup>a</sup>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.

#### NEW SECTION

**WAC 51-11C-40352 Section C403.5.2—Economizer heating system impact.**

**C403.5.2 Economizer heating system impact.** HVAC system design and economizer controls shall be such that economizer operation does not increase building heating energy use during normal operation.

EXCEPTION: Economizers on VAV systems that cause *zone* level heating to increase due to a reduction in supply air temperature.

#### NEW SECTION

**WAC 51-11C-40353 Section C403.5.3—Air economizers.**

**C403.5.3 Air economizers.** Air economizers shall comply with Sections C403.5.3.1 through C403.5.3.5.

**C403.5.3.1 Design capacity.** Air economizer systems shall be configured to modulate *outdoor air* and return air dampers to provide up to 100 percent of the design supply air quantity as *outdoor air* for cooling.

**C403.5.3.2 Control signal.** Economizer controls and dampers shall be configured to sequence the dampers with the mechanical cooling equipment and shall not be controlled by only mixed air temperature. Air economizers on systems with cooling capacity greater than 65,000 Btu/h shall be configured to provide partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

EXCEPTION: The use of mixed air temperature limit control shall be permitted for systems that are both controlled from space temperature (such as single *zone* systems) and having cooling capacity less than 65,000 Btu/h.

**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 no longer reduce cooling energy usage. High-limit shutoff control types for specific climates 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.

**Table C403.5.3.3  
High-Limit Shutoff Control Setting for Air Economizers<sup>b</sup>**

Device Type	Required High Limit (Economizer off when):		Required High Limit For Cycling Fans <sup>c</sup> (Economizer off when):	
	Equation	Description	Equation	Description
Fixed dry-bulb	$T_{OA} > 75^{\circ}\text{F}$	Outdoor air temperature exceeds 75°F	$T_{OA} > 70^{\circ}\text{F}$	Outdoor air temperature exceeds 70°F
Differential dry-bulb	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature	$T_{OA} > (T_{RA} - 5)$	Outdoor air temperature exceeds return air temperature - 5
Fixed enthalpy with fixed dry-bulb temperatures	$h_{OA} > 28 \text{ Btu/lb}^a$ or $T_{OA} > 75^{\circ}\text{F}$	Outdoor air enthalpy exceeds 28 Btu/lb of dry air <sup>a</sup> or outdoor air temperature exceeds 75°F	$h_{OA} > 26 \text{ Btu/lb}^a$ or $T_{OA} > 70^{\circ}\text{F}$	Outdoor air enthalpy exceeds 26 Btu/lb of dry air <sup>d</sup> or outdoor air temperature exceeds 70°F
Differential enthalpy with fixed dry-bulb temperature	$h_{OA} > h_{RA}$ or $T_{OA} > 75^{\circ}\text{F}$	Outdoor air enthalpy exceeds return air enthalpy or outdoor air temperature exceeds 75°F	$h_{OA} > (h_{RA} - 2)$ or $T_{OA} > 70^{\circ}\text{F}$	Outdoor air enthalpy exceeds return air enthalpy or outdoor air temperature exceeds 70°F

For SI: °C = (°F - 32) × 5/9, 1 Btu/lb = 2.33 kJ/kg.

<sup>a</sup>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.

<sup>b</sup>Devices with selectable setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.

<sup>c</sup>Where fans cycle on only to provide heating and cooling, limits are adjusted lower to compensate for fan energy use in economizer mode.

<sup>d</sup>For cycling fans at altitudes substantially different than sea level, the fixed enthalpy limit shall be set to the enthalpy value at 70°F and 50 percent relative humidity.

**C403.5.3.4 Relief of excess outdoor air.** Systems shall be capable of relieving excess *outdoor air* during air economizer operation to prevent over-pressurizing the building. The relief air outlet shall be located to avoid recirculation into the building.

**C403.5.3.5 Economizer dampers.** Return, exhaust/relief and outdoor air dampers used in economizers shall comply with Section C403.7.9.

## NEW SECTION

### **WAC 51-11C-40354 Section C403.5.4—Waterside economizers.**

**C403.5.4 Waterside economizers.** Waterside economizers shall comply with Sections C403.5.4.1 and C403.5.4.2.

**C403.5.4.1 Design capacity.** Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to 100 percent of the expected system cooling load at *outdoor air* temperatures of 50°F dry-bulb (10°C dry-bulb)/45°F wet-bulb (7.2°C wet-bulb) and below.

EXCEPTION: Systems where dehumidification requirements cannot be met using outdoor air temperatures of 50°F dry-bulb (10°C dry-bulb)/45°F wet-bulb (7.2°C wet-bulb) and where 100 percent of the expected system cooling load at 45°F dry-bulb (7.2°C dry-bulb)/40°F wet-bulb (4.5°C wet-bulb) is met with evaporative water economizers.

**C403.5.4.2 Maximum pressure drop.** Precooling coils and water-to-water heat exchangers used as part of a water economizer system shall either have a waterside pressure drop of less than 15 feet (4572 mm) of water or a secondary loop shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling (noneconomizer) mode.

#### NEW SECTION

**WAC 51-11C-40355 Section C403.5.5—Economizer fault detection and diagnostics.**

**C403.5.5 Economizer fault detection and diagnostics (FDD).** Air-cooled unitary direct-expansion units with a cooling capacity of 54,000 Btu/h or greater listed in Tables C403.3.2(1) through C403.3.2(3) that are equipped with an economizer in accordance with Section C403.5 shall include a fault detection and diagnostics (FDD) 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. Temperature sensors shall have an accuracy of  $\pm 2^{\circ}\text{F}$  ( $1.1^{\circ}\text{C}$ ) over the range of  $40^{\circ}\text{F}$  to  $80^{\circ}\text{F}$  ( $4^{\circ}\text{C}$  to  $26.7^{\circ}\text{C}$ ).
3. Refrigerant pressure sensors, where used, shall have an accuracy of  $\pm 3$  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 FDD 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.

**WAC 51-11C-40360 Section C403.6—(~~Dedicated outdoor air systems (DOAS)~~) Requirements for mechanical systems serving multiple zones.**

**C403.6 (~~Dedicated outdoor air systems (DOAS) (This section is optional until June 30, 2017; and becomes prescriptive as of July 1, 2017).~~** For office, retail, education, libraries and fire stations. Outdoor air shall be provided to each occupied space by a dedicated outdoor air system (DOAS) which delivers 100 percent outdoor air without requiring operation of the heating and cooling system fans for ventilation air delivery.

EXCEPTIONS:

1. Occupied spaces that are not ventilated by a mechanical ventilation system and are only ventilated by a natural ventilation system per Section 402 of the *International Mechanical Code*.
2. High efficiency variable air volume (VAV) systems complying with Section C403.7. This exception shall not be used as a substitution for a DOAS per Section C406.6 or as a modification to the requirements for the Standard Reference Design per Section C407.

**C403.6.1 Energy recovery ventilation with DOAS.** The DOAS shall include ~~energy recovery ventilation~~ that complies with the minimum energy recovery efficiency and energy recovery bypass requirements, where applicable, of Section C403.5.1.

EXCEPTIONS:

1. Occupied spaces under the threshold of Section C403.5 with an average occupant load greater than 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) that include demand control ventilation configured to reduce outdoor air by at least 50% below design minimum ventilation rates when the actual occupancy of the space served by the system is less than the design occupancy.
2. Systems installed for the sole purpose of providing makeup air for systems exhausting toxic, flammable, paint, or corrosive fumes or dust, dryer exhaust, or commercial kitchen hoods used for collecting and removing grease vapors and smoke.

**C403.6.2 Heating/cooling system fan controls.** Heating and cooling equipment fans, heating and cooling circulation pumps, and terminal unit fans shall cycle off and terminal unit primary cooling air shall be shut off when there is no call for heating or cooling in the zone.

EXCEPTION:

Fans used for heating and cooling using less than 0.12 watts per cfm may operate when space temperatures are within the setpoint deadband (Section C403.2.4.1.2) to provide destratification and air mixing in the space.

**C403.6.3 Impracticality.** Where the code official determines that full compliance with all the requirements of Sections C403.6.1 and C403.6.2 would be impractical, it is permissible to provide an approved alternate means of compliance that achieves a comparable level of energy efficiency. For the purposes of this section, impractical means that an HVAC system complying with Section C403.6 cannot effectively be utilized due to an unusual use or configuration of the building.

**C403.7 High efficiency variable air volume (VAV) systems.** For HVAC systems subject to the requirements of Section C403.6 but utilizing Exception 2 of that section, a high efficiency VAV system may be provided without a separate parallel DOAS when the system is designed, installed, and configured to comply with all of the following criteria (this exception shall not be used as a substitution for a DOAS per Section C406.6 or as a modification to the requirements for the Standard Reference Design per Section C407):

1. The VAV systems are provided with airside economizer per Section 403.3 without exceptions.

2. A direct-digital control (DDC) system is provided to control the VAV air handling units and associated terminal units per Section C403.2.4.1.2 regardless of sizing thresholds of Table C403.2.4.1.2.1.

3. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring outdoor airflow intake under all load conditions. The system shall be capable of increasing or reducing the out-

door airflow intake based on feedback from the VAV terminal units as required by Section C403.4.4.3, without exceptions, and Section C403.2.6.2 demand controlled ventilation.

4. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring supply airflow to the VAV terminal units under all load conditions.

5. In addition to meeting the zone isolation requirements of C403.2.4.4 a single VAV air handling unit shall not serve more than 50,000 square feet (2323 m<sup>2</sup>) unless a single floor is greater than 50,000 square feet (2323 m<sup>2</sup>) in which case the air handler is permitted to serve the entire floor.

6. The primary maximum cooling air for the VAV terminal units serving interior cooling load driven zones shall be sized for a supply air temperature that is a minimum of 5°F greater than the supply air temperature for the exterior zones in cooling.

7. Air terminal units with a minimum primary airflow setpoint of 50% or greater of the maximum primary airflow setpoint shall be sized with an inlet velocity of no greater than 900 feet per minute.

8. DDC systems be designed and configured per the guidelines set by high performance sequences of operation for HVAC systems (ASHRAE GPC 36, RP-1455).

9. Allowable fan motor horsepower shall not exceed 90% of the allowable HVAC fan system bhp (Option 2) as defined by Section C403.2.11.1.

10. All fan powered VAV terminal units (series or parallel) shall be provided with electronically commutated motors. The DDC system shall be configured to vary the speed of the motor as a function of the heating and cooling load in the space. Minimum speed shall not be greater than 66% of design airflow required for the greater of heating or cooling operation. Minimum speed shall be used during periods of low heating and cooling operation and ventilation-only operation.

EXCEPTION: For series fan-powered terminal units where the volume of primary air required to deliver the ventilation requirements at minimum speed exceeds the air that would be delivered at the speed defined above, the minimum speed setpoint shall be configured to exceed the value required to provide the required ventilation air.

11. Fan-powered VAV terminal units shall only be permitted at perimeter zones with an envelope heating load requirement. All other VAV terminal units shall be single duct terminal units.

12. When in occupied heating or in occupied deadband between heating and cooling all fan powered VAV terminal units shall be configured to reset the primary air supply setpoint, based on the VAV air handling unit outdoor air vent fraction, to the minimum ventilation airflow required per *International Mechanical Code* without utilizing the exceptions 2, 3, or 4 of Section C403.4.4.

13. Spaces that are larger than 150 square feet (14 m<sup>2</sup>) and with an occupant load greater than or equal to 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) shall be provided with all of the following features:

13.1. A dedicated VAV terminal unit capable of controlling the space temperature and minimum ventilation shall be provided.

13.2. Demand control ventilation (DCV) shall be provided that utilizes a carbon dioxide sensor to reset the ventilation setpoint of the VAV terminal unit from the design minimum to design maximum ventilation rate as required by Chapter 4 of the *International Mechanical Code*.

13.3. Occupancy sensors shall be provided that are configured to reduce the minimum ventilation rate to zero and setback room temperature setpoints by a minimum of 5°F, for both cooling and heating, when the space is unoccupied.

14. Dedicated server rooms, electronic equipment rooms, telecom rooms, or other similar spaces with cooling loads greater than 5 watts/sf shall be provided with separate, independent HVAC systems to allow the VAV air handlers to turn off during unoccupied hours in the office space and to allow the supply air temperature reset to occur.

EXCEPTION: The VAV air handling unit and VAV terminal units may be used for secondary backup cooling when there is a failure of the primary HVAC system.

Additionally, server rooms, electronic equipment rooms, telecom rooms, or other similar spaces shall be provided with airside economizer per Section 403.3 without using the exceptions to Section C403.3.

EXCEPTION: Heat recovery per exception 9 of Section 403.3 may be in lieu of airside economizer for the separate, independent HVAC system.

15. HVAC system central heating or cooling plant will include a minimum of one of the following options:

15.1. VAV terminal units with hydronic heating coils connected to systems with hot water generation equipment limited to the following types of equipment: Gas-fired hydronic boilers with a thermal efficiency,  $E_t$ , of not less than 90%, air-to-water heat pumps or heat recovery chillers.

15.2. Chilled water VAV air handling units connected to systems with chilled water generation equipment with IPLV values more than 25% higher than the minimum part load efficiencies listed in Table C403.2.3(7), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify. The smallest chiller or compressor in the central plant shall not exceed 20% of the total central plant cooling capacity or the chilled water system shall include thermal storage sized for a minimum of 20% of the total central cooling plant capacity.

16. The DDC system shall include a fault detection and diagnostics (FDD) system complying with the following:

16.1. The following temperature sensors shall be permanently installed to monitor system operation:

16.1.1. Outside air.

16.1.2. Supply air.

16.1.3. Return air.

16.2. Temperature sensors shall have an accuracy of  $\pm 2^\circ\text{F}$  ( $1.1^\circ\text{C}$ ) over the range of  $40^\circ\text{F}$  to  $80^\circ\text{F}$  ( $4^\circ\text{C}$  to  $26.7^\circ\text{C}$ ).

16.3. The VAV air handling unit controller shall be configured to provide system status by indicating the following:

16.3.1. Free cooling available.

16.3.2. Economizer enabled.

16.3.3. Compressor enabled.

16.3.4. Heating enabled.

16.3.5. Mixed air low limit cycle active.

16.3.6. The current value of each sensor.

16.4. The VAV air handling 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.

16.5. The VAV air handling unit shall be configured to report faults to a fault management application accessible by day-to-day op-

erating or service personnel or annunciated locally on zone thermostats.

16.6. The VAV terminal unit shall be configured to report if the VAV inlet valve has failed by performing the following diagnostic check at a maximum interval of once a month:

16.6.1. Command VAV terminal unit primary air inlet valve closed and verify that primary airflow goes to zero.

16.6.2. Command VAV terminal unit primary air inlet valve to design airflow and verify that unit is controlling to within 10% of design airflow.

16.7. The VAV terminal unit shall be configured to report and trend when the zone is driving the following VAV air handling unit reset sequences. The building operator shall have the capability to exclude zones used in the reset sequences from the DDC control system graphical user interface:

16.7.1. Supply air temperature setpoint reset to lowest supply air temperature setpoint for cooling operation.

16.7.2. Supply air duct static pressure setpoint reset for the highest duct static pressure setpoint allowable.

16.8. The FDD system shall be configured to detect the following faults:

16.8.1. Air temperature sensor failure/fault.

16.8.2. Not economizing when the unit should be economizing.

16.8.3. Economizing when the unit should not be economizing.

16.8.4. Outdoor air or return air damper not modulating.

16.8.5. Excess outdoor air.

16.8.6 VAV terminal unit primary air valve failure.)) **Requirements for mechanical systems serving multiple zones.** Sections C403.6.1 through C403.6.10 shall apply to mechanical systems serving multiple zones.

**C403.6.1 Variable air volume (VAV) and multiple zone systems.** Supply air systems serving multiple zones shall be VAV systems that have zone controls configured to reduce the volume of air that is reheated, re-cooled or mixed in each zone to one of the following:

1. Twenty percent of the zone design peak supply for systems with DDC and 30 percent of the maximum supply air for other systems.

2. Systems with DDV where items 2.1 through 2.3 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, or 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 Chapter 4 of the *International Mechanical Code*.

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 rates to comply with applicable codes or accreditation standards such as pressure relationships or minimum air change rates.

**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 source, including condenser heat.
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.
3. Ventilation systems comply with Section C403.3.5, DOAS, with ventilation rates comply with Section C403.2.2.

**C403.6.2 Single duct variable air volume (VAV) systems, terminal devices.** Single duct VAV systems shall use terminal devices capable of and configured to reduce the supply of primary supply air before reheating or recooling takes place.

**C403.6.3 Dual duct and mixing VAV systems, terminal devices.** Systems that have one warm air duct and one cool air duct shall use terminal devices which are capable of and configured to reduce the flow from one duct to a minimum before mixing of air from the other duct takes place.

**C403.6.4 Supply-air temperature reset controls.** Multiple zone HVAC systems shall include controls that 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 at least 25 percent of the difference between the design supply-air temperature and the design room 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 a site-recovered source.
3. Zones with peak supply air quantities of 300 cfm (142 L/s) or less.

**C403.6.5 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 configured to reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency ( $E_v$ ) as defined by the *International Mechanical Code*.

**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.

**C403.6.6 Parallel-flow fan-powered VAV air terminal control.** Parallel-flow fan-powered VAV air terminals shall have automatic controls configured to:

1. Turn off the terminal fan except when space heating is required or where required for ventilation.
2. Turn on the terminal fan as the first stage of heating before the heating coil is activated.
3. During heating for warmup or setback temperature control, either:
  - 3.1. Operate the terminal fan and heating coil without primary air.
  - 3.2. Reverse the terminal damper logic and provide heating from the central air handler by primary air.

**C403.6.7 Hydronic and multiple-zone HVAC system controls and equipment.** Hydronic and multiple-zone HVAC system controls and equipment shall comply with this section.

For buildings with a total equipment cooling capacity of 300 tons and above, the equipment shall comply with one of the following:

1. No one unit shall have a cooling capacity of more than 2/3 of the total installed cooling equipment capacity;
2. The equipment shall have a variable speed drive; or
3. The equipment shall have multiple compressors.

**C403.6.8 Set points for direct digital control.** For systems with direct digital control of individual zones reporting to the central control panel, the static pressure setpoint shall be reset based on the zone requiring the most pressure. In such cases, the set point is reset lower until one zone damper is nearly wide open. The direct digital controls shall be capable of monitoring zone damper positions or shall have an alternative method of indicating the need for static pressure that is configured to provide all of the following:

1. Automatically detecting any zone that excessively drives the reset logic.
2. Generating an alarm to the system operational location.
3. Allowing an operator to readily remove one or more zones from the reset algorithm.

**C403.6.9 Static pressure sensor location.** Static pressure sensors used to control VAV fans shall be located such that the controller setpoint is no greater than 1.2 inches w.c. (2099 Pa). Where this results in one or more sensors being located downstream of major duct splits, not less than one sensor shall be located on each major branch to ensure that static pressure can be maintained in each branch.

**EXCEPTION:** Systems complying with Section C403.6.8.

## NEW SECTION

**WAC 51-11C-403610 Section C403.6.10—High efficiency VAV systems.**

**C403.6.10 High efficiency variable air volume (VAV) systems.** For HVAC systems subject to the requirements of Section C403.3.5 but utilizing Exception 2 of that section, a high efficiency multiple-zone VAV system may be provided without a separate parallel DOAS when the system is designed, installed, and configured to comply with all of the following criteria (this exception shall not be used as a substitution for a DOAS per Section C406.6):

1. Each VAV system must serve a minimum of 3,000 square feet (278.7 m<sup>2</sup>) and have a minimum of five VAV zones.
2. The VAV systems are provided with airside economizer per Section C403.5 without exceptions.
3. A direct-digital control (DDC) system is provided to control the VAV air handling units and associated terminal units per Section C403.4.11 regardless of sizing thresholds of Table C403.4.11.1.
4. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring outdoor airflow intake under all load conditions. The system shall be capable of increasing or reducing the outdoor airflow intake based on feedback from the VAV terminal units as required by Section C403.6.5, without exceptions, and Section C403.7.1 demand controlled ventilation.
5. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring supply airflow to the VAV terminal units under all load conditions.
6. In addition to meeting the zone isolation requirements of C403.2.1 a single VAV air handling unit shall not serve more than

50,000 square feet (2323 m<sup>2</sup>) unless a single floor is greater than 50,000 square feet (2323 m<sup>2</sup>) in which case the air handler is permitted to serve the entire floor.

7. The primary maximum cooling air for the VAV terminal units serving interior cooling load driven zones shall be sized for a supply air temperature that is a minimum of 5°F greater than the supply air temperature for the exterior zones in cooling.

8. Air terminal units with a minimum primary airflow setpoint of 50 percent or greater of the maximum primary airflow setpoint shall be sized with an inlet velocity of no greater than 900 feet per minute.

9. Allowable fan motor horsepower shall not exceed 90 percent of the allowable HVAC fan system bhp (Option 2) as defined by Section C403.8.1.1.

10. All fan powered VAV terminal units (series or parallel) shall be provided with electronically commutated motors. The DDC system shall be configured to vary the speed of the motor as a function of the heating and cooling load in the space. Minimum speed shall not be greater than 66 percent of design airflow required for the greater of heating or cooling operation. Minimum speed shall be used during periods of low heating and cooling operation and ventilation-only operation.

EXCEPTION: For series fan powered terminal units where the volume of primary air required to deliver the ventilation requirements at minimum speed exceeds the air that would be delivered at the speed defined above, the minimum speed setpoint shall be configured to exceed the value required to provide the required ventilation air.

11. Fan-powered VAV terminal units shall only be permitted at perimeter zones with an envelope heating load requirement. All other VAV terminal units shall be single duct terminal units.

EXCEPTION: Fan powered VAV terminal units are allowed at interior spaces with an occupant load greater than or equal to 25 people per 1000 square feet of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) with demand control ventilation in accordance with Section C403.7.1.

12. When in occupied heating or in occupied deadband between heating and cooling all fan powered VAV terminal units shall be configured to reset the primary air supply setpoint, based on the VAV air handling unit outdoor air vent fraction, to the minimum ventilation airflow required per *International Mechanical Code*.

13. Spaces that are larger than 150 square feet (14 m<sup>2</sup>) and with an occupant load greater than or equal to 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) shall be provided with all of the following features:

13.1. A dedicated VAV terminal unit capable of controlling the space temperature and minimum ventilation shall be provided.

13.2. Demand control ventilation (DCV) shall be provided that utilizes a carbon dioxide sensor to reset the ventilation setpoint of the VAV terminal unit from the design minimum to design maximum ventilation rate as required by Chapter 4 of the *International Mechanical Code*.

13.3. Occupancy sensors shall be provided that are configured to reduce the minimum ventilation rate to zero and setback room temperature setpoints by a minimum of 5°F, for both cooling and heating, when the space is unoccupied.

14. Dedicated data centers, computer rooms, electronic equipment rooms, telecom rooms, or other similar spaces with cooling loads greater than 5 watts/sf shall be provided with separate cooling systems to allow the VAV air handlers to turn off during unoccupied hours

in the office space and to allow the supply air temperature reset to occur.

EXCEPTION: The VAV air handling unit and VAV terminal units may be used for secondary backup cooling when there is a failure of the primary HVAC system.

Additionally, computer rooms, electronic equipment rooms, telecom rooms, or other similar spaces shall be provided with airside economizer in accordance with Section 403.5 without using the exceptions to Section C403.5.

EXCEPTION: Heat recovery per Exception 9 of Section C403.5 may be in lieu of airside economizer for the separate, independent HVAC system.

15. HVAC system central heating or cooling plant will include a minimum of one of the following options:

15.1. VAV terminal units with hydronic heating coils connected to systems with hot water generation equipment limited to the following types of equipment: Gas-fired hydronic boilers with a thermal efficiency,  $E_t$ , of not less than 90 percent, air-to-water heat pumps or heat recovery chillers.

15.2. Chilled water VAV air handling units connected to systems with chilled water generation equipment with IPLV values more than 25 percent higher than the minimum part load efficiencies listed in Table C403.3.2(7), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify. The smallest chiller or compressor in the central plant shall not exceed 20 percent of the total central plant cooling capacity or the chilled water system shall include thermal storage sized for a minimum of 20 percent of the total central cooling plant capacity.

16. The DDC system shall include a fault detection and diagnostics (FDD) system complying with the following:

16.1. The following temperature sensors shall be permanently installed to monitor system operation:

16.1.1. Outside air.

16.1.2. Supply air.

16.1.3. Return air.

16.2. Temperature sensors shall have an accuracy of  $\pm 2^\circ\text{F}$  ( $1.1^\circ\text{C}$ ) over the range of  $40^\circ\text{F}$  to  $80^\circ\text{F}$  ( $4^\circ\text{C}$  to  $26.7^\circ\text{C}$ ).

16.3. The VAV air handling unit controller shall be configured to provide system status by indicating the following:

16.3.1. Free cooling available.

16.3.2. Economizer enabled.

16.3.3. Compressor enabled.

16.3.4. Heating enabled.

16.3.5. Mixed air low limit cycle active.

16.3.6. The current value of each sensor.

16.4. The VAV air handling 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.

16.5. The VAV air handling unit shall be configured to report faults to a fault management application accessible by day-to-day operating or service personnel or annunciated locally on zone thermostats.

16.6. The VAV terminal unit shall be configured to report if the VAV inlet valve has failed by performing the following diagnostic check at a maximum interval of once a month:

16.6.1. Command VAV terminal unit primary air inlet valve closed and verify that primary airflow goes to zero.

16.6.2. Command VAV terminal unit primary air inlet valve to design airflow and verify that unit is controlling to within 10 percent of design airflow.

16.7. The VAV terminal unit shall be configured to report and trend when the zone is driving the following VAV air handling unit reset sequences. The building operator shall have the capability to exclude zones used in the reset sequences from the DDC control system graphical user interface:

16.7.1. Supply air temperature setpoint reset to lowest supply air temperature setpoint for cooling operation.

16.7.2. Supply air duct static pressure setpoint reset for the highest duct static pressure setpoint allowable.

16.8. The FDD system shall be configured to detect the following faults:

16.8.1. Air temperature sensor failure/fault.

16.8.2. Not economizing when the unit should be economizing.

16.8.3. Economizing when the unit should not be economizing.

16.8.4. Outdoor air or return air damper not modulating.

16.8.5. Excess outdoor air.

16.8.6. VAV terminal unit primary air valve failure.

## NEW SECTION

### **WAC 51-11C-4037 Section C403.7—Ventilation and exhaust systems.**

**C403.7 Ventilation and exhaust systems.** In addition to other requirements of Section C403 applicable to the provisions of ventilation air or the exhaust of air, ventilation and exhaust systems shall be in accordance with Sections C403.7.1 through C403.7.8.

## NEW SECTION

### **WAC 51-11C-40371 Section C403.7.1—Demand control ventilation.**

**C403.7.1 Demand control ventilation.** Demand control ventilation (DCV) shall be provided for spaces larger than 500 square feet (50 m<sup>2</sup>) and with an occupant load greater than or equal to 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) 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; or
3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

**EXCEPTION:**

Demand control ventilation is not required for systems and spaces as follows:

1. Systems with energy recovery complying with Section C403.7.6.1 or C403.3.5.1. This exception is not available for space types located within the "inclusions" column of Groups A-1 and A-3 occupancy classifications of Table C403.3.5.
2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.
3. System with a design outdoor airflow less than 750 cfm (354 L/s).
4. Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1,200 cfm (566 L/s).
5. Ventilation provided for process loads only.
6. Spaces with one of the following occupancy categories (as defined by the *International Mechanical Code*): Correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alley seating.

## NEW SECTION

### **WAC 51-11C-40372 Section C403.7.2—Occupancy sensors.**

**C403.7.2 Occupancy sensors.** Classrooms, gyms, auditoriums, conference rooms, and other spaces with an occupant load greater than or equal to 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) that are larger than 500 square feet of floor area shall have occupancy sensor control that will either close outside air dampers, close ventilation supply dampers or turn off ventilation equipment when the space is unoccupied except where equipped with another means to automatically reduce outside air intake below design rates when spaces are partially occupied.

EXCEPTIONS:

1. Spaces with one of the following occupancy categories (as defined by the *International Mechanical Code*):
  - 1.1. Correctional cells.
  - 1.2. Daycare sickrooms.
  - 1.3. Science labs.
  - 1.4. Barbers.
  - 1.5. Beauty and nail salons.
  - 1.6. Bowling alley seating.
2. When the space is unoccupied during occupied building hours, a ventilation rate equal to or less than the zone outdoor airflow as defined in Section 403.3.1.1.1 of the *International Mechanical Code* with a zone population of zero.

## NEW SECTION

### **WAC 51-11C-40373 Section C403.7.3—Ventilation air heating control.**

**C403.7.3 Ventilation air heating control.** Units that provide ventilation air to multiple zones and operate in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air to a temperature greater than 60°F (16°C) when representative building loads or outdoor air temperature indicate that the majority of zones require cooling.

## NEW SECTION

### **WAC 51-11C-40374 Section C403.7.4—HVAC serving guestrooms.**

**C403.7.4 Automatic control of HVAC systems serving guestrooms.** In Group R-1 buildings containing more than 50 guestrooms, each guestroom shall be provided with controls complying with the provisions of Sections C403.7.4.1 and C403.7.4.2. Card key controls comply with these requirements.

**C403.7.4.1 Temperature setpoint controls.** Controls shall be provided on each HVAC system that are capable of and configured to 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. The controls shall be capable of and configured to 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) when the guestroom is unrented or has been continu-

ously unoccupied for over 16 hours or a networked guestroom control system indicates that the guestroom is unrented and the guestroom is unoccupied for more than 30 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

**C403.7.4.2 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 30 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 preoccupancy 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.

#### NEW SECTION

**WAC 51-11C-40375 Section C403.7.5—Loading dock and parking garage ventilation system controls.**

**C403.7.5 Enclosed loading dock and parking garage exhaust ventilation system controls.** Mechanical ventilation systems for enclosed loading docks and parking garages shall be designed to exhaust the airflow rates (maximum and minimum) determined in accordance with the *International Mechanical Code*.

Ventilation systems shall be equipped with a control device that operates the system automatically by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Controllers shall be configured to shut off fans or modulate fan speed to 50 percent or less of design capacity, or intermittently operate fans less than 20 percent of the occupied time or as required to maintain acceptable contaminant levels in accordance with the *International Mechanical Code* provisions.

Gas sensor controllers used to activate the exhaust ventilation system shall stage or modulate fan speed upon detection of specified gas levels. All equipment used in sensor controlled systems shall be designed for the specific use and installed in accordance with the manufacturer's recommendations. The system shall be arranged to operate automatically by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Garages and loading docks shall be equipped with a controller and a full array of carbon monoxide (CO) sensors set to maintain levels of carbon monoxide below 35 parts per million (ppm). Additionally, a full array of nitrogen dioxide detectors shall be connected to the controller set to maintain the nitrogen dioxide level below the OSHA standard for eight hour exposure.

Spacing and location of the sensors shall be installed in accordance with manufacturer recommendations.

**C403.7.5.1 System activation devices for enclosed loading docks.** Ventilation systems for enclosed loading docks shall be activated by one of the following:

1. Gas sensors installed in accordance with the *International Mechanical Code*; or
2. Occupant detection sensors used to activate the system that detects entry into the loading area along both the vehicle and pedestrian pathways.

**C403.7.5.2 System activation devices for enclosed parking garages.** Ventilation systems for enclosed parking garages shall be activated by gas sensors.

EXCEPTION: A parking garage ventilation system having a total design capacity under 8,000 cfm may use occupant sensors.

## NEW SECTION

**WAC 51-11C-40376 Section C403.7.6—Energy recovery ventilation systems.**

**C403.7.6 Energy recovery ventilation systems.** Any system with minimum outside air requirements at design conditions greater than 5,000 cfm or any system where the system's supply airflow rate exceeds the value listed in Tables C403.7.6(1) and C403.7.6(2), based on the climate zone and percentage of outdoor airflow rate at design conditions, shall include an energy recovery system. Table C403.7.6(1) shall be used for all ventilation systems that operate less than 8,000 hours per year, and Table C403.7.6(2) shall be used for all ventilation systems that operate 8,000 hours or more per year. The energy recovery system shall have the capability to provide a change in the enthalpy of the outdoor air supply 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 which permit operation of the economizer as required by Section C403.5. Where a single room or space is supplied by multiple units, the aggregate ventilation (cfm) of those units shall be used in applying this requirement. The return/exhaust air stream temperature for heat recovery device selection shall be 70°F (21°C) at 30 percent relative humidity, or as calculated by the registered design professional.

EXCEPTION: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are restricted per Section 514 of the *International Mechanical Code* to sensible energy, recovery shall comply with one of the following:
  - 1.1. Kitchen exhaust systems where they comply with Section C403.7.7.1.
  - 1.2. Laboratory fume hood systems where they comply with Exception 2 of Section C403.7.6.
  - 1.3. Other sensible energy recovery systems with the capability to provide a change in dry-bulb temperature of the outdoor air supply of not less than 50 percent of the difference between the outdoor air and the return air dry-bulb temperatures, at design conditions.
2. Laboratory fume hood systems that include at least one of the following features and also comply with Section C403.7.7.2:
  - 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 at least 75 percent of the exhaust rate, heated no warmer than 2°F (1.1°C) above room setpoint, cooled to no cooler than 3°F (1.7°C) below room setpoint, 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 are not cooled.
4. Where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy.
5. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.
6. Cooling energy recovery.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
8. Multiple-zone systems where the supply airflow rate is less than the values specified in Tables C403.7.6 (1) and (2), for the corresponding percent of outdoor air. Where a value of NR is listed, energy recovery shall not be required.
9. Equipment which meets the requirements of Section C403.9.8.



9.1. Systems serving Group R dwelling or sleeping units where the largest source of air exhausted at a single location at the building exterior is less than 25 percent of the design outdoor air flow rate.

**Table C403.7.6(1)**  
**Energy Recovery Requirement**  
**(Ventilation systems operating less than 8,000 hours per year)**

Percent (%) Outdoor Air at Full Design Airflow Rate								
Climate zone	≥ 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)								
4C, 5B	NR	NR	NR	NR	NR	NR	≥ 5000	≥ 5000

NR = Not required.

**Table C403.7.6(2)**  
**Energy Recovery Requirement**  
**(Ventilation systems operating not less than 8,000 hours per year)**

Percent (%) Outdoor Air at Full Design Airflow Rate								
Climate zone	≥ 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)								
4C	NR	≥ 19500	≥ 9000	≥ 5000	≥ 4000	≥ 3000	≥ 1500	≥ 120
5B	≥ 2500	≥ 2000	≥ 1000	≥ 500	≥ 0	≥ 0	≥ 0	≥ 80

NR = Not required.

## NEW SECTION

### **WAC 51-11C-40377 Section C403.7.7—Exhaust systems.**

#### **C403.7.7 Exhaust systems.**

##### **C403.7.7.1 Kitchen exhaust systems.**

**C403.7.7.1.1 Replacement air.** Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10 percent of the hood exhaust airflow rate.

**C403.7.7.1.2 Kitchen exhaust hood certification and maximum airflow.** Where a kitchen or kitchen/dining facility has a total kitchen hood exhaust airflow rate that is greater than 2,000 cfm, each hood shall be a factory built commercial exhaust hood listed by a nationally recognized testing laboratory in compliance with UL 710 and each hood shall have a maximum exhaust rate as specified in Table C403.7.7.1.2. 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: Type II dishwasher exhaust hoods that have an exhaust airflow of 1000 cfm or less.

**Table C403.7.7.1.2**  
**Maximum Net Exhaust Flow Rate,**  
**CFM Per Linear Foot of Hood Length**

Type of Hood	Light-duty Equipment	Medium-duty Equipment	Heavy-duty Equipment	Extra-heavy-duty Equipment
Wall-mounted canopy	140	210	280	385

Type of Hood	Light-duty Equipment	Medium-duty Equipment	Heavy-duty Equipment	Extra-heavy-duty Equipment
Single island	280	350	420	490
Double island (per side)	175	210	280	385
Eye brow	175	175	NA	NA
Backshelf/pass-over	210	210	280	NA

For SI: 1 cfm = 0.4719 L/s; 1 foot = 305 mm  
NA = Not allowed

**C403.7.7.1.3 Kitchen exhaust hood system.** Where a kitchen or kitchen/dining facility has a total kitchen hood exhaust airflow rate greater than 2000 cfm, it 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 total exhaust hood airflow that are configured to provide not less than a 50 percent reduction in exhaust and replacement air system airflow rates, including 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 energy recovery devices with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent of the total exhaust hood airflow.

EXCEPTIONS:

1. Where not less than 75 percent of all the replacement air is transfer air that would otherwise be exhausted.
2. UL 710 listed exhaust hoods that have a design maximum exhaust airflow rate no greater than 250 cfm per linear foot of hood that serve kitchen or kitchen/dining facilities with a total kitchen hood exhaust airflow rate less than 5000 cfm.
3. Type II dishwasher exhaust hoods that have an exhaust airflow of 1000 cfm or less.

**C403.7.7.2 Laboratory exhaust systems.** Buildings with laboratory exhaust systems having a total exhaust rate greater than 5,000 cfm (2360 L/s) shall include heat recovery systems to precondition makeup air from laboratory exhaust. The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 25°F (13.9°C). A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section C403.5.

EXCEPTIONS:

1. Variable air volume laboratory exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values; or
2. Direct makeup (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2°F (1.1°C) below room setpoint, cooled to no cooler than 3°F (1.7°C) above room setpoint, no humidification added, and no simultaneous heating and cooling used for dehumidification control; or
3. Combined energy reduction method: VAV exhaust and room supply system configured to reduce exhaust and makeup air volumes and a heat recovery system to precondition makeup air from laboratory exhaust that when combined will produce the same energy reduction as achieved by a heat recovery system with a 50 percent sensible recovery effectiveness as required above. For calculation purposes, the heat recovery component can be assumed to include the maximum design supply airflow rate at design conditions. The combined energy reduction ( $Q_{ER}$ ) shall meet the following:

$$Q_{ER} \geq Q_{MIN}$$

$$Q_{MIN} = CFM_S \cdot (T_R - T_O) \cdot 1.1 \cdot 0.6$$

$$Q_{ER} = CFM_S \cdot (T_R - T_O) \cdot 1.1(A + B)/100$$

Where:

$$Q_{MIN} = \text{Energy recovery at 60 percent sensible effectiveness (Btu/h)}$$

$$Q_{ER} = \text{Combined energy reduction (Btu/h)}$$

$$CFM_S = \text{The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute}$$

- $T_R$  = Space return air dry-bulb at winter design conditions
- $T_O$  = Outdoor air dry-bulb at winter design conditions
- $A$  = Percentage that the exhaust and makeup air volumes can be reduced from design conditions
- $B$  = Percentage sensible heat recovery effectiveness

**C403.7.7.3 Transfer air.** Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of:

1. The supply flow required to meet the space heating or cooling load;
2. The ventilation rate required by the authority having jurisdiction, the facility environmental health and safety department, or Section C403.2.2; or
3. The mechanical exhaust flow minus the available transfer air from conditioned spaces or return air plenums that at their closest point are within 15 feet of each other on the same floor that are not in different smoke or fire compartments. Available transfer air is that portion of outdoor ventilation air that:
  - 3.1. Is not required to satisfy other exhaust needs;
  - 3.2. Is not required to maintain pressurization of other spaces; and
  - 3.3. Is transferable according to applicable codes and standards and per the *International Mechanical Code*.

EXCEPTIONS:

1. Laboratories classified as biosafety level 3 or higher.
2. Vivarium spaces.
3. Spaces that are required by applicable codes and standards to be maintained at positive pressure relative to adjacent spaces. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.
4. Spaces where the demand for transfer air may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.

## NEW SECTION

### **WAC 51-11C-40378 Section C403.7.8—Shutoff dampers.**

**C403.7.8 Shutoff dampers.** Mechanical openings shall be provided with shutoff dampers in accordance with Sections C403.7.8.1 through C403.7.8.4.

**C403.7.8.1 Shutoff dampers for building isolation.** Outdoor air supply, exhaust openings and relief outlets and stairway and elevator hoistway shaft vents shall be provided with Class I motorized dampers. See Sections C403.10.1 and C403.10.2 for ductwork insulation requirements upstream and downstream of the shutoff damper.

EXCEPTIONS:

1. Gravity (nonmotorized) dampers shall be permitted in lieu of motorized dampers as follows:
  - 1.1. Relief dampers serving systems less than 5,000 cfm total supply shall be permitted in buildings less than three stories in height.
  - 1.2. Gravity (nonmotorized) dampers where the design outdoor air intake or exhaust capacity does not exceed 400 cfm.
  - 1.3. Systems serving areas which require continuous operation for 24/7 occupancy schedules.
2. Shutoff dampers are not required in:
  - 2.1. Combustion air intakes.
  - 2.2. Systems serving areas which require continuous operation in animal hospitals, kennels and pounds, laboratories, and Group H, I and R occupancies.
  - 2.3. Subduct exhaust systems or other systems that are required to operate continuously by the *International Mechanical Code*.
  - 2.4. Type I grease exhaust systems or other systems where dampers are prohibited by the *International Mechanical Code* to be in the airstream.
  - 2.5. Unconditioned stairwells or unconditioned elevator hoistway shafts that are only connected to unconditioned spaces.

**C403.7.8.2 Shutoff dampers for return air.** Return air openings used for airside economizer operation shall be equipped with Class I motorized dampers.

**C403.7.8.3 Damper leakage rating.** Class 1 dampers shall have a maximum leakage rate of 4 cfm/ft<sup>2</sup> (20.3 L/s x m<sup>2</sup>) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D and shall be labeled by an approved agency for such purpose. Gravity (nonmotorized) dampers shall have an air leakage rate not greater than 20 cfm/ft<sup>2</sup> where not less than 24 inches (610 mm) in either dimension and 40 cfm/ft<sup>2</sup> where less than 24 inches in either dimension. The rate of air leakage shall be determined at 1.0 inch w.g. (249 Pa) when tested in accordance with AMCA 500D for such purpose. The dampers shall be labeled by an approved agency. Gravity dampers for ventilation air intakes shall be protected from direct exposure to wind.

EXCEPTIONS: 1. Gravity (nonmotorized) dampers are not required to be tested to verify the air leakage rating when installed in exhaust systems where the exhaust capacity does not exceed 400 cfm and the gravity damper is provided with a gasketed seal.  
2. Motorized dampers on return air openings in unitary packaged equipment that have the minimum leakage rate available from the manufacturer.

**C403.7.8.4 Damper actuation.** Outdoor air intake, relief and exhaust shutoff 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 the *International Mechanical Code* or the dampers are opened to provide intentional economizer cooling. Stairway and elevator hoistway 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.

## NEW SECTION

### **WAC 51-11C-4038 Section C403.8—Fan and fan controls.**

**C403.8 Fan and fan controls.** Fans in HVAC systems shall comply with Sections C403.8.1 through C403.8.5.1.

The airflow requirements of Section C403.8.5.1 shall apply to all fan motors. Group R occupancy exhaust fans shall also comply with Section C403.8.4.

**C403.8.1 Allowable fan motor horsepower.** Each HVAC system having a total fan system motor nameplate horsepower exceeding 5 hp (3.7 kW) at fan system design conditions shall not exceed the allowable *fan system motor nameplate hp* (Option 1) or *fan system bhp* (Option 2) as shown in Table C403.8.1(1). This includes supply fans, exhaust fans, return/relief fans, and fan-powered VAV air terminal units associated with systems providing heating or cooling capability. Single zone variable-air-volume systems shall comply with the constant volume fan power limitation. Zone heating and/or cooling terminal units installed in conjunction with a dedicated outdoor air system (DOAS) shall be evaluated as separate HVAC systems for allowable fan motor horsepower.

EXCEPTIONS: 1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.

2. Individual exhaust fans with motor nameplate horsepower of 1 hp or less are exempt from allowable fan motor horsepower requirements.

**Table C403.8.1(1)**  
**Fan Power Limitation**

	Limit	Constant Volume	Variable Volume
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	$hp \leq CFM_S \times 0.0011$	$hp \leq CFM_S \times 0.0015$
Option 2: Fan system bhp	Allowable fan system bhp	$bhp \leq CFM_S \times 0.00094 + A$	$bhp \leq CFM_S \times 0.0013 + A$

For SI: 1 cfm = 0.471 L/s. 1 bhp = 735.5 W, 1 hp = 745.5 W.

Where:

$CFM_S$  = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.

hp = The maximum combined motor nameplate horsepower.

bhp = The maximum combined fan brake horsepower.

$A$  = Sum of  $[PD \times CFM_D / 4131]$

Where:

$PD$  = Each applicable pressure drop adjustment from Table C403.8.1(2) in. w.c.

$CFM_D$  = The design airflow through each applicable device from Table C403.8.1(2) in cubic feet per minute.

**Table C403.8.1(2)**  
**Fan Power Limitation Pressure Drop Adjustment**

Device	Adjustment
<b>Credits</b>	
Return air or exhaust system required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.5 inch w.c. (2.15 inches w.c. for laboratory and vivarium systems)
Return and/or exhaust air flow control devices	0.5 inch w.c.
Exhaust filters, scrubbers, or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate filtration credit: MERV 9 - 12	0.5 inch w.c.
Particulate filtration credit: MERV 13 - 15	0.9 inch w.c.
Particulate filtration credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2x clean filter pressure drop at fan system design condition
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition
Biosafety cabinet	Pressure drop of device at fan system design condition

Device	Adjustment
Energy recovery device, other than coil runaround loop	For each airstream (2.2 × energy recovery effectiveness – 0.5) inch w.c.
Coil runaround loop	0.6 inch w.c. for each airstream
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design conditions
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.15 inch w.c.
Exhaust system serving fume hoods	0.35 inch w.c.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 inch w.c./100 feet of vertical duct exceeding 75 feet
<b>Deductions</b>	
Systems without central cooling device	-0.6 inch w.c
Systems without central heating device	-0.3 inch w.c.
Systems with central electric resistance heat	-0.2 inch w.c.

For SI: 1 inch w.c. = 249 Pa, 1 inch = 25.4 mm.  
w.c. = water column.

**C403.8.2 Motor nameplate horsepower.** For each fan, the selected fan motor shall be no larger than the first available motor size greater than the brake horsepower (bhp). The fan brake horsepower (bhp) shall be indicated on the design documents to allow for compliance verification by the *code official*.

EXCEPTIONS:

1. For fans less than 6 bhp (4413 W), where the first available motor larger than the brake horsepower has a nameplate rating within 50 percent of the bhp, selection of the next larger nameplate motor size is allowed.
2. For fans 6 bhp (4413 W) and larger, where the first available motor larger than the bhp has a nameplate rating within 30 percent of the bhp, selection of the next larger nameplate motor size is allowed.
3. For fans used only in *approved* life safety applications such as smoke evacuation.
4. Fans with motor nameplate horsepower less than 1 hp are exempt from this section.

**C403.8.3 Fan efficiency.** Fans shall have a fan efficiency grade (FEG) of 67 or higher based on manufacturers' certified data, as defined by AMCA 205. 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.

EXCEPTION:

The following fans are not required to have a fan efficiency grade:

1. Fans of 5 hp (3.7 kW) or less as follows:
  - 1.1. Individual fans with a motor nameplate horsepower of 5 hp (3.7 kW) or less, unless Exception 1.2. applies.
  - 1.2. Multiple fans in series or parallel that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less and are operated as the functional equivalent of a single fan.
2. Fans that are part of equipment covered under Section C403.3.2.
3. 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. Fans that are intended to operate only during emergency conditions.

**C403.8.4 Group R occupancy exhaust fan efficacy.** The Group R occupancies of the building shall be provided with ventilation that meets the requirements of the *International Mechanical Code*, as applicable, or with other approved means of ventilation. Mechanical ventilation sys-

tem fans with 400 cfm or less in capacity shall meet the efficacy requirements of Table C403.8.4.

**EXCEPTIONS:**

1. Group R heat recovery ventilator and energy recovery ventilator fans that are less than 400 cfm.
2. Where whole house ventilation fans are integrated with forced-air systems that are tested and listed HVAC equipment, provided they are powered by an electronically commutated motor where required by Section C405.8.
3. Domestic clothes dryer booster fans, domestic range hood exhaust fans, and domestic range booster fans that operate intermittently.

**Table C403.8.4  
Group R Exhaust Fan Efficacy**

<b>Fan Location</b>	<b>Air Flow Rate Minimum (cfm)</b>	<b>Minimum Efficacy (cfm/watt)</b>	<b>Air Flow Rate Maximum (cfm)</b>
Exhaust fan: Bathroom, utility room, whole house	10	2.8	< 90
Exhaust fan: Bathroom, utility room, whole house	90	3.5	Any
In-line (single-port and multi-port) fans	Any	3.8	Any

**C403.8.5 Fan controls.** Controls shall be provided for fans in accordance with Section C403.8.5.1 and as required for specific systems provided in Section C403.

**C403.8.5.1 Fan airflow control.** Each cooling system listed in Table C403.8.5.1 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 no 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 airside economizer in accordance with Section C403.5 shall have not fewer than two speeds of 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 the *International Mechanical Code* at low speed exceeds the air that would be delivered at the minimum speed defined in Section C403.8.5, the minimum speed shall be selected to provide the required ventilation air.

**Table C403.8.5.1  
Fan Control**

<b>Cooling System Type</b>	<b>Fan Motor Size</b>	<b>Mechanical Cooling Capacity</b>
DX cooling	Any	≥ 42,000 Btu/h
Chilled water and evaporative cooling	≥ 1/4 hp	Any

## NEW SECTION

### **WAC 51-11C-4039 Section C403.9—Heat rejection and heat recovery equipment.**

**C403.9 Heat rejection and heat recovery equipment.** Heat rejection equipment, including air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers and evaporative condensers, shall comply with this section.

EXCEPTION: Heat rejection devices where energy usage is included in the equipment efficiency ratings listed in Tables C403.3.2(1)A, C403.3.2(1)B, C403.3.2(1)C, C403.3.2(2), C403.3.2(3), C403.3.2(7) and C403.3.2(9).

Heat rejection equipment shall have a minimum efficiency performance not less than values specified in Table C403.3.2(8). These requirements apply to all propeller, axial fan and centrifugal fan cooling towers. Table C403.3.2(8) specifies requirements for air-cooled condensers that are within rating conditions specified within the table.

**C403.9.1 Fan speed control.** Each fan powered by an individual motor or array of motors with a connected power, including the motor service factor, totaling 5 hp (3.7 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 at 50 percent of the design airflow.

EXCEPTIONS: 1. Fans serving multiple refrigerant or fluid cooling circuits.  
2. Condenser fans serving flooded condensers.

**C403.9.1.1 Variable flow controls.** Cooling tower fans 7.5 hp and greater shall have control devices that vary flow by controlling the leaving fluid temperature or condenser temperature/pressure of the heat rejection device.

**C403.9.1.2 Limitation on centrifugal fan cooling towers.** Open cooling towers with a combined rated capacity of 1,100 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers.

**C403.9.2 Multiple-cell heat rejection equipment.** Multiple-cell heat rejection equipment with variable speed fan drives shall be controlled to operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and so that all fans can operate at the same fan speed required for the instantaneous cooling duty, as opposed to staged (on/off) operation. The minimum fan speed shall be the minimum allowable speed of the fan drive system in accordance with the manufacturer's recommendations.

**C403.9.3 Limitation on centrifugal fan open-circuit cooling towers.** Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1,100 gpm (4164 L/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.

**C403.9.4 Tower flow turndown.** Open-circuit cooling towers used on water-cooled chiller systems that are configured with multiple- or vari-



able-speed condenser water pumps shall be designed so that all open circuit cooling tower cells can be run in parallel with the larger of the flow that is produced by the smallest pump at its minimum expected flow rate or at 50 percent of the design flow for the cell.

**C403.9.5 Heat recovery for service water heating.** Condenser heat recovery shall be installed for heating or reheating of service hot water provided the facility operates 24 hours a day, the total installed heat capacity of water cooled systems exceeds 1,500,000 Btu/hr of heat rejection, and the design service water heating load exceeds 250,000 Btu/hr.

The required heat recovery system shall have the capacity to provide the smaller of:

1. Sixty percent of the peak heat rejection load at design conditions; or
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.

**C403.9.6 Steam condensate systems.** On-site steam heating systems shall have condensate water heat recovery. On-site includes a system that is located within or adjacent to one or more buildings within the boundary of a contiguous area or campus under one ownership and which serves one or more of those buildings.

Buildings using steam generated off-site with steam heating systems which do not have condensate water recovery shall have condensate water recovery.

**C403.9.7 Refrigeration condenser heat recovery.** Facilities having food service, meat or deli departments and having 500,000 Btu/h or greater of remote refrigeration condensers shall have condenser waste heat recovery from freezers and coolers and shall use the waste heat for service water heating, space heating or for dehumidification reheat. Facilities having a gross conditioned floor area of 40,000 ft<sup>2</sup> or greater and 1,000,000 Btu/h or greater of remote refrigeration shall have condenser waste heat recovery from freezers and coolers and shall use the waste heat for service water heating, and either for space heating or for dehumidification reheat for maintaining low space humidity.

**C403.9.8 Heat recovery for space heating.** A condenser heat recovery system meeting the requirements of Sections C403.9.8.1 through C403.9.8.4 shall be installed to serve heating systems in buildings meeting the following criteria:

1. The facility operates greater than 70 hours per week.
2. The sum of all heat rejection equipment capacity exceeds 1,500,000 Btu/hr.
3. The sum of zone minimum airflows in all zones with zone reheat coils divided by the conditioned floor area served by those systems is at least 0.45 cfm per square foot.

EXCEPTION:      Systems complying with Section C403.3.5 Dedicated outdoor air systems.

**C403.9.8.1 Water-to-water heat recovery.** Ninety percent (90%) of the total building space heat shall be served by systems that include heat recovery chiller or water-to-water heat pump equipment capable of rejecting heat from the cooling loop to the space heating loop as the first stage of heating.

**C403.9.8.2 Exhaust heat recovery.** Heat shall be recovered by the condenser heat recovery system from 90 percent of the total building exhaust airflow. The maximum leaving air temperature of exhaust air after heat recovery shall be 55°F dry-bulb when operating at full capacity.

**C403.9.8.3 Process heat recovery.** Spaces with year-round cooling loads from lights and equipment of 5 watts and greater per square foot shall be served by water cooled equipment. Cooling loops serving the water cooled equipment shall be served by water-to-water heat recovery systems meeting the requirements of Section C403.9.8.1. Such spaces shall not be provided with an air or water economizer.

**C403.9.8.4 Water-to-water heat recovery sizing.** The minimum total combined capacity of heat recovery chillers or water-to-water heat pumps shall match the total combined capacity of equipment meeting the requirements of Sections C403.9.8.2 and C403.9.8.3.

#### NEW SECTION

**WAC 51-11C-40391 Section C403.10—Construction of HVAC system elements.**

**C403.10 Construction of HVAC system elements.** Ducts, plenums, piping and other elements that are part of an HVAC system shall be constructed and insulated in accordance with Sections C403.10.1 through C403.10.3.1.

**C403.10.1 Duct and plenum insulation and sealing.**

**C403.10.1.1 Ducts conveying outdoor air.** Ducts, shafts and plenums conveying outdoor air from the exterior of the building to the mechanical system shall meet all air leakage and building envelope insulation requirements of Section C402, plus building envelope vapor control requirements from the *International Building Code*, extending continuously from the building exterior to an automatic shutoff damper or heating or cooling equipment. For the purposes of building envelope insulation requirements, duct surfaces shall be insulated with the minimum insulation values in Table C403.10.1.1. Duct surfaces included as part of the building envelope shall not be used in the calculation of maximum glazing area as described in Section C402.4.1.

EXCEPTIONS:

1. Outdoor air ducts serving individual supply air units with less than 2,800 cfm of total supply air capacity, provided these are insulated to the minimum insulation values in Table C403.10.1.1.
2. Unheated equipment rooms with combustion air louvers, provided they are isolated from conditioned space at sides, top and bottom of the room with R-11 nominal insulation.

**Table C403.10.1.1  
Outdoor Air Ductwork Insulation**

Duct system	Duct Location and Use	Climate Zone	Airflow	Minimum Installed Duct Insulation R-value <sup>a,b</sup>	Notes
Outdoor Air	Inside conditioned space and upstream of automatic shutoff damper	4C and 5B	≥ 2800 CFM	R-16	See Section C403.10.1.1 for additional requirements

Duct system	Duct Location and Use	Climate Zone	Airflow	Minimum Installed Duct Insulation <i>R</i> -value <sup>a,b</sup>	Notes
Outdoor Air	Inside conditioned space and downstream of automatic shutoff damper to HVAC unit or room	4C	≥ 2800 CFM	R-8	
Outdoor Air	Inside conditioned space and downstream of automatic shutoff damper to HVAC unit or room	5B	≥ 2800 CFM	R-12	
Outdoor Air	Inside conditioned space	4C and 5B	≤ 2800 CFM	R-7	See Exception 1 to Section C403.10.1.1 for additional details

<sup>a</sup> Insulation *R*-values, measured in h·ft<sup>2</sup>·°F/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.

<sup>b</sup> See *International Mechanical Code* Sections 603.12 and 604 for further details on duct insulation requirements.

**C403.10.1.2 Other supply and return ducts.** All other supply and return air ducts and plenums shall be insulated with a minimum of R-6 insulation where located in unconditioned spaces and where located outside the building with a minimum of R-8 insulation in Climate Zone 4 and R-12 insulation in Climate Zone 5. Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by minimum insulation value as required for exterior walls by Section C402.1.3.

EXCEPTIONS:

1. Where located within equipment.
2. Supply and return ductwork located in unconditioned spaces where the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F (8°C) are insulated in accordance with Table C403.10.1.2.

Where located within conditioned space, supply ducts which convey supply air at temperatures less than 55°F or greater than 105°F shall be insulated with a minimum insulation *R*-value in accordance with Table C403.10.1.2.

EXCEPTION: Ductwork exposed to view within a zone that serves that zone is not required to be insulated.

Where located within conditioned space, return or exhaust air ducts that convey return or exhaust air downstream of an energy recovery media shall be insulated with a minimum insulation *R*-value in accordance with Table C403.10.1.2.

All ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply with Section 603.9 of the *International Mechanical Code*.

**Table C403.10.1.2**  
**Supply, Return, Exhaust and Relief Air Ductwork Insulation**

Duct System	Duct Location and Use	Climate Zone	Minimum Installed Duct Insulation <i>R</i> -value <sup>a,b</sup>	Notes
Supply air or return air	Outside the building (outdoors and exposed to weather) <sup>c</sup>	4C	R-8	See Section C403.10.1.2 for details

Duct System	Duct Location and Use	Climate Zone	Minimum Installed Duct Insulation <i>R</i> -value <sup>a,b</sup>	Notes
Supply air or return air	Outside the building (outdoors and exposed to weather) <sup>c</sup>	5B	R-12	See Section C403.10.1.2 for details
Supply air or return air	Unconditioned space (enclosed but not in the building conditioned envelope)	4C and 5B	R-6	See Section C403.10.1.2 for details
Supply air or return air	Unconditioned space where the duct conveys air that is within 15°F of the air temperature of the surrounding unconditioned space	4C and 5B	R-3.3	See IMC Section 603.12 for additional requirements for condensation control at ductwork
Supply air or return air	Where located in a building envelope assembly	4C and 5B	R-16	Duct or plenum is separated from building envelope assembly with the minimum insulation value
Supply air	Within conditioned space where the supply duct conveys air that is less than 55°F or greater than 105°F	4C and 5B	R-3.3	See Section C403.10.1.2 for details
Supply air	Within conditioned space that the duct directly serves where the supply duct conveys air that is less than 55°F or greater than 105°F	4C and 5B	None	See Section C403.10.1.2 for details
Supply air	Within conditioned space where the supply duct conveys air that is 55°F or greater and 105°F or less	4C and 5B	None	
Return or exhaust air	Within conditioned space, downstream of an energy recovery media, upstream of an automatic shutoff damper	4C	R-8	
Return or exhaust air	Within conditioned space, downstream of an energy recovery media, upstream of an automatic shutoff damper	5B	R-12	
Relief or exhaust air	Conditioned space and downstream of an automatic shutoff damper	4C and 5B	R-16	

<sup>a</sup> Insulation *R*-values, measured in h·ft<sup>2</sup>·°F/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.

<sup>b</sup> See *International Mechanical Code* Sections 603.12 and 604 for further details on duct insulation requirements.

<sup>c</sup> Includes attics above insulated ceilings, parking garages and crawl spaces.

**C403.10.2 Duct construction.** Ductwork shall be constructed and erected in accordance with the *International Mechanical Code*.

**C403.10.2.1 Low-pressure duct systems.** 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.) (500 Pa) shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus embedded-fabric systems or tapes in-

stalled in accordance with the manufacturer's installation instructions. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

EXCEPTION: Continuously welded and locking-type longitudinal joints and seams on ducts operating at static pressures less than 2 inches water gauge (w.g.) (500 Pa) pressure classification.

**C403.10.2.2 Medium-pressure duct systems.** Ducts and plenums designed to operate at a static pressure greater than 2 inches water gauge (w.g.) (500 Pa) but less than 3 inches w.g. (750 Pa) shall be insulated and sealed in accordance with Section C403.10.1. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

**C403.10.2.3 High-pressure duct systems.** Ducts designed to operate at static pressures equal to or greater than 3 inches water gauge (w.g.) (750 Pa) shall be insulated and sealed in accordance with Section C403.10.1. 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 4-9.

**(Equation 4-9)**

$$CL = F/P^{0.65}$$

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 at least 25 percent of the duct area have been tested and that all tested sections meet the requirements of this section.

**C403.10.3 Piping insulation.** All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.10.3.

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 840, respectively.
3. Piping that conveys fluids that have a design operating temperature range between 60°F (15°C) and 105°F (41°C).
4. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.
5. Strainers, control valves, and balancing valves associated with piping 1 inch (25 mm) or less in diameter.
6. Direct buried piping that conveys fluids at or below 60°F (15°C).

**Table C403.10.3**  
**Minimum Pipe Insulation Thickness (thickness in inches)<sup>a</sup>**

Fluid Operating Temperature Range and Usage (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (inches)				
	Conductivity Btu • in. /(h • ft <sup>2</sup> • °F) <sup>b</sup>	Mean Rating Temperature, °F	< 1	1 to < 1-1/2	1-1/2 to < 4	4 to < 8	≥ 8
> 350	0.32 - 0.34	250	4.5	5.0	5.0	5.0	5.0
251 - 350	0.29 - 0.32	200	3.0	4.0	4.5	4.5	4.5
201 - 250	0.27 - 0.30	150	2.5	2.5	2.5	3.0	3.0
141 - 200	0.25 - 0.29	125	1.5	1.5	2.0	2.0	2.0
105 - 140	0.21 - 0.28	100	1.0	1.0	1.5	1.5	1.5
40 - 60	0.21 - 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 - 0.26	75	0.5	1.0	1.0	1.0	1.5

<sup>a</sup> For piping smaller than 1-1/2 inch (38 mm) and located in partitions within *conditioned spaces*, reduction of these thicknesses by 1 inch (25 mm) shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch (25 mm).

b For insulation outside the stated conductivity range, the minimum thickness ( $T$ ) shall be determined as follows:

$$T = r\{(1 + t/r)^{K/k} - 1\}$$

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 ( $\text{Btu} \times \text{in/h} \times \text{ft}^2 \times ^\circ\text{F}$ ).

$k$  = 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 (25 mm)).

**C403.10.3.1 Protection of piping insulation.** Piping insulation exposed to weather shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesives tape shall not be permitted.

## NEW SECTION

**WAC 51-11C-40392 Section C403.11—Mechanical systems outside the building envelope.**

**C403.11 Mechanical systems located outside of the building thermal envelope.** Mechanical systems providing heat outside of the thermal envelope of a building shall comply with Sections C403.11.1 through C403.11.3.

**C403.11.1 Heating outside a building.** Systems installed to provide heat outside a building shall be radiant systems.

Such heating systems shall be controlled by an occupancy sensing device or a timer switch, so that the system is automatically deenergized when no occupants are present.

**C403.11.2 Snow- and ice-melt system controls.** Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls configured to shut off the system when the pavement temperature is above 50°F (10°C) and no precipitation is falling and an automatic control that is configured to shutoff when the outdoor temperature is above 40°F (4°C) so that the potential for snow or ice accumulation is negligible.

**C403.11.3 Freeze protection system controls.** Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, shall include automatic controls configured to shut off the systems when outdoor air temperatures are above 40°F (4°C) or when the conditions of the protected fluid will prevent freezing.

## NEW SECTION

**WAC 51-11C-40393 Section C403.12—High efficiency single zone VAV systems.**

**C403.12 High efficiency single-zone variable air volume (VAV) systems.** For HVAC systems subject to the requirements of Section C403.3.5 but utilizing Exception 2 of that section, a high efficiency single-zone VAV system may be provided without a separate parallel DOAS when the system is designed, installed, and configured to comply with all of the following criteria (this exception shall not be used as a substitution for a DOAS per Section C406.6 or as a modification to the requirements for the *Standard Reference Design* in accordance with Section C407):

1. The single-zone VAV system is provided with airside economizer in accordance with Section C403.3 without exceptions.

2. A direct-digital control (DDC) system is provided to control the system as a single zone in accordance with Section C403.4.11 regardless of sizing thresholds of Table C403.4.11.1.

3. Single-zone VAV systems with a minimum outdoor air requirement of 1,000 cfm (472 L/s) or greater shall be equipped with a device capable of measuring outdoor airflow intake under all load conditions. The system shall be capable of increasing or reducing the outdoor airflow intake based on Section C403.7.1 demand controlled ventilation.

4. Allowable fan motor horsepower shall not exceed 90 percent of the allowable HVAC fan system bhp (Option 2) as defined by Section C403.8.1.1.

5. Each single-zone VAV system shall be designed to vary the supply fan airflow as a function of heating and cooling load and minimum fan speed shall not be more than the greater of:

5.1. 30 percent of peak design airflow; or

5.2. The required ventilation flow assuming no occupants.

6. Spaces that are larger than 150 square feet (14 m<sup>2</sup>) and with an occupant load greater than or equal to 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) shall be provided with all of the following features:

6.1. Demand control ventilation (DCV) shall be provided that utilizes a carbon dioxide sensor to reset the ventilation setpoint of the single-zone VAV system from the design minimum to design maximum ventilation rate as required by Chapter 4 of the *International Mechanical Code*.

6.2. Occupancy sensors shall be provided that are configured to reduce the minimum ventilation rate to zero and setback room temperature setpoints by a minimum of 5°F, for both cooling and heating, when the space is unoccupied.

7. Single-zone VAV systems shall comply with one of the following options:

7.1. Single-zone VAV air handling units with a hydronic heating coil connected to systems with hot water generation equipment limited to the following types of equipment: Gas-fired hydronic boilers with a thermal efficiency,  $E_t$ , of not less than 92 percent, air-to-water heat pumps or heat recovery chillers. Hydronic heating coils shall be sized for a maximum entering hot water temperature of 120°F for peak anticipated heating load conditions.

7.2. Single-zone VAV air handling units with a chilled water coil connected to systems with chilled water generation equipment with IPLV values more than 25 percent higher than the minimum part load efficiencies listed in Table C403.3.2(7), in the appropriate size category, using the same test procedures. Equipment shall be listed in the

appropriate certification program to qualify. The smallest chiller or compressor in the central plant shall not exceed 20 percent of the total central plant cooling capacity or the chilled water system shall include thermal storage sized for a minimum of 20 percent of the total central cooling plant capacity.

7.3. Single-zone VAV air handling units with DX cooling, heat pump heating or gas-fired furnace shall comply with the following requirements as applicable:

7.3.1. Have a DX cooling coil with cooling part load efficiency that is a minimum of 15 percent higher than the minimum SEER or IEER listed in Tables C403.3.2(1) and C403.3.2(2).

7.3.2. Have a gas-fired furnace with a thermal efficiency,  $E_t$ , of not less than 90 percent or heat pump with a minimum heating HSPF or COP efficiency that are a minimum of 10 percent higher than the minimum heating efficiency in Tables C403.3.2(1) and C403.3.2(2).

7.3.3. Heating coils or burner output shall be modulating or have a minimum of 2 stages with the first stage being less than 50 percent of total heating capacity. Cooling coils shall be modulating or have a minimum of 2 stages with the first stage being less than 50 percent of the total cooling capacity.

8. The DDC system shall include a fault detection and diagnostics (FDD) system complying with the following:

8.1. The following temperature sensors shall be permanently installed to monitor system operation:

8.1.1. Outside air.

8.1.2. Supply air.

8.1.3. Return air.

8.2. Temperature sensors shall have an accuracy of  $\pm 2^{\circ}\text{F}$  ( $1.1^{\circ}\text{C}$ ) over the range of  $40^{\circ}\text{F}$  to  $80^{\circ}\text{F}$  ( $4^{\circ}\text{C}$  to  $26.7^{\circ}\text{C}$ ).

8.3. The single-zone VAV air handling unit controller shall be configured to provide system status by indicating the following:

8.3.1. Free cooling available.

8.3.2. Economizer enabled.

8.3.3. Compressor enabled.

8.3.4. Heating enabled.

8.3.5. Mixed air low limit cycle active.

8.3.6. The current value of each sensor.

8.4. The single-zone VAV air handling 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.

8.5. The single-zone VAV air handling unit shall be configured to report faults to a fault management application accessible by day-to-day operating or service personnel or annunciated locally on zone thermostats.

8.6. The FDD system shall be configured to detect the following faults:

8.6.1. Air temperature sensor failure/fault.

8.6.2. Not economizing when the unit should be economizing.

8.6.3. Economizing when the unit should not be economizing.

8.6.4. Outdoor air or return air damper not modulating.

8.6.5. Excess outdoor air.

**C403.13 Commissioning.** Mechanical systems shall be commissioned in accordance with Section C408.



AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-40400 Section C404—Service water heating  
(~~((Mandatory))~~) and pressure-booster systems.**

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40402 Section C404.2—Service water-heating equipment performance efficiency.**

**C404.2 Service water-heating equipment performance efficiency.** Water-heating equipment and hot water storage tanks shall meet the requirements of Table C404.2. The efficiency shall be verified through certification and *listed* under an *approved* certification program, or if no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Water-heating equipment (~~((also))~~) intended to be used to provide space heating shall meet the applicable provisions of Table C404.2.

**C404.2.1 High input-rated service water heating systems.** (~~((Gas-fired))~~) All water-heating equipment installed in new buildings, other than Group R-1 and R-2 occupancies, shall be in compliance with this section. Where a singular piece of water-heating equipment serves the entire building and the input rating of the equipment is 1,000,000 Btu/h (293 kW) or greater, such equipment shall ((have a thermal efficiency,  $E_t$ )) be a heat pump water heater or have an  $E_t$  or  $E_f$  of not less than 90 percent as determined by the applicable test procedures in Table C404.2.

Where multiple pieces of water-heating equipment serve the building and the combined input rating of the water-heating equipment is equal or greater than 1,000,000 Btu/h (293 kW) ((or greater)), the combined input-capacity-weighted-average ((thermal efficiency,  $E_t$ , shall not be less than 90 percent)) shall be no less than the following for each water heating fuel source:

1. A rated COP of not less than 2.0. For air-source heat pump equipment, the COP rating will be reported at the design leaving heat pump water temperature with an enter air temperature of 60°F (15.6°C) or less.

2. A rated  $E_t$  of not less than 90 percent as determined by the applicable test procedure in Table C404.2.

((EXCEPTIONS: 1. Where 25 percent of the annual service water-heating requirement is provided by site-solar 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.))

EXCEPTION: Where not less than 25 percent of the annual service water-heating requirement is provided from any of the following sources:  
1. Renewable energy generated on-site that is not being used to satisfy another requirement of this code; or  
2. Heat recovered on-site from the building's wastewater, or from air that would otherwise be exhausted to the outdoors without heat recovery, that is not being used to satisfy other requirements of this code.

**C404.2.2 High input-rated service water heating system for Group R-1 and R-2 occupancies.** In new construction with over 1,000,000 Btu/h installed service water heating capacity serving Group R-1 and R-2 occu-

pancies, at least 25 percent of annual water heating energy shall be provided from any combination of the following water heating sources:

1. Renewable energy generated on-site that is not being used to satisfy other requirements of this code; or

2. Heat recovered on-site from the building's wastewater, air source heat pumps, or from air that would otherwise be exhausted to the outdoors without heat recovery, that is not being used to satisfy other requirements of this code.

**EXCEPTION:**

Compliance with this section is not required if the combined input-capacity-weighted average equipment rating for each service water heating fuel source type is not less than the following:

1. A heat pump water heater or an electric water heater with a rating of 125 percent of the rated efficiency of Table C404.2.

2. A rated COP of not less than 2.0. For air-source heat pump equipment the COP rating will be reported at the design leaving heat pump water temperature with an entering air temperature of 60°F (15.6°C) or lower.

3. A rated  $E_t$  or  $E_F$  of not less than 90 percent as determined by the applicable test procedures in Table C404.2.

**AMENDATORY SECTION** (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

**WAC 51-11C-404021 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 <sup>a, b</sup>	Test Procedure
Storage water heaters, electric	$\leq 12 \text{ kW}^d$	((Resistance)) Tabletop <sup>c</sup> $\geq 20 \text{ gal}$ and $\geq 120 \text{ gal}$	$0.93 - 0.00132V, EF$	DOE 10 C.F.R. Part 430
		Resistance $\geq 20 \text{ gal}$ and $\leq 55 \text{ gal}$	$0.960 - 0.0003V, EF$	
		Grid-enabled <sup>f</sup> $> 75 \text{ gal}$ and $\leq 120 \text{ gal}$	$1.06 - 0.00168V, EF$	
	<del>((<math>\leq 24 \text{ amps}</math> and <math>\leq 250 \text{ volts}</math>))</del>	Heat pump	<del><math>0.93 - 0.00132V, EF</math></del>	<del>DOE 10 C.F.R. Part 430))</del>
	$> 12 \text{ kW}^d$	Resistance	$(0.3 + 27)/V_m, \%/h^g$	Section G.2 of ANSI Z21.10.3
	$\leq 24 \text{ amps}$ and $\leq 250 \text{ volts}$	Heat pump	$2.057 - 0.00113V, EF$	DOE 10 C.F.R. Part 430
Instantaneous water heaters, electric	All	Resistance	$0.93 - 0.00132V, EF$	DOE 10 C.F.R. Part 430
Storage water heaters, gas	$\leq 75,000 \text{ Btu/h}$	$\geq 20 \text{ gal}$ and $\leq 55 \text{ gal}$	<del><math>((0.67 - 0.0019V, EF))</math></del> $0.675 - 0.0015V, EF$	DOE 10 C.F.R. Part 430
		$\geq 55 \text{ gal}$ and $\leq 100 \text{ gal}$	$0.8012 - 0.00078V, EF$	
	$> 75,000 \text{ Btu/h}$	$< 4,000 \text{ Btu/h/gal}$	$80\% E_t (Q/800 + 110\sqrt{V})$ SL, Btu/h	Section G.1 and G.2 of ANSI Z21.10.3
Instantaneous water heaters, gas	$> 50,000 \text{ Btu/h}$ and $< 200,000 \text{ Btu/h}$	$\geq 4,000 \text{ (Btu/h)/gal}$ and $< 2 \text{ gal}$	<del><math>((0.62))</math></del> $0.82 - 0.0019V, EF$	DOE 10 C.F.R. Part 430
	$\geq 200,000 \text{ Btu/h}^c$	$\geq 4,000 \text{ Btu/h/gal}$ and $< 10 \text{ gal}$	$80\% E_t$	Section G.1 and G.2 of ANSI Z21.10.3
	$\geq 200,000 \text{ Btu/h}$	$\geq 4,000 \text{ Btu/h/gal}$ and $\geq 10 \text{ gal}$	$80\% E_t (Q/800 + 110\sqrt{V})$ SL, Btu/h	
Storage water heaters, oil	$\leq 105,000 \text{ Btu/h}$	$\geq 20 \text{ gal}$	<del><math>((0.59))</math></del> $0.68 - 0.0019V, EF$	DOE 10 C.F.R. Part 430
	$> 105,000 \text{ Btu/h}$	$< 4,000 \text{ Btu/h/gal}$	$78\% E_t (Q/800 + 110\sqrt{V})$ SL, Btu/h	Section G.1 and G.2 of ANSI Z21.10.3
Instantaneous water heaters, oil	$\leq 210,000 \text{ Btu/h}$	$\geq 4,000 \text{ Btu/h/gal}$ and $< 2 \text{ gal}$	$0.59 - 0.0019V, EF$	DOE 10 C.F.R. Part 430
	$> 210,000 \text{ Btu/h}$	$\geq 4,000 \text{ Btu/h/gal}$ and $< 10 \text{ gal}$	$80\% E_t$	Section G.1 and G.2 of ANSI Z21.10.3
	$> 210,000 \text{ Btu/h}$	$\geq 4,000 \text{ Btu/h/gal}$ and $\geq 10 \text{ gal}$	$78\% E_t (Q/800 + 110\sqrt{V})$ SL, Btu/h	

Equipment Type	Size Category (input)	Subcategory or Rating Condition	Performance Required <sup>a, b</sup>	Test Procedure
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% $E_t$	Section G.1 and G.2 of 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% $E_t$ ( $Q/800 + 110\sqrt{V}$ ) 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% $E_t$ ( $Q/800 + 110\sqrt{V}$ ) SL, Btu/h	
Pool heaters, gas and oil	All	—	((78)) 82% $E_t$	ASHRAE 146
Heat pump pool heaters	All	—	4.0 COP	AHRI 146
Unfired storage tanks	All	—	Minimum insulation requirement R-12.5 (h • ft <sup>2</sup> • °F)/Btu	(none)

For SI: °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.

<sup>a</sup>Energy factor (EF) and thermal efficiency ( $E_t$ ) are minimum requirements. In the EF equation,  $V$  is the rated volume in gallons.

<sup>b</sup>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 SL equation 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.

<sup>c</sup>Instantaneous water heaters with input rates below 200,000 Btu/h shall comply with these requirements if the water heater is designed to heat water to temperatures 180°F or higher.

<sup>d</sup>Electric water heaters with an input rating of 12 kW (40,950 Btu/h) or less that are designed to heat water to temperatures of 180°F or greater shall comply with the requirements for electric water heaters that have an input rating greater than 12 kW (40,950 Btu/h).

<sup>e</sup>A tabletop water heater is a water heater that is enclosed in a rectangular cabinet with a flat top surface not more than three feet (0.91 m) in height.

<sup>f</sup>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. Is 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 a 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."

<sup>g</sup>%/h is the energy consumed to replace the heat loss from the tank while on standby, expressed as a percentage of the total energy in the stored water per hour.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

#### **WAC 51-11C-40404 Section C404.4—Heat traps.**

**C404.4 Heat traps for hot water storage tanks.** ((Water-heating equipment not supplied with integral heat traps and serving noncirculating systems shall be provided with heat traps on the supply and discharge piping associated with the equipment.)) Storage tank-type water heaters and hot water storage tanks that have vertical water pipes connecting to the inlet and outlet of the tank shall be provided with integral heat traps at those inlets and outlets or shall have pipe-configured heat traps in the piping connected to those inlets and outlets. Tank inlets and outlets associated with solar water heating system circulation loops shall not be required to have heat traps.

**For Section C404.6, Insulation of Piping, see Page 282.**

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

#### **WAC 51-11C-40407 Section C404.7—Heated-water circulating and temperature maintenance systems.**

**C404.7 Heated-water circulating and temperature maintenance systems.** Heated-water circulation systems shall be in accordance with Section C404.7.1. Heat trace temperature maintenance systems shall be in accordance with Section C404.7.2. Controls for hot water storage shall be in accordance with Section C404.7.3. Automatic controls, temperature sensors and pumps shall be ~~((accessible))~~ in a location with access. Manual controls shall be ~~((readily accessible))~~ in a location with ready access.

**C404.7.1 Circulation systems.** Heated-water circulation systems 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. Controls ~~((for circulating hot water system pumps))~~ shall start the pump based on the identification of a demand for hot water within the occupancy. ~~((The controls shall))~~

**C404.7.1.1 Single riser systems.** Where the circulation system serves only a single domestic hot water riser or zone, the following controls shall be provided:

1. Control to automatically turn off the pump when the water in the circulation loop is at the ~~((desired temperature and when there is no demand for hot water))~~ supply temperature and shall not turn the pump back on until the temperature is a minimum of 10°F lower than the supply temperature or have controls equipped with automatic time switches or other controls that can be set to switch off the pump during unoccupied hours when hot water is not required.

2. Control shall be equipped with manual switch or other controls that can be used to turn off the pump during extended periods when hot water is not required.

**C404.7.1.2 Multiple riser systems.** Where the circulation system serves multiple domestic hot water risers or piping zones, controls shall be provided such that they can be set to switch off the pump during extended periods when hot water is not required. System shall include means for balancing the flow rate through each individual hot water supply riser or piping zone.

**C404.7.2 Heat trace systems.** Electric heat trace systems shall comply with IEEE 515.1. Controls for such systems shall be able to automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy. Heat trace shall be arranged to be turned off automatically when there is no hot water demand.

**C404.7.3 Controls for hot water storage.** The controls on pumps that circulate water between a water heater and a heated-water storage tank shall limit operation of the pump from heating cycle startup to not greater than 5 minutes after the end of the cycle.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40408 Section C404.8—Demand recirculation controls.**

**C404.8 Demand recirculation controls.** (~~(A water distribution system having one or more recirculation pumps that pump water from a heated-water supply pipe back to the heated-water source through a cold-water supply pipe shall be a))~~ Demand recirculation water systems(~~(. Pumps)~~) shall have controls that comply with both of the following:

1. The controls shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.

2. The controls shall limit the temperature of the water entering the cold-water piping to not greater than 104°F (40°C).

AMENDATORY SECTION (Amending WSR 14-24-122, filed 12/3/14, effective 1/3/15)

**WAC 51-11C-40409 Section C404.9—Domestic hot water meters.**

**C404.9 Domestic hot water meters.** Each individual dwelling unit in a Group R-2 occupancy with central service domestic hot water systems shall be provided with a domestic hot water meter to allow for domestic hot water billing based on actual domestic hot water usage.

EXCEPTION: Dwelling units in other than Group R-2 apartment and live/work units are not required to provide domestic hot water metering at each dwelling unit where domestic hot water is metered separately for each of the following building end uses:

1. Dwelling units.
2. Sleeping units.
3. Commercial kitchens.
4. Central laundries.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40410 Section C404.11—Pools and spas.**

**C404.11 Energy consumption of pools and permanent spas** (~~((mandatory))~~). The energy consumption of pools and permanent spas shall be controlled by the requirements in Sections C404.11.1 through C404.11.4.

**C404.11.1 Heaters.** Heat pump pool heaters shall have a minimum COP of 4.0 determined in accordance with ASHRAE Standard 146. Other pool heating equipment shall comply with the applicable efficiencies in Section C404.2.

The electric power to all heaters shall be controlled by (~~(a readily-accessible))~~ an on-off switch that is an integral part of the heater, mounted on the exterior of the heater, or external to and within 3 feet of the heater in a location with ready access. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with constant burning pilot lights.

**C404.11.2 Time switches.** Time switches or other control method that can automatically turn off and on heaters and pump motors according to a preset schedule shall be installed for heaters and pump motors.

Heaters and pump motors that have built-in time switches shall be in compliance with this section.

EXCEPTIONS: 1. Where public health standards require 24-hour pump operation.  
2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

**C404.11.3 Covers.** Heated pools and permanent spas shall be provided with a vapor-retardant cover on or at the water surface. Pools heated to more than 90°F shall have a pool cover with a minimum insulation value of R-12, and the sides and bottom of the pool shall also have a minimum insulation value of R-12.

**C404.11.4 Heat recovery.** Heated indoor swimming pools, spas or hot tubs with water surface area greater than 200 square feet shall provide for energy conservation by an exhaust air heat recovery system that heats ventilation air, pool water or domestic hot water. The heat recovery system shall be configured to decrease the exhaust air temperature at design heating conditions (80°F indoor) by 36°F (10°C).

EXCEPTION: Pools, spas or hot tubs that include system(s) that provide equivalent recovered energy on an annual basis through one of the following methods:  
1. ~~((Renewable energy;))~~ Solar water heating systems not claimed in Section C406.5 or C407;  
2. Dehumidification heat recovery;  
3. Waste heat recovery; or  
4. A combination of these system sources capable of and configured to ~~((provided))~~ provide at least 70 percent of the heating energy required over an operating season.

**C404.12 Energy consumption of portable spas ~~((mandatory))~~.** The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40413 Section C404.13—Service ~~((water-heating system commissioning and completion requirements))~~ water pressure-booster systems.**

**C404.13 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 C408)) water pressure-booster systems. Service water pressure-booster systems shall be designed and configured such that the following apply:**

1. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensors shall either be located near the critical fixtures that determine the pressure required, or logic shall be employed that adjusts the setpoint to simulate operations of remote sensors.

2. No devices shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, except for safety devices.

3. Booster system pumps shall not operate when there is no service water flow except to refill hydro-pneumatic tanks.

4. System pump motors 7.5 hp and greater shall be provided with variable flow capacity in accordance with Section C403.2.3.

**C404.14 Commissioning.** Service water heating systems shall be commissioned in accordance with Section C408.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40501 Section C405.1—General.**

**C405.1 General ((~~mandatory~~)).** This section covers lighting system controls, the maximum lighting power for interior and exterior applications, electrical energy consumption, vertical and horizontal transportation systems, and minimum efficiencies for motors and transformers.

((EXCEPTION: ~~Dwelling units within commercial buildings shall not be required to comply with Sections C405.2 through C405.6 provided that they comply with Section R404.1.~~))

Dwelling units within multifamily buildings shall comply with this section. All other dwelling units in dormitory, hotel and other residential occupancies that are not classified as multifamily residential occupancies shall comply with Section C405.2.5 and with this section or Section C405.4. No less than 90 percent of the permanently installed lighting serving dwelling units or sleeping units shall be provided by lamps with an efficacy of not less than 60 lumens per watt or luminaire with an efficacy of not less than 55 lumens per watt.

Lighting installed in walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with the lighting requirements of Section C410.2.

Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE Standard 90.4 in addition to this code.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40502 Section C405.2—Electrical power and lighting systems.**

**C405.2 Lighting controls ((~~mandatory~~)).** Lighting systems shall be provided with controls ((~~as specified in Sections C405.2.1 through C405.2.8~~)) 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 (LLC) and lighting controls as specified in Sections C405.2.1, C405.2.3 and C405.2.5. The LLC luminaire shall be independently configured to:

2.1. Monitor occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.

2.2. Monitor ambient light, both electric 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, time-outs, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configuration.

EXCEPTION: Except for specific application controls required by Section C405.2.5, 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.)) Means of egress illumination serving the exit access that does not exceed 0.02 watts per square foot of building area is exempt from this requirement.
3. Emergency egress lighting that is normally off.
4. Industrial or manufacturing process areas, as may be required for production and safety.

((5. Luminaire-level lighting controls that control interior lighting. The LLC luminaire shall be independently configured to:  
5.1. Monitor occupant activity to brighten or dim its lighting when occupied or unoccupied, respectively.  
5.2. Monitor ambient light (both electric light and daylight) and brighten or dim electric light to maintain desired light level.  
5.3. Configuration and reconfiguration of performance parameters, including bright and dim setpoints, time-outs, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations, for each control strategy.  
5.4. Meet the operational and commissioning requirements of Sections C405.2.1, C405.2.2, C405.2.3, C405.2.4 and C408.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405021 Section C405.2.1—Occupant sensor controls.**

**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. ~~((Employee lunch and break rooms.))~~ Enclosed offices.
6. ~~((Private offices.))~~ Open plan office areas.
7. Restrooms.
8. Storage rooms.
9. ~~((Janitorial closets.~~
- 10.)) Locker rooms.

~~((11.))~~ 10. Other spaces 300 square feet (28 m<sup>2</sup>) or less that are enclosed by floor-to-ceiling height partitions.

~~((12.))~~ 11. Warehouse(s) storage areas.

12. Enclosed fire rated stairways.

13. Service corridors.

14. Covered parking areas.

Occupant sensor controls in warehouse storage areas, stairways, corridors, and library stacks, shall comply with Section C405.2.1.1. Occupant sensor controls in open plan office areas shall comply with Section C405.2.1.3. Occupant sensor controls in covered parking areas shall comply with Section C405.2.1.4. Occupant sensor controls for all other spaces shall comply with Section C405.2.1.1.

**EXCEPTIONS:**

1. Corridors in manufacturing facilities.

2. Digital timer switch controls may be provided in lieu of occupant sensor controls in the following space types in under 300 square feet: Copy/print rooms, storage rooms, and janitorial closets. Digital timer switches shall comply with the following:

2.1. Turn lights on or off with operation of a button, switch or other manual means.

2.2. Automatically turn lights off within 15 minutes of the lights being turned on. The means for setting the time delay shall not be visible on the front of the switch.

2.3. The switch shall provide both audible and visual indication of impending time-out of the switch. Audible and visual indication shall be given at least once within 5 minutes of time-out of the switch. Visual indication shall consist of turning the lights momentarily off, and then back on.

**C405.2.1.1 Occupant sensor control function.** Occupant sensor controls shall comply with all of the following:

1. They shall be configured to automatically turn off lights within ((30)) 20 minutes of all occupants leaving the space.

2. They shall be manual on or ((controlled)) configured to automatically turn the lighting on to not more than 50 percent power.

**EXCEPTION:**

Full automatic-on controls shall be permitted to control lighting in public corridors, stairways, restrooms, primary building entrances areas and lobbies, and areas where manual-on operation would endanger the safety or security of the room or building occupants.

3. They shall incorporate a manual control to allow occupants to turn lights off.

**C405.2.1.2 Occupant sensor control function in warehouses**~~((In warehouses, the lighting in aiseways and open areas shall be controlled~~



with occupant sensors that automatically reduce lighting power by not less than 50 percent when the areas are unoccupied. The occupancy sensor shall control lighting in each aisleway independently, and shall not control lighting beyond the aisleway being controlled by the sensor), **storage areas and service corridors.** Occupant sensor controls shall be configured to comply with all of the following:

1. Automatically reduce lighting power by not less than 50 percent within 20 minutes of all occupants leaving the area.

2. Control lighting in each aisleway and corridor independently, and shall not control lighting beyond the aisleway or corridor being controlled by the sensor.

3. Automatically turn lighting off within 20 minutes of all occupants leaving the space, or comply with Section C405.2.2 to turn lighting off when the building is vacant.

4. Restore lighting to full power when occupants enter the space.

#### **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<sup>2</sup>) in area shall comply with Section C405.2.1.1. Occupant sensor controls in all other open plan office spaces shall be configured to comply with all of the following:

1. General lighting is controlled separately in control zones with floor areas not greater than 600 square feet (55 m<sup>2</sup>) within the open plan office space.

2. Automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the open plan office space.

3. General lighting power in each control zone is reduced by not less than 80 percent of the full zone general lighting power within 20 minutes of all occupants leaving that control zone. Control functions that switch control zone lights completely off when the zone is unoccupied meet this requirement.

4. Daylight responsive control activate open plan office space general lighting or control zone general lighting only when occupancy for the same area is detected.

#### **C405.2.1.4 Occupant sensor control function in parking garages.** Occupant sensor controls shall be configured to comply with all of the following:

1. Lighting power of each *luminaire* shall be automatically reduced by a minimum of 30 percent when there is no vehicle or pedestrian activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be no larger than 3,600 square feet.

##### **Exceptions:**

1.1. Lighting in daylight transition zones and ramps without parking.

1.2. Covered parking garages with a total lighting power less than 0.07 watts per square foot.

2. Automatically turn all the lighting off within 20 minutes of all occupants leaving the space and restore lighting to full power when occupants enter the space, or comply with Section C405.2.2 to turn lighting off when the building is vacant.

#### **C405.2.1.5 Occupant sensor control function in enclosed fire rated stairways.** Occupant sensor controls shall be configured to automatically reduce lighting power by not less than 50 percent when no occupants have been detected in the stairway for a period not exceeding 20

minutes and restore lighting to full power when occupants enter the stairway. All portions of stairways shall remain illuminated to meet the requirements of Section 1009 of the International Building Code when the lighting power is reduced.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405022 Section C405.2.2—Time switch controls.**

**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))~~ or digital timer switch controls complying with Section ~~((C405.2.6))~~ C405.2.1 shall be provided with time switch controls complying with Section C405.2.2.1.

EXCEPTION: Where a manual control provides light reduction in accordance with Section ~~((C405.2.2.2, automatic))~~ C405.2.3.1, time switch controls shall not be required for the following:

1. ~~((Sleeping units.~~
- 2.)) Spaces where patient care is directly provided.
- ~~((3.))~~ 2. Spaces where an automatic shutoff would endanger occupant safety or security.
- ~~((4.))~~ 3. Lighting intended for continuous operation.
- ~~((5.))~~ 4. Shop and laboratory classrooms.

**C405.2.2.1 Time switch control function.** Each space provided with time switch controls shall also be provided with a manual control for light reduction in accordance with Section ~~((C405.2.2.2))~~ C405.2.3.1. Time switch controls shall comply with the following:

1. Have a minimum 7 day clock.
2. Be capable of being set for 7 different day types per week.
3. Incorporate an automatic holiday "shut-off" feature, which turns off all controlled lighting loads for at least 24 hours and then resumes normally scheduled operations.
4. Have program back-up capabilities, which prevent the loss of program and time settings for at least 10 hours, if power is interrupted.
5. Include an override switching device that complies with the following:

- 5.1. The override switch shall be a manual control.
- 5.2. The override switch, when initiated, shall permit the controlled lighting to remain on for not more than 2 hours.
- 5.3. Any individual override switch shall control the lighting for an area not larger than 5,000 square feet (465 m<sup>2</sup>).

6. Time switch controls are allowed to automatically turn on lighting to full power in corridors, lobbies, restrooms, storage rooms less than 50 square feet, and medical areas of health care facilities. In all other spaces, time switch controls are allowed to automatically turn on the lighting to not more than 50 percent power.

EXCEPTIONS:

1. Within ~~((malls, arcades, auditoriums, single tenant retail spaces, industrial facilities and arenas))~~ 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 the ~~((override))~~ switch is a captive key device.
  - 1.2. The area controlled by the override switch ~~((is permitted to be greater than))~~ shall not be limited to 5,000 square feet (465 m<sup>2</sup>), ((but shall not be greater)) provided that such area is less than 20,000 square feet (1860 m<sup>2</sup>).
- ~~((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 100 watts.
- 2.2. Spaces that use less than 0.6 watts per square foot (6.5 W/m<sup>2</sup>).
- 2.3. Corridors, equipment rooms, public lobbies, electrical or mechanical rooms.

~~**C405.2.2.2 Light reduction controls.** Spaces required to have light-reduction controls shall have a manual control that allows the occupant~~

to reduce the connected lighting load in a reasonably uniform illumination pattern by at least 50 percent. Lighting reductions shall be achieved by one of the following ~~approved methods~~:

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.~~

EXCEPTION: ~~Light reduction controls are not required in daylight zones with *daylight responsive controls* complying with Section C405.2.4.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405023 Section C405.2.3—Manual controls.**

**C405.2.3 Manual controls.** All lighting shall have manual controls ((for lights shall comply)) complying with the following:

1. They shall be ((readily accessible)) in a location with ready access to occupants.
2. They shall be located where the controlled lights are visible, or shall identify the area served by the lights and indicate their status.
3. Each control device shall control an area no larger than a single room, or 2,500 square feet if the room area is less than or equal to 10,000 square feet, or 10,000 square feet if the room area is greater than 10,000 square feet.

EXCEPTIONS: 1. A manual control may be installed in a remote location for the purpose of safety or security provided each remote control device has an indicator pilot light as part of or next to the control device and the light is clearly labeled to identify the controlled lighting.  
2. Restrooms.

**C405.2.3.1 Light reduction controls.** Manual controls shall be configured to provide light reduction control that allows the occupant to reduce the connected lighting load between 30 and 70 percent. Lighting reductions shall be achieved by one of the following *approved methods*:

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 *daylight responsive controls* complying with Section C405.2.4.  
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 100 watts.  
2.2. Spaces that use less than 0.6 watts per square foot (6.5 W/m<sup>2</sup>).  
2.3. Lighting in corridors, lobbies, electrical rooms, restrooms, storage rooms, airport concourse baggage areas, dwelling and sleeping rooms, and mechanical rooms.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405024 Section C405.2.4—Daylight responsive controls.**

**C405.2.4 Daylight responsive controls.** *Daylight responsive controls* complying with Section C405.2.4.1 shall be provided to control the lighting within *daylight* zones in the following spaces:

1. (~~((Sidelight daylight))~~) Sidelit zones as defined in Section C405.2.4.2 with more than two *general lighting* fixtures within the combined primary and secondary (~~((sidelight daylight))~~) sidelit zones.

2. (~~((Toplight daylight))~~) Toplit zones as defined in Section C405.2.4.3 with more than two *general lighting* fixtures within the daylight zone.

EXCEPTION: *Daylight responsive controls* are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.

2. (~~((Dwelling units and sleeping units.~~

3.)) Lighting that is required to have specific application control in accordance with Section C405.2.4.

(~~((4. Sidelight daylight))~~) 3. Sidelit zones on the first floor above grade in Group A-2 and Group M occupancies.

(~~((5.))~~) 4. Daylight zones where the total proposed lighting power density is less than 35 percent of the lighting power allowance per Section C405.4.2.

**C405.2.4.1 Daylight responsive controls 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 primary (~~((sidelight daylight))~~) sidelit zones shall be controlled independently of lights in secondary (~~((sidelight daylight))~~) sidelit zones in accordance with Section C405.2.4.2.

EXCEPTION: Spaces enclosed by walls or ceiling height partitions with no more than three *general lighting* fixtures may have combined daylight zone control of primary and secondary daylight zones provided *uniform illumination* can be achieved.

2. Lights in (~~((toplight daylight))~~) toplit zones in accordance with Section C405.2.4.3 shall be controlled independently of lights in (~~((sidelight daylight))~~) sidelit zones in accordance with Section C405.2.4.2.

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 (~~((readily accessible))~~) in a location with ready access.

5. *Daylight responsive controls* shall be configured to completely shut off all controlled lights in that zone.

6. Lights in (~~((sidelight daylight))~~) sidelit zones in accordance with Section C405.2.4.2 facing different cardinal orientations (i.e., within 45 degrees of due north, east, south, west) shall be controlled independently of each other.

EXCEPTION: Up to two light fixtures in each space are permitted to be controlled together with lighting in a daylight zone facing a different cardinal orientation.

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 m<sup>2</sup>).

9. Occupant override capability of daylight dimming controls is not permitted, other than a reduction of light output from the level established by the daylighting controls.

**C405.2.4.1.1 Dimming.** *Daylight responsive controls* shall be configured to automatically reduce the power of *general lighting* in the daylight zone in response to available daylight, while maintaining *uniform illumination* in the space through one of the following methods:

1. Continuous dimming using dimming ballasts/dimming drivers and daylight-sensing 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 daylight-sensing controls. The system shall provide a minimum of two steps of uniform illumination between 0 percent 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.

**C405.2.4.2 ((Sidelight daylight)) Sidelit zone.** The ((sidelight daylight)) sidelit zone is the floor area adjacent to vertical fenestration which complies with the following:

1. Where the fenestration is located in a wall, the ((sidelight daylight)) sidelit zone includes the primary and secondary daylight zones. The primary 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), whichever is less, as indicated in Figure C405.2.4.2(1). The secondary daylight zone begins at the edge of the primary daylight zone and extends laterally to the nearest full height wall, or up to 2.0 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 sidelight 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)).

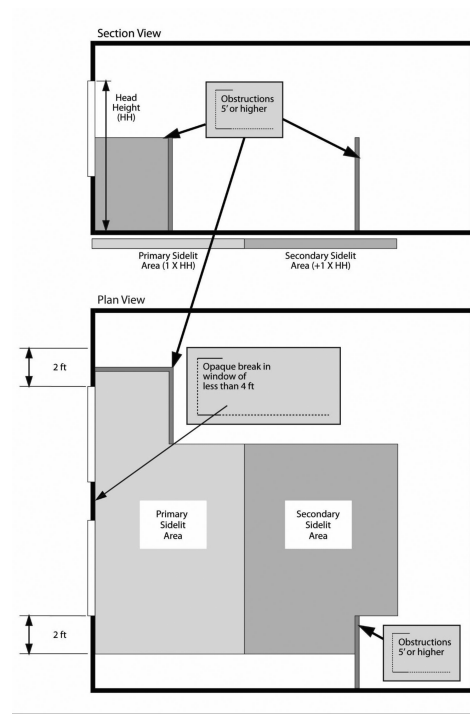
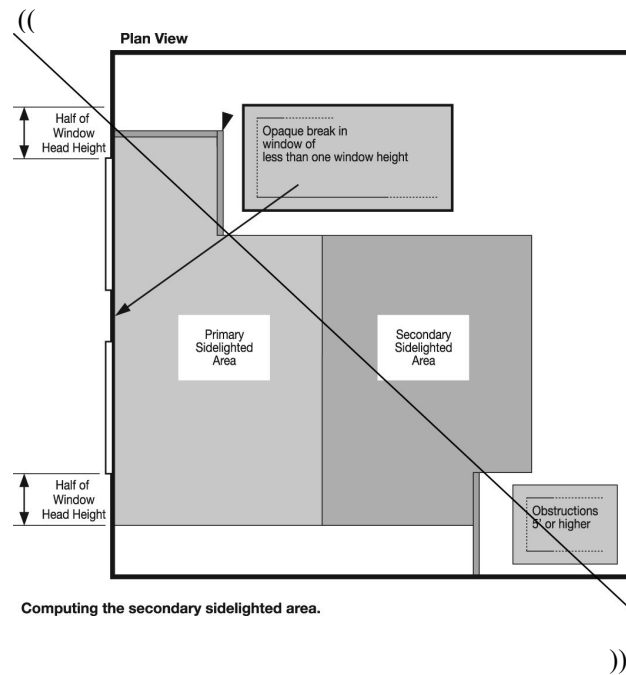
3.)) Where clerestory fenestration is located in a wall, the ((sidelight daylight)) sidelit zone includes a lateral area twice the depth of the clerestory fenestration height, projected upon the floor at a 45 degree angle from the center of the clerestory fenestration. The longitudinal width of the ((daylight)) sidelit 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)) sidelit zone shall remain the same lateral area but be located between the clerestory and the obstruction, as indicated in Figure C405.2.4.2((4+)) (2).

((4.)) 3. If the rough opening area of a vertical fenestration assembly is less than 10 percent of the calculated primary ((daylight)) sidelit zone area for this fenestration, it does not qualify as a ((daylight)) sidelit zone.

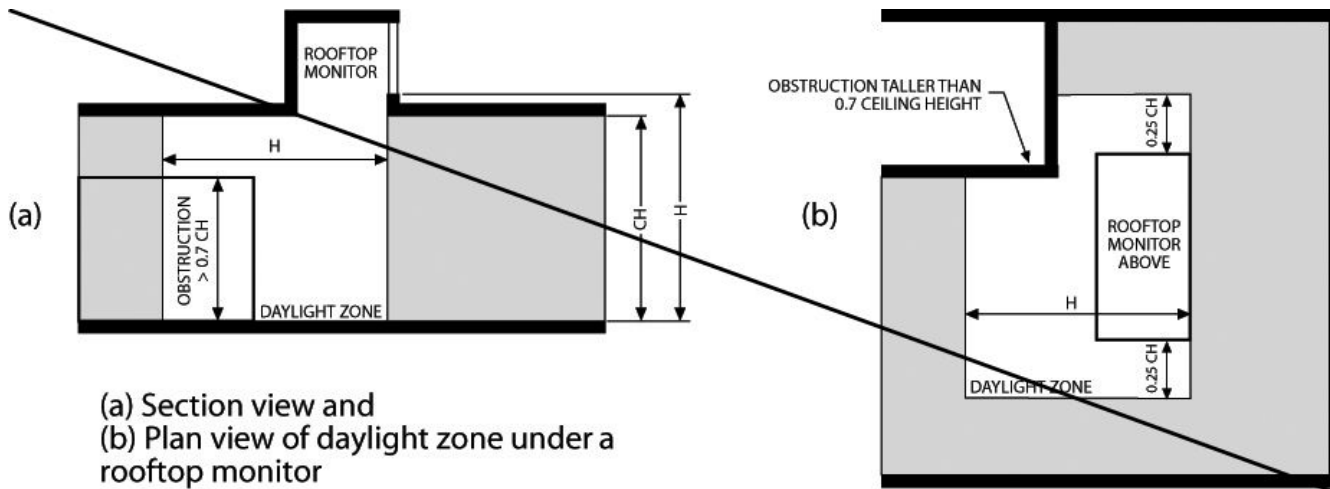
((5. Where located in existing buildings,)) 4. The visible transmittance of the fenestration is no less than 0.20.

((6.)) 5. In parking garages with floor area adjacent to perimeter wall openings, the ((daylight)) sidelit 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.

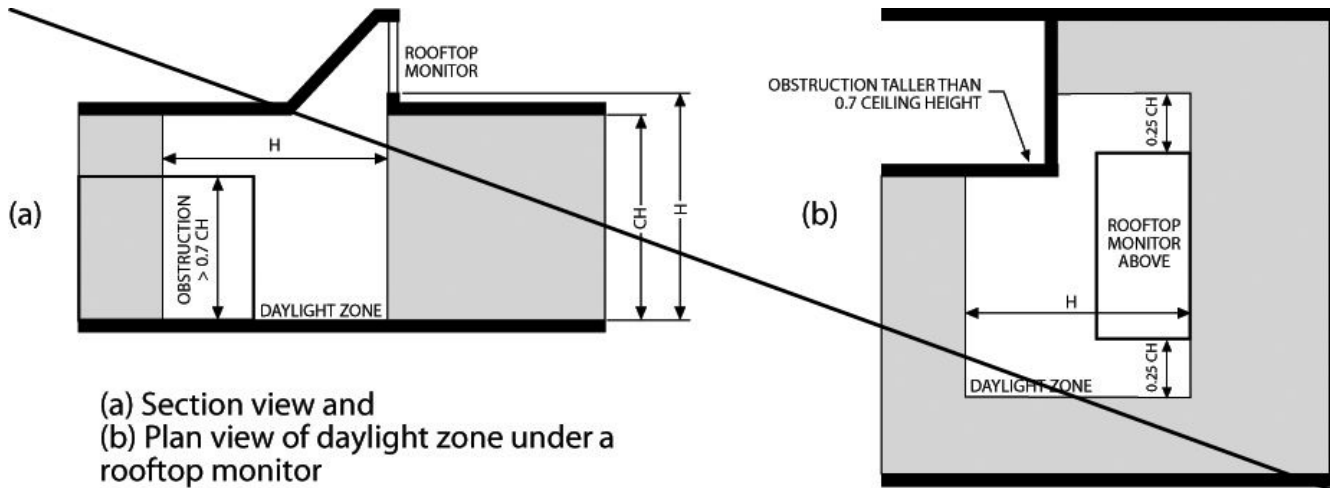
**Figure C405.2.4.2(1)**  
**((Daylight)) Sidelit Zone Adjacent to Fenestration in a Wall**



**Figure C405.2.4.2(2)**  
~~( Daylight Zone Under a Rooftop Monitor~~

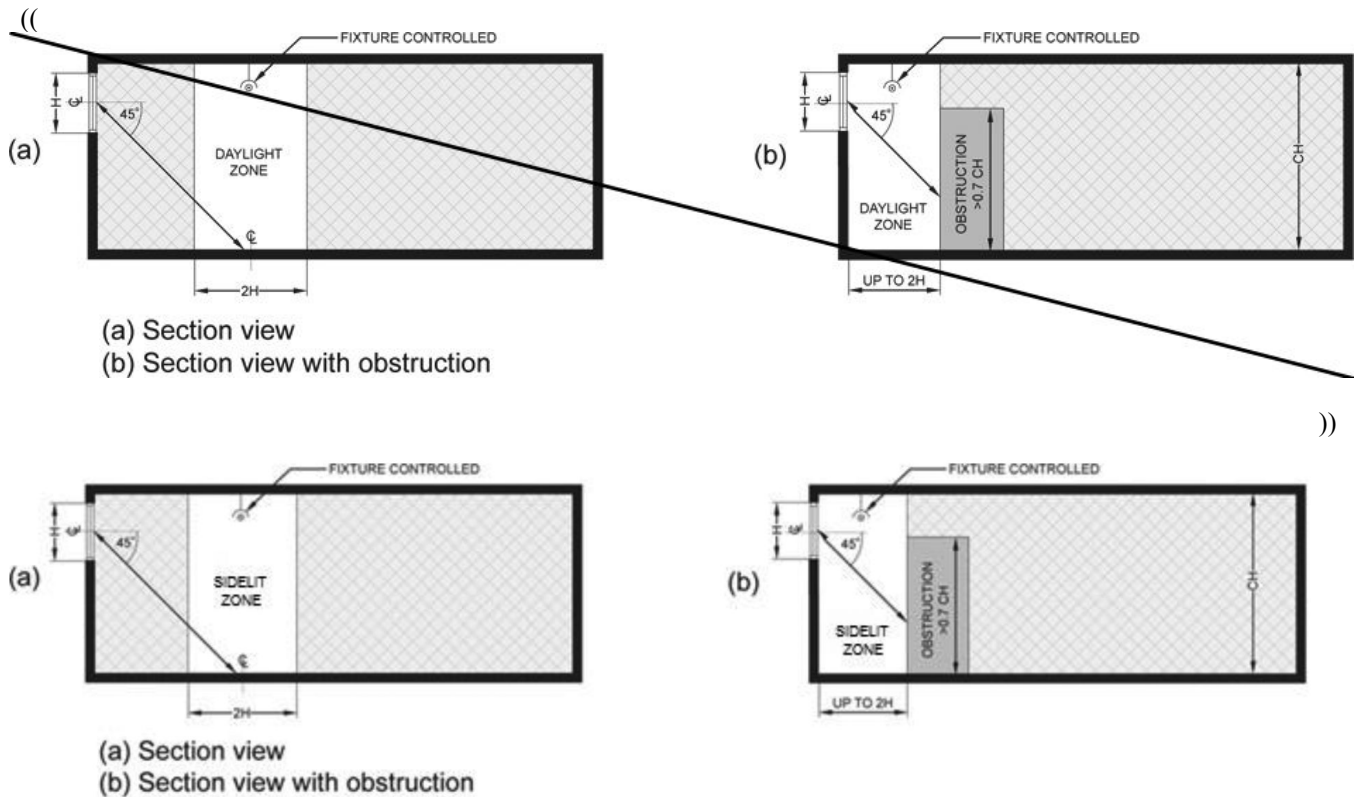


**Figure C405.2.4.2(3)**  
~~Daylight Zone Under a Sloped Rooftop Monitor~~



**Figure C405.2.4.2(4)**

**Daylight)) Sidelit Zone Adjacent to Clerestory Fenestration in a Wall**



**C405.2.4.3 ((Toplight daylight)) Toplit zone.** The ((toplight day-light)) toplit zone is the floor area underneath a roof fenestration assembly which complies with the following:

1. The ((toplight daylight)) toplit 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(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 C405.2.4.3(2) and C405.2.4.3(3).

3. Where ((toplight daylight)) toplit zones overlap with ((side-light daylight)) sidelit zones, lights within the overlapping area shall be assigned to the ((toplight daylight)) toplit zone.

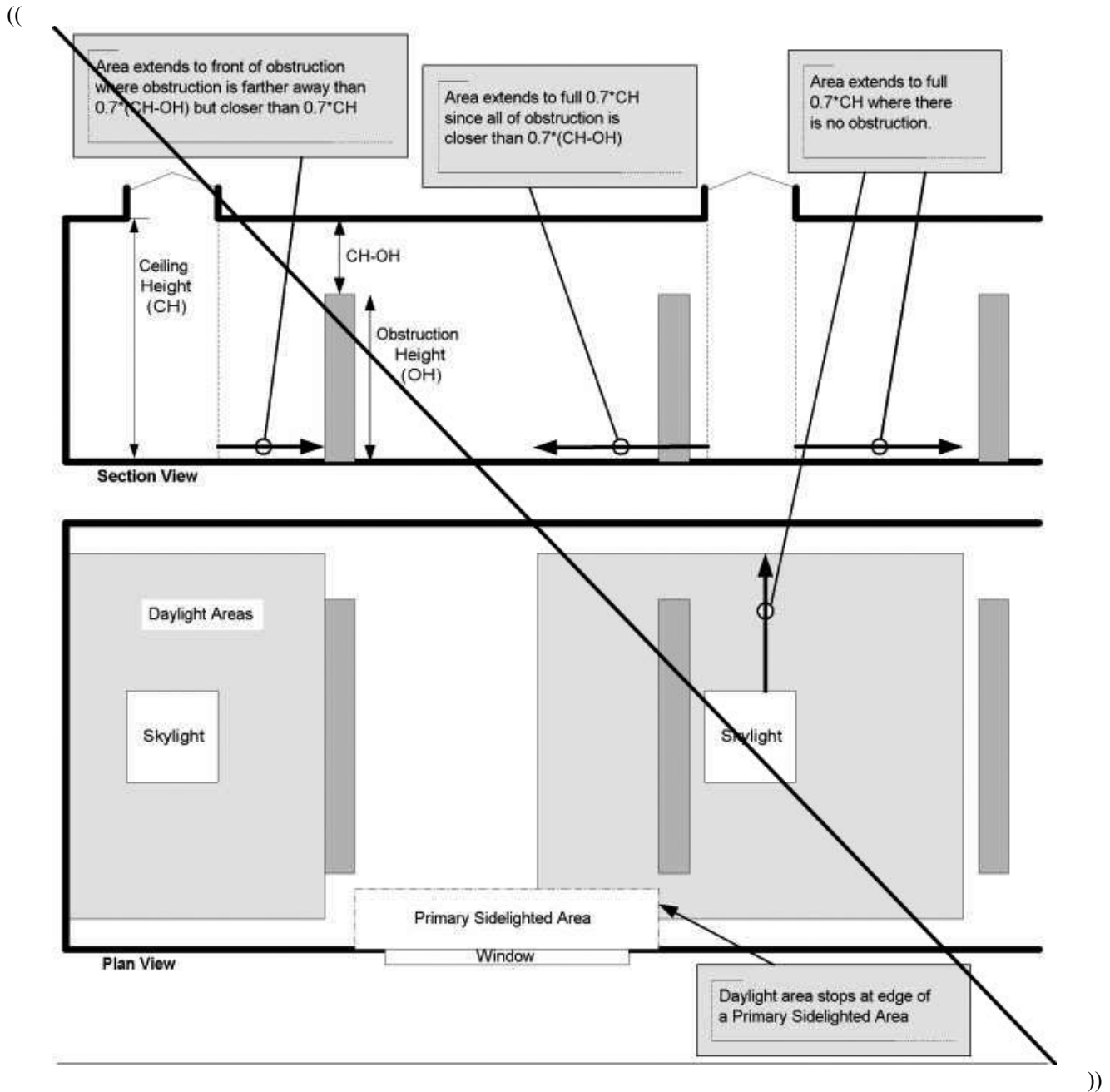
((3. Where located in existing buildings,)) 4. The product of the visible transmittance of the roof fenestration assembly and the area of the rough opening of the roof fenestration assembly, divided by the area of the ((daylight)) toplit zone is no less than 0.008.

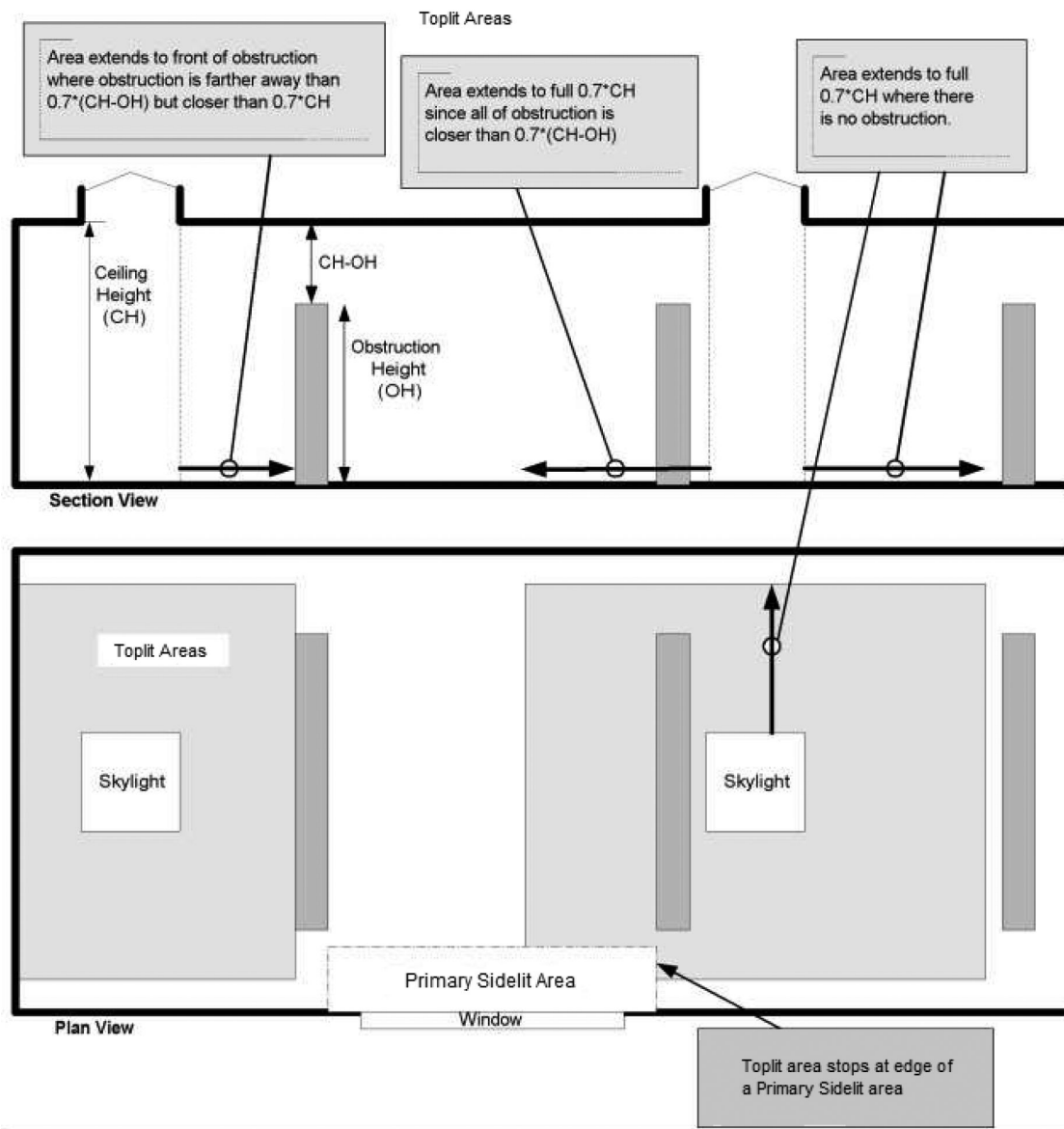
((4.)) 5. Where located under atrium fenestration, the ((day-light)) toplit zone shall include the bottom floor area directly be-



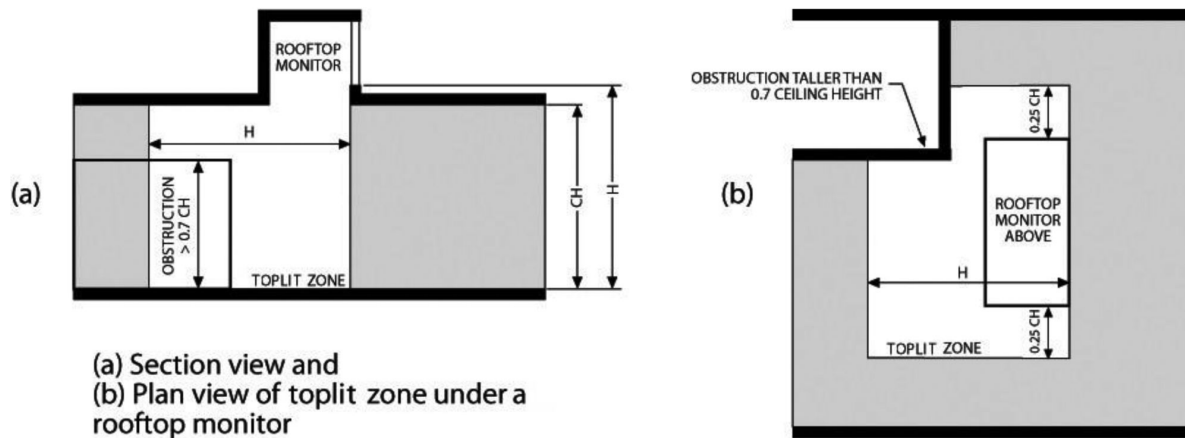
neath the atrium fenestration, and the top floor directly under the atrium fenestration, as indicated in Figure C405.2.4.3((+2)) (4). The ((daylight)) toplit zone area at the top floor is calculated the same as for a ((~~toplight~~ daylight)) toplit zone. Intermediate levels below the top floor that are not directly beneath the atrium are not included.

**Figure C405.2.4.3(1)**  
**((Daylight)) Toplit Zone Under a Rooftop Fenestration Assembly**



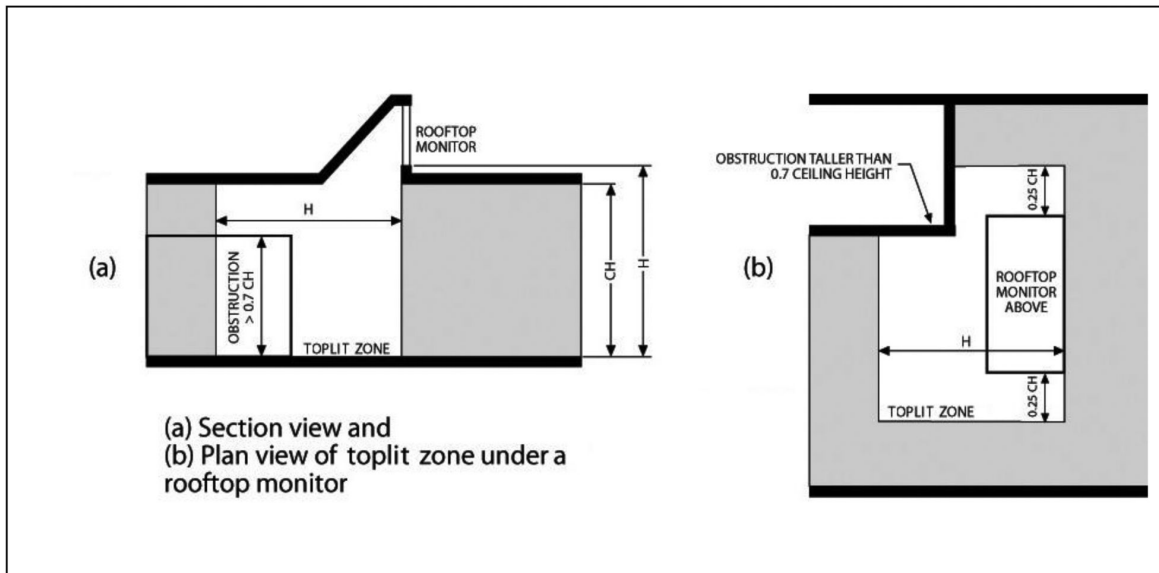


**Figure C405.2.4.3(2)**  
**Toplit Zone Under a Rooftop Monitor**



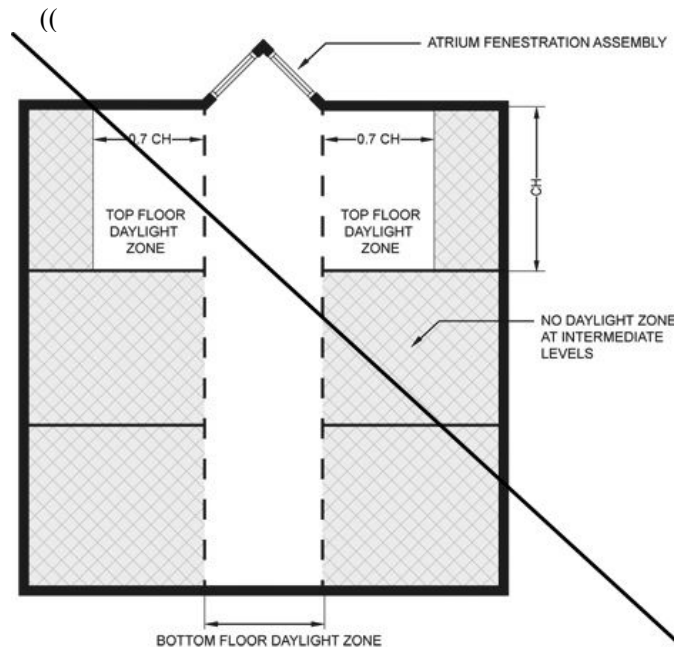
(a) Section view and  
(b) Plan view of toplit zone under a rooftop monitor

**Figure C405.2.4.3(3)**  
**Toplit Zone Under a Sloped Rooftop Monitor**

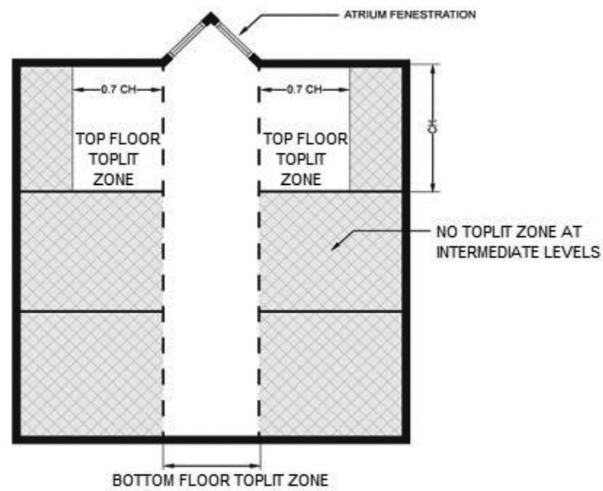


(a) Section view and  
(b) Plan view of toplit zone under a rooftop monitor

**Figure C405.2.4.3((2)) (4)**  
**((Daylight)) Toplit Zone Under Atrium Fenestration**



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AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405025 Section C405.2.5—Additional lighting controls.**

**C405.2.5 Additional lighting controls.** Specific application lighting shall be provided with controls, in addition to controls required by other sections, for the following:

~~1. ((Display and accent light shall be controlled by a dedicated control that is independent of the controls for other lighting within the room or space.~~

~~2. Lighting in cases used for display case purposes shall be controlled by a dedicated control that is independent of the controls for other lighting within the room or space.~~

~~3. Hotel and motel sleeping units and guest suites))~~ 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. Display and accent.

1.2. Lighting in display cases.

1.3. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.

1.4. Lighting equipment that is for sale or demonstration in lighting education.

2. Sleeping units shall have control device(s) or systems configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants ~~((leave the room))~~ have left the unit.

EXCEPTIONS:

1. Lighting and switched receptacles controlled by ((eaptive-key systems)) card key controls.

2. Spaces where patient care is directly provided.

~~((4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting, shall be automatically shut off whenever that space is unoccupied and shall have a control device integral to the luminaires or be controlled by a wall-mounted control device provided that the control device is readily accessible.~~

~~5.))~~ 3. Permanently installed luminaires within dwelling units shall be provided with controls complying with either Section C405.2.1.1 or C405.2.2.2.

4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a dedicated control that is independent of the controls for other lighting within the room or space. Each control zone shall be no greater than the area served by a single luminaire or 4,000 square feet, whichever is larger.

~~((6. Lighting equipment that is for sale or for demonstrations in lighting education shall be controlled by a dedicated control that is independent of the controls for other lighting within the room or space.~~

~~7.))~~ 5. Luminaires serving the exit access and providing means of egress illumination required by Section 1006.1 of the *International Building Code*, including luminaires that function as both normal and emergency means of egress illumination shall be controlled by a combination of listed emergency relay and occupancy sensors, or signal from another building control system, that automatically shuts off the lighting when the areas served by that illumination are unoccupied.

EXCEPTION:

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

**WAC 51-11C-405026 Section C405.2.6—(~~Digital timer switch~~) Exterior lighting controls.**

~~((C405.2.6 Digital timer switch controls. For each of the following space types, when under 300 square feet, digital timer switch controls may be provided in lieu of occupancy sensor controls:~~

- ~~1. Copy/print rooms.~~
- ~~2. Storage rooms.~~
- ~~3. Janitorial closets.~~

**C405.2.6.1 Digital timer switch function.** ~~Digital timer switches shall comply with the following:~~

~~1. Turn lights on or off with operation of a button, switch or other manual means.~~

~~2. Automatically turn lights off within 15 minutes of the lights being turned on. The means for setting the time delay shall not be visible on the front of the switch.~~

~~3. The switch shall provide both audible and visual indication of impending time-out of the switch. Audible and visual indication shall be given at least once within five minutes of time-out of the switch. Visual indication shall consist of turning the lights momentarily off, and then back on.))~~

**C405.2.6 Exterior lighting controls.** Exterior lighting systems shall be provided with controls that comply with Sections C405.2.6.1 through C405.2.6.4. Decorative lighting systems shall comply with Sections C405.2.6.1, C405.2.6.2, and C405.2.6.4.

EXCEPTIONS: 1. Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security or eye adaption.  
2. Lighting controlled from within dwelling units.

**C405.2.6.1 Daylight shutoff.** Lights shall be configured to automatically turn off when daylight is present and satisfies the lighting needs.

**C405.2.6.2 Façade and landscape lighting shutoff.** Building façade and landscaping lighting shall be configured to automatically shutoff for a minimum of 6 hours per night or from not later than 1 hour after business closing to not earlier than 1 hour before business opening, whichever is less.

EXCEPTION: Areas where an automatic shutoff would endanger safety or security.

**C405.2.6.3 Lighting setback.** Lighting that is not controlled in accordance with Section C405.2.6.2 shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 30 percent by selectively switching off or dimming luminaires at one of the following times:

1. From not later than 12 midnight to 6 a.m.
2. From not later than 1 hour after business closing to not earlier than 1 hour before business opening.
3. During any period when no activity has been detected for 15 minutes or more.

**C405.2.6.4 Exterior time-switch control functions.** Time-switch controls for exterior lighting shall comply with the following:

1. They shall have a clock capable of being programmed for not fewer than 7 days.

2. They shall be capable of being set for 7 different day types per week.

3. They shall incorporate an automatic holiday setback feature.

4. They shall have program backup capabilities that prevent the loss of program and time settings for a period of at least 10 hours in the event that power is interrupted.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405027 ((Section C405.2.7 Exterior lighting controls.)) Reserved.**

~~((C405.2.7 Exterior lighting controls. Lighting for exterior applications other than emergency lighting that is intended to be automatically off during building operation, lighting specifically required to meet health and life safety requirements or decorative gas lighting systems shall:~~

~~1. Be provided with a control that automatically turns off the lighting as a function of available daylight.~~

~~2. Where lighting the building façade or landscape, the lighting shall have controls that automatically shut off the lighting as a function of dawn/dusk and a set opening and closing time.~~

~~3. Where not covered in Item 2, the lighting shall have controls configured to automatically reduce the connected lighting power by at least 30 percent from no later than 12 midnight to 6 a.m. or from one hour after business closing to one hour before business opening or during any period when no activity has been detected for a time of no longer than 15 minutes.~~

~~Time switches shall be capable of retaining programming and the time setting for at least 10 hours without power.~~

EXCEPTION: ~~Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security or eye adaption.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405028 Section C405.2.8—Area controls.**

**C405.2.8 Area controls.** The maximum lighting power that may be controlled from a single switch or automatic control device shall not exceed that which is provided by a 20 ampere circuit loaded to not more than 80 percent. A master control may be installed provided the individual switches retain their capability to function independently. Circuit breakers may not be used as the sole means of switching.

EXCEPTION: Areas less than 5 percent of the building footprint for footprints over 100,000 ft<sup>2</sup>.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40504 ((Section C405.3 Exit signs.)) Reserved.**

~~((C405.3 Exit signs (mandatory). Internally illuminated exit signs shall not exceed 5 watts per side.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40505 Section C405.4—Interior lighting power requirements.**

**C405.4 Interior lighting power requirements ((prescriptive)).** A building complies with this section if its total connected interior lighting power calculated under Section C405.4.1 is no greater than the interior lighting power allowance calculated under Section C405.4.2.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405051 Section C405.4.1—Total connected interior lighting power.**

**C405.4.1 Total connected interior lighting power.** The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [((SL + LV + LTPB)) \underline{LVL + BLL + TRK + POE + Other}]$$

**(Equation 4-10)**

Where:

TCLP = Total connected lighting power (watts).

~~((SL = Labeled wattage of luminaires for screw-in lamps.~~

~~LV = Wattage of the transformer supplying low-voltage lighting.~~

~~LTPB = Wattage of line-voltage lighting tracks and plug-in busways as the specified wattage of the luminaires but at least 50 W/lin. ft., or the wattage limit of the system's circuit breaker, or the wattage limit of other permanent current limiting devices on the system.))~~ LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp, which must be minimum 60 lumens/watt.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating the lamp.

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 16 W/lin. ft. (52 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.

POE = For other modular lighting systems served with power supplied by a driver, power supply for transformer including, but not limited to, low-voltage lighting systems, the wattage of the system shall be the maximum rated input wattage of the driver, power supply or transformed published in the manufacturer's catalogs, as specified by UL 2108 or 8750. For power-over-Ethernet lighting systems, power provided to installed nonlighting devices may be subtracted from the total power rating of the power-over-Ethernet systems.

Other = The wattage of all other luminaires and lighting, sources not covered above and associated with interior lighting verified by data supplied by the manufacturer or other approved sources.

((EXCEPTIONS:

- 1. The connected power associated with the following lighting equipment is not included in calculating total connected lighting power.
- 1.1. Professional sports arena playing field lighting.
- 1.2. Emergency lighting automatically off during normal building operation.
- 1.3. Lighting in spaces specifically designed for use by occupants with special lighting needs including the visually impaired and other medical and age-related issues.
- 1.4. Casino gaming areas.
- 1.5. General area lighting power in industrial and manufacturing occupancies dedicated to the inspection or quality control of goods and products.
- 1.6. Lighting in sleeping units, provided that the lighting complies with Section R404.1.
- 1.7. Mirror lighting in dressing rooms.
- 2. Lighting equipment used for the following shall be exempt provided that it is in addition to general lighting and is controlled by an independent control device:
- 2.1. Task lighting for medical and dental purposes.
- 2.2. Display lighting for exhibits in galleries, museums and monuments.
- 3. Lighting for theatrical purposes, including performance, stage, film production and video production.
- 4. Lighting for photographic processes.
- 5. Lighting integral to equipment or instrumentation and is installed by the manufacturer.
- 6. Task lighting for plant growth or maintenance where the lamp efficacy is not less than 90 lumens per watt.
- 7. Advertising signage or directional signage.
- 8. In restaurant buildings and areas, lighting for food warming or integral to food preparation equipment.
- 9. Lighting equipment that is for sale.
- 10. Lighting demonstration equipment in lighting education facilities.
- 11. Lighting approved because of safety or emergency considerations, inclusive of exit lights.
- 12. Lighting integral to both open and glass enclosed refrigerator and freezer cases.
- 13. Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions.
- 14. Furniture mounted supplemental task lighting that is controlled by automatic shutoff.
- 15. Lighting used for aircraft painting.))

The connected power associated with the following lighting equipment is not included in calculating total connected lighting power.

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. General area lighting power in industrial and manufacturing occupancies dedicated to the inspection or quality control of goods and products.

6. Mirror lighting in dressing rooms.

7. Task lighting for medical and dental purposes that is in addition to general lighting and controlled by an independent control device.

8. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting and controlled by an independent control device.

9. Lighting for theatrical purposes, including performance, stage, film production and video production.

10. Lighting for photographic processes.

11. Lighting integral to equipment or instrumentation and installed by the manufacturer.
12. Task lighting for plant growth or maintenance where the lamp efficacy is not less than 90 lumens per watt.
13. Advertising signage or directional signage.
14. Lighting for food warming.
15. Lighting equipment that is for sale.
16. Lighting demonstration equipment in lighting education facilities.
17. Lighting approved because of safety considerations.
18. Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions.
19. Furniture mounted supplemental task lighting that is controlled by automatic shutoff.
20. Exit signs.
21. Lighting used for aircraft painting.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405052 Section C405.4.2—Interior lighting power requirements.**

**C405.4.2 Interior lighting power allowance.** The total interior lighting power allowance (watts) is determined according to Table C405.4.2(1) using the Building Area Method, or Table C405.4.2(2) using the Space-by-Space Method, for all areas of the building covered in this permit.

**C405.4.2.1 Building area method.** For the Building Area Method, the interior lighting power allowance is the floor area for each building area type listed in Table C405.4.2(1) times the value from Table C405.4.2(1) for 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 as listed in Table C405.4.2(1). Where this method is used to calculate the total interior lighting power for an entire building, each building area type shall be treated as a separate area.

**C405.4.2.2 Space-by-Space Method.** For the Space-by-Space Method, the interior lighting power allowance is determined by multiplying the floor area of each space times the value for the space type in Table C405.4.2(2) that most closely represents the proposed use of the space, and then summing the lighting power allowances for all spaces. Tradeoffs among spaces are permitted.

Each area enclosed by partitions that are 80 percent of the ceiling height or taller shall be considered a separate space and assigned the appropriate space type from Table C405.4.2(2). If a space has multiple functions where more than one space type is applicable, that space shall be broken up into smaller subspaces, each using their own space type. Any of these subspaces that are smaller in floor area than 20 percent of the enclosed space and less than 1,000 square feet need not be broken out separately.

**C405.4.2.2.1 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. 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 for lighting equipment to be installed in sales areas specifically to highlight merchandise. The additional lighting power shall be determined in accordance with Equation 4-11.

**(Equation 4-11)**

$$\text{Additional Interior Lighting Power Allowance} = 500 \text{ watts} + (\text{Retail Area 1} \times ((\cancel{0.6})) \underline{0.45} \text{ W/ft}^2) + (\text{Retail Area 2} \times ((\cancel{0.6})) \underline{0.45} \text{ W/ft}^2) + (\text{Retail Area 3} \times ((\cancel{1.4})) \underline{1.05} \text{ W/ft}^2) + (\text{Retail Area 4} \times ((\cancel{2.5})) \underline{1.87} \text{ W/ft}^2).$$

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.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405053 Table C405.4.2(1)—Interior lighting power allowances—Building area method.**

**Table C405.4.2(1)  
Interior Lighting Power Allowances—Building Area Method**

<b>((Building Area Type</b>	<b>LPD (w/ ft<sup>2</sup>)</b>
Automotive facility	0.64
Convention center	0.81
Court house	0.81
Dining: Bar lounge/leisure	0.79
Dining: Cafeteria/fast food	0.72
Dining: Family	0.71
Dormitory	0.46
Exercise center	0.67
Fire station	0.54
Gymnasium	0.75
Health care clinic	0.70

<b>((Building Area Type</b>	<b>LPD (w/ ft<sup>2</sup>)</b>
Hospital	0.84
Hotel/motel	0.70
Library	0.94
Manufacturing facility	0.89
Motion picture theater	0.61
Multifamily	0.41
Museum	0.80
Office	0.66
Parking garage	0.16
Penitentiary	0.65
Performing arts theater	1.00
Police station	0.70
Post office	0.70
Religious building	0.80
Retail	1.01
School/university	0.70
Sports arena	0.62
Town hall	0.71
Transportation	0.56
Warehouse	0.40
Workshop	0.95))

<b>Building Area Type</b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
Automotive facility	0.60	0.60	0.60
Convention center	0.65	0.65	0.65
Court house	0.70	0.70	0.70
Dining: Bar lounge/leisure	0.79	0.70	0.70
Dining: Cafeteria/fast food	0.70	0.70	0.70
Dining: Family	0.70	0.70	0.70
Dormitory <sup>a,b</sup>	0.61	0.41	0.41
Exercise center	0.65	0.61	0.61
Fire station <sup>a</sup>	0.53	0.53	0.50
Gymnasium	0.65	0.65	0.65
Health care clinic	0.70	0.70	0.70
Hospital <sup>a</sup>	0.90	0.84	0.84
Hotel/motel <sup>a,b</sup>	0.70	0.67	0.67
Library	0.78	0.70	0.70
Manufacturing facility	0.89	0.60	0.60
Motion picture theater	0.61	0.60	0.60
Multifamily <sup>c</sup>	0.41	0.40	0.40
Museum	0.80	0.72	0.72
Office	0.65	0.66	0.65
Parking garage	0.14	0.13	0.13
Penitentiary	0.65	0.65	0.65

<b>Building Area Type</b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
Performing arts theater	1.00	0.80	0.80
Personal service-salon, cleaners, laundromat	0.60	0.60	0.60
Police station	0.70	0.68	0.68
Post office	0.67	0.63	0.63
Religious building	0.80	0.70	0.70
Retail	0.90	0.91	0.90
School/university	0.65	0.65	0.60
Sports arena	0.62	0.75	0.75
Town hall	0.71	0.70	0.70
Transportation	0.50	0.51	0.51
Warehouse	0.40	0.40	0.40
Workshop	0.90	0.90	0.90

- a Where sleeping units are excluded from lighting power calculations by application of Section R404.1, 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 by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.
- c Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405054 Table C405.4.2(2)—Interior lighting power allowances—Space-by-space method.**

**Table C405.4.2(2)  
Interior Lighting Power Allowances—Space-by-Space Method**

<b>((Common Space-by-Space Types<sup>a</sup></b>	<b>LPD<sup>d</sup> (w/ft<sup>2</sup>)</b>
Atrium - First 40 feet in height <sup>c</sup>	0.02 per ft. ht.
Atrium - Above 40 feet in height <sup>c</sup>	0.03 + 0.02 per ft. in total height
Audience/seating area -- Permanent	
In an auditorium	0.50
In a convention center	0.66
In a gymnasium	0.34
In a motion picture theater	0.91
In a penitentiary	0.22
In a performing arts theater	1.94
In a religious building	1.22
In a sports arena	0.34
Otherwise	0.34
Banking activity area	0.81
Breakroom (see Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	1.07

<b>((Common Space-by-Space Types<sup>a</sup></b>	<b>LPD<sup>d</sup> (w/ft<sup>2</sup>)</b>
Otherwise	1.00
Conference/meeting/multipurpose	0.98
Copy/print room	0.58
Corridor	
In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup>	0.74
In a hospital	0.63
In a manufacturing facility	0.33
Otherwise	0.53
Courtroom	1.38
Computer room	1.37
Dining area	
In a penitentiary	0.77
In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup>	1.52
In a bar/lounge or leisure dining	0.86
In a family dining area	0.71
Otherwise	0.52
Electrical/mechanical	0.76
Emergency vehicle garage	0.45
Food preparation	0.79
Guest room	0.38
Laboratory	
In or as a classroom	1.02
Otherwise	1.45
Laundry/washing area	0.48
Loading dock, interior	0.38
Lobby <sup>c</sup>	
In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup>	1.44
For an elevator	0.51
In a hotel	0.85
In a motion picture theater	0.42
In a performing arts theater	1.60
Otherwise	0.72
Locker room	0.60
Lounge/breakroom	
In a health care facility	0.74
Otherwise	0.58
Office <sup>f</sup>	
Enclosed	0.89
Open plan	0.78
Parking area, interior	0.15
Pharmacy area	0.91

<b>((Common Space-by-Space Types<sup>a</sup></b>	<b>LPD<sup>d</sup> (w/ft<sup>2</sup>)</b>
Restroom	
In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup>	0.97
Otherwise	0.78
Sales area	1.27
Seating area, general	0.43
Stairway (see space containing stairway)	
Stairwell	0.55
Storage room	0.50
Vehicular maintenance	0.54
Workshop	1.27

<b>Building Specific Space-by-Space Types<sup>a</sup></b>	
<b>Building Specific Space-by-Space Types</b>	<b>LPD<sup>d</sup> (w/ft<sup>2</sup>)</b>
Automotive – (See Vehicular maintenance, above)	
Convention center – Exhibit space	1.16
Dormitory living quarters	0.30
Facility for the visually impaired <sup>b</sup>	
In a chapel (and not used primarily by the staff) <sup>b</sup>	1.77
In a recreation room (and not used primarily by the staff) <sup>b</sup>	1.93
Fire stations – Sleeping quarters	0.18
Engine rooms	0.45
Gymnasium/fitness center	
In an exercise area	0.58
In a playing area	0.96
Health care facility	
In an exam/treatment room	1.33
In an imaging room	1.06
In a medical supply room	0.59
In a nursery	0.70
In a nurse's station	0.57
In an operating room	1.51
In a patient room	0.50
In a physical therapy room	0.73
In a recovery room	0.92
Library <sup>f</sup>	
In a reading area	0.74
In the stacks	1.37
Manufacturing facility	
In a detailed manufacturing area	1.03
In an equipment room	0.59

<b>Building Specific Space-by-Space Types<sup>a</sup></b>	
<b>Building Specific Space-by-Space Types</b>	<b>LPD<sup>d</sup> (w/ft<sup>2</sup>)</b>
In an extra-high bay area (greater than 50-foot floor-to-ceiling height)	0.84
In a high bay area (25 – 50-foot floor-to-ceiling height)	0.98
In a low bay (< 25-foot floor-to-ceiling height)	0.95
<b>Museum</b>	
In a general exhibition area	0.84
In a restoration room	0.82
Performing arts theater dressing/ fitting room	0.32
Post office – Sorting area	0.75
<b>Religious buildings</b>	
In a fellowship hall	0.51
In a worship/pulpit/choir area	1.22
<b>Retail facilities</b>	
In a dressing/fitting room	0.57
In a mall concourse	0.88
<b>Sports arena – Playing area</b>	
For a Class 1 facility	2.41
For a Class 2 facility	1.54
For a Class 3 facility	0.96
For a Class 4 facility	0.58
<b>Transportation</b>	
In a baggage/carousel area	0.42
In an airport concourse	0.29
At a terminal ticket counter	0.64
<b>Warehouse – Storage area</b>	
For medium to bulky palletized items	0.46
For smaller, hand-carried items	0.76))

<b>Common Space-by-Space Types<sup>a</sup></b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
<u>Atrium - First 40 feet in height (per foot)</u>	<u>0.48</u>	<u>0.02</u>	<u>0.48</u>
<u>Atrium - Above 40 feet in height (per foot)</u>	<u>0.70</u>	<u>0.02</u>	<u>0.70</u>
<u>Audience/seating area - Permanent</u>			
In an auditorium	0.61	0.61	0.61
In a convention center	0.65	0.25	0.25
In a gymnasium	0.34	0.23	0.23
In a motion picture theater	0.82	0.27	0.27
In a penitentiary	0.67	0.44	0.67



<b>Common Space- by-Space Types<sup>a</sup></b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
<u>In a performing arts theater</u>	<u>1.06</u>	<u>1.06</u>	<u>1.06</u>
<u>In a religious building</u>	<u>1.22</u>	<u>0.72</u>	<u>0.72</u>
<u>In a sports arena</u>	<u>0.33</u>	<u>0.33</u>	<u>0.33</u>
<u>Otherwise</u>	<u>0.23</u>	<u>0.23</u>	<u>0.23</u>
<u>Banking activity area</u>	<u>0.79</u>	<u>0.61</u>	<u>0.61</u>
<u>Beauty salon, barber area</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
<u>Breakroom (see lounge/breakroom)</u>			
<u>Classroom/lecture hall/training room</u>			
<u>In a penitentiary</u>	<u>1.38</u>	<u>1.07</u>	<u>1.38</u>
<u>Otherwise</u>	<u>0.84<sup>m</sup></u>	<u>0.84<sup>m</sup></u>	<u>0.74<sup>m</sup></u>
<u>Computer room, data center</u>	<u>1.33</u>	<u>1.00</u>	<u>1.00</u>
<u>Conference/meeting/multipurpose</u>	<u>0.97</u>	<u>0.97</u>	<u>0.97</u>
<u>Copy/print room</u>	<u>0.70</u>	<u>0.50</u>	<u>0.31</u>
<u>Corridor</u>			
<u>In a facility for the visually impaired (and not used primarily by the staff)<sup>b</sup></u>	<u>0.71</u>	<u>0.71</u>	<u>0.71</u>
<u>In a hospital</u>	<u>0.71</u>	<u>0.63</u>	<u>0.71</u>
<u>In a manufacturing facility</u>	<u>0.41</u>	<u>0.29</u>	<u>0.41</u>
<u>Otherwise</u>	<u>0.41</u>	<u>0.41</u>	<u>0.41</u>
<u>Courtroom</u>	<u>1.25</u>	<u>1.25</u>	<u>1.25</u>
<u>Dining area</u>			
<u>In a penitentiary</u>	<u>0.42</u>	<u>0.42</u>	<u>0.42</u>
<u>In a facility for the visually impaired (and not used primarily by the staff)<sup>b</sup></u>	<u>1.38</u>	<u>1.38</u>	<u>1.38</u>
<u>In a bar/lounge or leisure dining</u>	<u>0.86<sup>n</sup></u>	<u>0.86<sup>n</sup></u>	<u>0.86<sup>n</sup></u>
<u>In cafeteria or fast food dining</u>	<u>0.63</u>	<u>0.40</u>	<u>0.40</u>
<u>In a family dining area</u>	<u>0.71<sup>n</sup></u>	<u>0.60<sup>n</sup></u>	<u>0.60<sup>n</sup></u>
<u>Otherwise</u>	<u>0.52</u>	<u>0.43</u>	<u>0.43</u>
<u>Electrical/mechanical</u>	<u>0.42</u>	<u>0.42</u>	<u>0.42</u>
<u>Emergency vehicle garage</u>	<u>0.52</u>	<u>0.52</u>	<u>0.52</u>
<u>Food preparation</u>	<u>1.29</u>	<u>0.92</u>	<u>1.29</u>
<u>Guest room<sup>a,b</sup></u>	<u>0.41</u>	<u>0.41</u>	<u>0.41</u>
<u>Laboratory</u>			
<u>In or as a classroom</u>	<u>1.17</u>	<u>1.02</u>	<u>1.17</u>
<u>Otherwise</u>	<u>1.70<sup>o</sup></u>	<u>1.45<sup>o</sup></u>	<u>1.70<sup>o</sup></u>
<u>Laundry/washing area</u>	<u>0.59</u>	<u>0.43</u>	<u>0.59</u>

<b>Common Space-by-Space Types<sup>a</sup></b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
Loading dock, interior	0.38	0.38	0.38
Lobby <sup>c</sup> In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup> For an elevator In a hotel In a motion picture theater In a performing arts theater Otherwise	2.49 0.71 0.51 0.23 1.25 1.11	1.44 0.51 0.51 0.23 1.25 0.72	2.49 0.71 0.51 0.23 1.25 1.11
Locker room	0.52	0.86	0.52
Lounge/breakroom	0.67	0.58	0.42
Office Enclosed < 250 Enclosed > 250 Open plan	0.88 <sup>P</sup> 0.79 <sup>P</sup> 0.67 <sup>P</sup>	0.88 <sup>P</sup> 0.79 <sup>P</sup> 0.67 <sup>P</sup>	0.70 <sup>P</sup> 0.70 <sup>P</sup> 0.60 <sup>P</sup>
Parking area, interior	0.15	0.15	0.15
Parking facility, dedicated ramp	0.25	0.25	0.25
Pharmacy area	1.90	1.23	1.90
Restroom In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup> Otherwise	1.26 0.78 <sup>q,r</sup>	0.96 0.75 <sup>q,r</sup>	1.26 0.63 <sup>q,r</sup>
Sales area	1.12	1.12	1.04
Sales area, grocery	1.05	1.05	1.05
Seating area, general	0.23	0.23	0.23
Stairway (see space containing stairway)			
Stairwell	0.55 <sup>q,r</sup>	0.49 <sup>q,r</sup>	0.49 <sup>q,r</sup>
Storage room < 50 ft <sup>2</sup> 50-100 ft <sup>2</sup> All other storage	0.40 0.38 0.38	0.40 0.38 0.38	0.40 0.38 0.38
Vehicular maintenance	0.60	0.54	0.60
Workshop	1.26	1.14	1.26
<b>Building Specific Space-by-Space Types<sup>a</sup></b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
Automotive	0.60	0.54	0.60
Convention center - Exhibit space	0.50	0.50	0.50
Dormitory living quarters <sup>a,b</sup>	0.84	0.46	0.46

<b>Building Specific Space-by-Space Types<sup>a</sup></b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
<u>Facility for the visually impaired<sup>b</sup></u>			
<u>In a chapel (and not used primarily by the staff)<sup>b</sup></u>	<u>0.70</u>	<u>0.70</u>	<u>0.70</u>
<u>In a recreation room (and not used primarily by the staff)<sup>b</sup></u>	<u>1.77</u>	<u>1.77</u>	<u>1.77</u>
<u>Fire stations<sup>g</sup></u>			
<u>Engine rooms</u>	<u>0.45</u>	<u>0.45</u>	<u>0.45</u>
<u>Sleeping quarters</u>	<u>0.20</u>	<u>0.18</u>	<u>0.20</u>
<u>Gymnasium/fitness center</u>			
<u>In an exercise area</u>	<u>0.90</u>	<u>0.50</u>	<u>0.90</u>
<u>In a playing area</u>	<u>0.85</u>	<u>0.82</u>	<u>0.85</u>
<u>Health care facility</u>			
<u>In an exam/treatment room</u>	<u>1.40</u>	<u>1.33</u>	<u>1.40</u>
<u>In an imaging room</u>	<u>0.85</u>	<u>0.85</u>	<u>0.85</u>
<u>In a medical supply room</u>	<u>0.64</u>	<u>0.54</u>	<u>0.62</u>
<u>In a nursery</u>	<u>1.37</u>	<u>0.94</u>	<u>1.37</u>
<u>In a nurse's station</u>	<u>1.11</u>	<u>0.75</u>	<u>1.11</u>
<u>In an operating room</u>	<u>2.26</u>	<u>1.90</u>	<u>2.26</u>
<u>In a patient room<sup>g</sup></u>	<u>1.15</u>	<u>0.68</u>	<u>0.68</u>
<u>In a physical therapy room</u>	<u>0.91</u>	<u>0.85</u>	<u>0.91</u>
<u>In a recovery room</u>	<u>1.25</u>	<u>0.92</u>	<u>1.25</u>
<u>Library</u>			
<u>In a reading area</u>	<u>0.96</u>	<u>0.80</u>	<u>0.96</u>
<u>In the stacks</u>	<u>1.16</u>	<u>1.16</u>	<u>1.16</u>
<u>Manufacturing facility</u>			
<u>In a detailed manufacturing area</u>	<u>0.80</u>	<u>0.80</u>	<u>0.80</u>
<u>In an equipment room</u>	<u>0.76</u>	<u>0.65</u>	<u>0.76</u>
<u>In an extra high bay area (greater than 50-foot floor-to-ceiling height)</u>	<u>1.42</u>	<u>0.84</u>	<u>1.42</u>
<u>In a high bay area (25 - 50-foot floor-to-ceiling height)</u>	<u>1.24</u>	<u>0.75</u>	<u>1.24</u>
<u>In a low bay (&lt; 25-foot floor-to-ceiling height)</u>	<u>0.86</u>	<u>0.86</u>	<u>0.86</u>
<u>Museum</u>			
<u>In a general exhibition area</u>	<u>0.84</u>	<u>0.31</u>	<u>0.31</u>
<u>In a restoration room</u>	<u>1.10</u>	<u>1.10</u>	<u>1.10</u>

<b>Building Specific Space-by-Space Types<sup>a</sup></b>	<b>Option 1: LPD (w/ft<sup>2</sup>)</b>	<b>Option 2: LPD (w/ft<sup>2</sup>)</b>	<b>Option 3: LPD (w/ft<sup>2</sup>)</b>
<u>Performing arts theater dressing/ fitting room</u>	<u>0.41</u>	<u>0.41</u>	<u>0.41</u>
<u>Post office - Sorting area</u>	<u>0.76</u>	<u>0.68</u>	<u>0.76</u>
<u>Religious buildings</u>			
<u>In a fellowship hall</u>	<u>0.54</u>	<u>0.51</u>	<u>0.54</u>
<u>In a worship/ pulpit/choir area</u>	<u>0.85</u>	<u>0.85</u>	<u>0.84</u>
<u>Retail facilities</u>			
<u>In a dressing/ fitting room</u>	<u>0.51</u>	<u>0.50</u>	<u>0.51</u>
<u>In a mall concourse</u>	<u>1.03</u>	<u>0.88</u>	<u>1.03</u>
<u>Sports arena - Playing area</u>			
<u>For a Class 1 facility<sup>i</sup></u>	<u>2.94</u>	<u>2.41</u>	<u>2.94</u>
<u>For a Class 2 facility<sup>j</sup></u>	<u>2.01</u>	<u>2.01</u>	<u>2.01</u>
<u>For a Class 3 facility<sup>k</sup></u>	<u>1.30</u>	<u>0.96</u>	<u>1.30</u>
<u>For a Class 4 facility<sup>l</sup></u>	<u>0.86</u>	<u>0.72</u>	<u>0.86</u>
<u>Transportation</u>			
<u>In a baggage/ carousel area</u>	<u>0.39</u>	<u>0.39</u>	<u>0.39</u>
<u>In an airport concourse</u>	<u>0.25</u>	<u>0.25</u>	<u>0.25</u>
<u>At a terminal ticket counter</u>	<u>0.51</u>	<u>0.51</u>	<u>0.51</u>
<u>Warehouse - Storage area</u>			
<u>For medium to bulky palletized items</u>	<u>0.33</u>	<u>0.33</u>	<u>0.33</u>
<u>For smaller, hand-carried items</u>	<u>0.69</u>	<u>0.69</u>	<u>0.69</u>

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 11 W/m<sup>2</sup>.

- <sup>a</sup> 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.
- <sup>b</sup> 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.
- <sup>c</sup> For spaces in which lighting is specified to be installed in addition to, and controlled separately from, the general lighting for the purpose of highlighting art or exhibits, provided that the additional lighting power shall not exceed 0.5 W/ft<sup>2</sup> of such spaces.
- <sup>d</sup> ((The watts per square foot may be increased by 2 percent per foot of ceiling height above 20 feet, unless specifically directed otherwise by subsequent footnotes.)) Reserved.
- <sup>e</sup> ((Footnote d may not be used for these occupancy types.)) Reserved.
- <sup>f</sup> ((The watts per square foot may be increased by 2 percent per foot of ceiling height above 9 feet. Footnote d may not be used for these occupancy types.)) Reserved.
- <sup>g</sup> Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.
- <sup>h</sup> Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

- i Class I facilities consist of professional facilities; and  
- semiprofessional, collegiate or club facilities with seating for 5,000 or more spectators.
- j Class II facilities consist of collegiate and semiprofessional  
- facilities with seating for fewer than 5,000 spectators; club facilities with seating between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.
- k Class III facilities consist of club, amateur league and high school  
- facilities with seating for 2,000 or fewer spectators.
- l Class IV facilities consist of elementary school and recreational  
- facilities; and amateur league and high school facilities without provisions for spectators.
- m For classrooms, additional lighting power allowance of 4.50 W/  
- lineal foot of white or chalk boards for directional lighting dedicated to white or chalk boards.
- n Additional lighting power allowance of 0.30 W/ft<sup>2</sup> for ornamental  
- lighting. Qualifying ornamental lighting includes luminaires such as chandeliers, sconces, lanterns, neon and cold cathode, light emitting diodes, theatrical projectors, moving lights and light color panels when any of those lights are used in a decorative manner that does not serve as display lighting or general lighting.
- o For scientific laboratories, additional lighting power allowance of  
- 0.35 W/ft<sup>2</sup> for specialized task work - lighting that provides for small-scale, cognitive or fast performance visual tasks, lighting required for operating specialized equipment associated with pharmaceutical/laboratorial activities.
- p For offices, additional lighting power allowance of 0.20 W/ft<sup>2</sup> for  
- portable lighting, which includes under shelf or furniture-mounted supplemental task lighting qualifies when controlled by a time clock or an occupancy sensor.
- q Additional lighting power allowance of 0.15 W/ft<sup>2</sup> for decorative  
- lighting. Primary function shall be decorative and not to provide general lighting.
- r Additional lighting power allowance of 0.20 W/ft<sup>2</sup> for accent,  
- display and feature lighting - luminaires shall be adjustable or directional.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40506 Section C405.5—Exterior lighting.**

**C405.5 Exterior lighting ((~~mandatory~~)) power requirements.** ((Where the power for exterior lighting is supplied through the energy service to the building, all exterior lighting shall comply with Sections C405.5.1 and C405.5.2.

EXCEPTION: Where ~~approved~~ because of historical, safety, signage or emergency considerations.))

The total connected exterior lighting power calculated in accordance with Section C405.5.2 shall not be greater than the exterior lighting power allowance calculated in accordance with Section C405.5.3.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405061 Section C405.5.1—Exterior building grounds lighting.**

**C405.5.1 Exterior building grounds lighting.** All exterior building grounds luminaires that operate at greater than 100 watts shall have a minimum efficacy of 80 lumens per watt unless the luminaire is con-

trolled by a motion sensor or qualifies for one of the exceptions under Section C405.5.2.

**EXCEPTIONS:**

1. Solar-powered lamps not connected to any electrical source.
2. Luminaires controlled by a motion sensor.
3. Luminaires that qualify for one of the exceptions under Section C405.5.2.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405062 Section C405.5.2—Exterior building lighting power.**

**C405.5.2 Total connected exterior building lighting power.** The total exterior connected lighting power ((allowance for all exterior building applications is the sum of the base site allowance plus the individual allowances for areas that are to be illuminated and are permitted in Table C405.5.2(2) for the applicable lighting zone. Tradeoffs are allowed only among exterior lighting applications listed in Table C405.5.2(2), Tradable Surfaces section. The lighting zone for the building exterior is determined from Table C405.5.2(1) unless otherwise specified by the local jurisdiction)) 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 ((exterior)) applications ((is exempt where equipped with a control device independent of the control of the nonexempt lighting)) 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;
- ~~((2.))~~ 5. Advertising signage or directional signage;
- ~~((3.))~~ 6. Integral to equipment or instrumentation and is installed by its manufacturer;
- ~~((4.))~~ 7. Theatrical purposes, including performance, stage, film production and video production;
- ~~((5.))~~ 8. Athletic playing areas;
- ~~((6.))~~ 9. Temporary lighting;
- ~~((7.))~~ 10. Industrial production, material handling, transportation sites and associated storage areas;
- ~~((8.))~~ 11. Theme elements in theme/amusement parks; ((and
- 9.)) 12. Lighting integrated within or used to highlight features of art, public monuments and ((registered historic landmark structures or buildings)) the national flag;
13. Lighting for water features and swimming pools; and
14. Lighting that is controlled from within dwelling units, where the lighting complies with Section R404.1.

**C405.5.3 Exterior lighting power allowance.** The total exterior lighting power allowance is the sum of the base site allowance plus the individual allowances for areas that are to be illuminated by lighting that is powered through the energy service for the building. Lighting power allowances are as specified in Table C405.5.3(2). The lighting zone for the building exterior is determined in accordance with Table C405.5.3(1) unless otherwise specified by the code official.

**C405.5.3.1 Additional exterior lighting power.** Any increase in the exterior lighting power allowance is limited to the specific lighting applications indicated in Table C405.5.3(3). The additional power shall be used only for the luminaires that are serving these applications and shall not be used for any other purpose.

**C405.5.4 Gas lighting.** Gas-fired lighting appliances shall not be equipped with continuously burning pilot ignition systems.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405063 Table ((C405.5.2)) C405.5.3(1)—Exterior lighting zones.**

**Table ((C405.5.2)) C405.5.3(1)  
Exterior Lighting Zones**

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

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-405064 Table ((C405.5.2)) C405.5.3(2)—Individual lighting power allowances for building exteriors.**

**Table ((C405.5.2)) C405.5.3(2)  
((Individual)) Lighting Power Allowances for Building Exteriors**

		<b>((Lighting Zones</b>			
		<b>Zone 1</b>	<b>Zone 2</b>	<b>Zone 3</b>	<b>Zone 4</b>
Base Site Allowance (Base allowance is usable in tradable or nontradable surfaces.)		500 W	600 W	750 W	1300 W
Tradable Surfaces	<b>Uncovered Parking Areas</b>				
(Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas are tradable.)	Parking areas and drives	0.04 W/ft <sup>2</sup>	0.06 W/ft <sup>2</sup>	0.08 W/ft <sup>2</sup>	0.10 W/ft <sup>2</sup>
	<b>Building Grounds</b>				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas, special feature areas	0.14 W/ft <sup>2</sup>	0.14 W/ft <sup>2</sup>	0.16 W/ft <sup>2</sup>	0.2 W/ft <sup>2</sup>
	Stairways	0.75 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>
	Pedestrian tunnels	0.15 W/ft <sup>2</sup>	0.15 W/ft <sup>2</sup>	0.2 W/ft <sup>2</sup>	0.3 W/ft <sup>2</sup>
	<b>Building Entrances and Exits</b>				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width

		((Lighting Zones			
		Zone 1	Zone 2	Zone 3	Zone 4
	Entry canopies	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>
	<b>Sales Canopies</b>				
	Free standing and attached	0.6 W/ft <sup>2</sup>	0.6 W/ft <sup>2</sup>	0.8 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>
	<b>Outdoor Sales</b>				
	Open areas (including vehicle sales lots)	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.5 W/ft <sup>2</sup>	0.7 W/ft <sup>2</sup>
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Street frontage for vehicle sales lots in addition to "open area" allowance	No Allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot
	Building facades	No allowance	0.075 W/ft <sup>2</sup> of gross above-grade wall area	0.113 W/ft <sup>2</sup> of gross above-grade wall area	0.150 W/ft <sup>2</sup> of gross above-grade wall area
	Automated teller machines and night depositories	270 W-per location plus 90 W-per additional ATM-per location	270 W-per location plus 90 W-per additional ATM-per location	270 W-per location plus 90 W-per additional ATM-per location	270 W-per location plus 90 W-per additional ATM-per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft <sup>2</sup> of covered and uncovered area
	Drive-up windows/doors	400 W-per drive-through	400 W-per drive-through	400 W-per drive-through	400 W-per drive-through
	Parking near 24-hour retail entrances	800 W-per main entry	800 W-per main entry	800 W-per main entry	800 W-per main entry))

	<b>Lighting Zones</b>			
	Zone 1	Zone 2	Zone 3	Zone 4
<u>Base Site Allowance</u>	<u>350 W</u>	<u>400 W</u>	<u>500 W</u>	<u>900 W</u>
<b>Uncovered Parking Areas</b>				
<u>Parking areas and drives</u>	<u>0.03 W/ft<sup>2</sup></u>	<u>0.04 W/ft<sup>2</sup></u>	<u>0.06 W/ft<sup>2</sup></u>	<u>0.08 W/ft<sup>2</sup></u>
<b>Building Grounds</b>				
<u>Walkways and ramps less than 10 feet wide</u>	<u>0.5 W/linear foot</u>	<u>0.5 W/linear foot</u>	<u>0.6 W/linear foot</u>	<u>0.7 W/linear foot</u>
<u>Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas</u>	<u>0.10 W/ft<sup>2</sup></u>	<u>0.10 W/ft<sup>2</sup></u>	<u>0.11 W/ft<sup>2</sup></u>	<u>0.14 W/ft<sup>2</sup></u>
<u>Dining areas</u>	<u>0.65 W/ft<sup>2</sup></u>	<u>0.65 W/ft<sup>2</sup></u>	<u>0.75 W/ft<sup>2</sup></u>	<u>0.95 W/ft<sup>2</sup></u>
<u>Stairways</u>	<u>0.6 W/ft<sup>2</sup></u>	<u>0.7 W/ft<sup>2</sup></u>	<u>0.7 W/ft<sup>2</sup></u>	<u>0.7 W/ft<sup>2</sup></u>
<u>Pedestrian tunnels</u>	<u>0.12 W/ft<sup>2</sup></u>	<u>0.12 W/ft<sup>2</sup></u>	<u>0.14 W/ft<sup>2</sup></u>	<u>0.21 W/ft<sup>2</sup></u>
<u>Landscaping</u>	<u>0.03 W/ft<sup>2</sup></u>	<u>0.04 W/ft<sup>2</sup></u>	<u>0.04 W/ft<sup>2</sup></u>	<u>0.04 W/ft<sup>2</sup></u>
<b>Building Entrances and Exits</b>				



	<b>Lighting Zones</b>			
	<b>Zone 1</b>	<b>Zone 2</b>	<b>Zone 3</b>	<b>Zone 4</b>
<u>Pedestrian and vehicular entrances and exits</u>	<u>14 W/ linear foot of opening</u>	<u>14 W/ linear foot of opening</u>	<u>21 W/ linear foot of opening</u>	<u>21 W/ linear foot of opening</u>
<u>Entry canopies</u>	<u>0.2 W/ft<sup>2</sup></u>	<u>0.25 W/ft<sup>2</sup></u>	<u>0.4 W/ft<sup>2</sup></u>	<u>0.4 W/ft<sup>2</sup></u>
<u>Loading docks</u>	<u>0.35 W/ft<sup>2</sup></u>	<u>0.35 W/ft<sup>2</sup></u>	<u>0.35 W/ft<sup>2</sup></u>	<u>0.35 W/ft<sup>2</sup></u>
<b>Sales Canopies</b>				
<u>Free standing and attached</u>	<u>0.4 W/ft<sup>2</sup></u>	<u>0.4 W/ft<sup>2</sup></u>	<u>0.6 W/ft<sup>2</sup></u>	<u>0.7 W/ft<sup>2</sup></u>
<b>Outdoor Sales</b>				
<u>Open areas (including vehicle sales lots)</u>	<u>0.2 W/ft<sup>2</sup></u>	<u>0.2 W/ft<sup>2</sup></u>	<u>0.35 W/ft<sup>2</sup></u>	<u>0.5 W/ft<sup>2</sup></u>
<u>Street frontage for vehicle sales lots in addition to "open area" allowance</u>	<u>No Allowance</u>	<u>7 W/ linear foot</u>	<u>7 W/ linear foot</u>	<u>21 W/ linear foot</u>

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m<sup>2</sup>

**Table C405.5.3(3)**  
**Individual Lighting Power Allowances**  
**for Building Exteriors**

	<b>Lighting Zones</b>			
	<b>Zone 1</b>	<b>Zone 2</b>	<b>Zone 3</b>	<b>Zone 4</b>
<u>Building facades</u>	<u>No allowance</u>	<u>0.075 W/ft<sup>2</sup> of gross above-grade wall area</u>	<u>0.113 W/ft<sup>2</sup> of gross above-grade wall area</u>	<u>0.150 W/ft<sup>2</sup> of gross above-grade wall area</u>
<u>Automated teller machines and night depositories</u>	<u>135W per location plus 45W per additional ATM per location</u>			
<u>Entrances and gatehouse inspection stations at guarded facilities</u>	<u>0.5 W/ft<sup>2</sup></u>			
<u>Loading areas for law enforcement, fire, ambulance and other emergency service vehicles</u>	<u>0.35 W/ft<sup>2</sup></u>			
<u>Drive-up windows/doors</u>	<u>200 W per drive-through</u>			
<u>Parking near 24-hour retail entrances</u>	<u>400 W per main entry</u>			

AMENDATORY SECTION (Amending WSR 17-10-062, filed 5/2/17, effective 6/2/17)

**WAC 51-11C-40507 Section C405.6—Electrical energy consumption.**

**C405.6 Electrical transformers (~~((Mandatory))~~).** Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of Table C405.6 as tested and rated in accordance with the test procedure listed in DOE 10 C.F.R. 431. The efficiency shall be verified through certification under an approved certification program or, where no certification program exists, 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 C.F.R. 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 C.F.R. 431.
3. Transformers that meet the Energy Policy Act of 2005 exclusions with multiple voltage taps where the highest tap is ~~((at least))~~ 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 transformer.
12. Welding transformer.
13. Grounding transformer.
14. Testing transformer.

**Table C405.6  
Minimum Nominal Efficiency Levels  
For 10 C.F.R. 431 Low Voltage Dry-  
Type Distribution Transformers**

Single Phase Transformers		Three Phase Transformers	
kVA <sup>a</sup>	Efficiency (%) <sup>b</sup>	kVA <sup>a</sup>	Efficiency (%) <sup>b</sup>
15	97.70	15	<del>((97.0))</del> 97.89
25	98.00	30	<del>((97.5))</del> 98.23
37.5	98.20	45	<del>((97.7))</del> 98.40
50	98.30	75	<del>((98.0))</del> 98.60
75	98.50	112.5	<del>((98.2))</del> 98.74
100	98.60	150	<del>((98.3))</del> 98.83
167	98.70	225	<del>((98.5))</del> 98.94
250	98.80	300	<del>((98.6))</del> 99.02
333	98.90	500	<del>((98.7))</del> 99.14
		750	<del>((98.8))</del> 99.23
		1000	<del>((98.9))</del> 99.28

<sup>a</sup> kiloVolt-Amp rating.

<sup>b</sup> Nominal efficiencies shall be established in accordance with the DOE 10 C.F.R. 431 test procedure for low voltage dry-type transformers.

**C405.7 Dwelling unit electrical energy consumption (~~((Mandatory))~~).** Each dwelling unit located in a Group R-2 building shall have a separate electrical meter. A utility tenant meter meets this requirement. See Section C409 for additional requirements for energy metering and energy consumption management.

EXCEPTION: Dwelling units in other than Group R-2 apartment and live/work units are not required to provide a separate electrical metering at each dwelling unit where electrical usage is metered separately for each of the following building end uses:

1. Dwelling units.
2. Sleeping units.
3. Commercial kitchens.
4. Central laundries.

**WAC 51-11C-40508 Section C405.8—Electric motors.**

**C405.8 Electric motor efficiency ((~~mandatory~~)).** All electric motors, fractional or otherwise, shall meet the minimum efficiency requirements of Tables C405.8(1) through C405.8(4) when tested and rated in accordance with DOE 10 C.F.R. 431. The efficiency shall be verified through certification under an approved certification program or, where no certification program exists, 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. Components sets of an electric motor.
3. Liquid-cooled electric motors.
4. Submersible electric motors.
5. Inverter-only electric motors.

Fractional hp fan motors that are 1/12 hp or greater and less than 1 hp (based on output power) which are not covered by Tables C405.8(3) and C405.8(4) shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with DOE 10 C.F.R. 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of a varying motor speed.

- EXCEPTIONS:**
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 used as a component of the equipment meeting the minimum efficiency requirements of Section C403.2.3 and Tables C403.2.3(1) through C403.2.3(10) provided that the motor input is included when determining the equipment efficiency.
  4. Motors in the airstream within fan-coils and terminal units that operate only when providing heating to the space served.
  5. Fan motors that are not covered by Tables C405.8(1) through C405.8(4) and are used to power heat recovery ventilators, energy recovery ventilators, or local exhaust fans in Group R subject to the high efficacy requirements of Section ((~~C403.2.11.4~~)) C403.8.4.
  6. Domestic clothes dryer booster fans, range hood exhaust fans, and domestic range booster fans that operate intermittently.
  7. Radon and contaminated soil exhaust fans.
  8. Group R heat recovery ventilator and energy recovery ventilator fans that are less than 400 cfm.

**((~~Table C405.8(1)~~**

**~~Minimum Nominal Full-load Efficiency for 60 Hz NEMA General Purpose Electric Motors (Subtype I) Rated 600 Volts or Less (Random Wound)~~<sup>a</sup>**

NUMBER OF POLES►	OPEN-DRIP-PROOF MOTORS			TOTALLY ENCLOSED FAN-COOLED MOTORS		
	2	4	6	2	4	6
SYNCHRONOUS SPEED (RPM)►	3600	1800	1200	3600	1800	1200
MOTOR HORSEPOWER▼						
1	77.0	85.5	82.5	77.0	85.5	82.5
1.5	84.0	86.5	86.5	84.0	86.5	87.5
2	85.5	86.5	87.5	85.5	86.5	88.5
3	85.5	89.5	88.5	86.5	89.5	89.5
5	86.5	89.5	89.5	88.5	89.5	89.5
7.5	88.5	91.0	90.2	89.5	91.7	91.0
10	89.5	91.7	91.7	90.2	91.7	91.0
15	90.2	93.0	91.7	91.0	92.4	91.7
20	91.0	93.0	92.4	91.0	93.0	91.7
25	91.7	93.6	93.0	91.7	93.6	93.0
30	91.7	94.1	93.6	91.7	93.6	93.0
40	92.4	94.1	94.1	92.4	94.1	94.1

NUMBER OF POLES►	OPEN DRIP-PROOF MOTORS			TOTALLY ENCLOSED FAN-COOLED MOTORS		
	2	4	6	2	4	6
SYNCHRONOUS SPEED (RPM)►	3600	1800	1200	3600	1800	1200
MOTOR HORSEPOWER▼						
50	93.0	94.5	94.1	93.0	94.5	94.1
60	93.6	95.0	94.5	93.6	95.0	94.5
75	93.6	95.0	94.5	93.6	95.4	94.5
100	93.6	95.4	95.0	94.1	95.4	95.0
125	94.1	95.4	95.0	95.0	95.4	95.0
150	94.1	95.8	95.4	95.0	95.8	95.8
200	95.0	95.8	95.4	95.4	96.2	95.8
250	95.0	95.8	95.4	95.8	96.2	95.8
300	95.4	95.8	95.4	95.8	96.2	95.8
350	95.4	95.8	95.4	95.8	96.2	95.8
400	95.8	95.8	95.8	95.8	96.2	95.8
450	95.8	96.2	96.2	95.8	96.2	95.8
500	95.8	96.2	96.2	95.8	96.2	95.8

<sup>a</sup> Nominal efficiencies shall be established in accordance with DOE 10 C.F.R. 431.

**Table C405.8(2)**  
**Minimum Nominal Full-load Efficiency of General Purpose Electric Motors (Subtype II) And All Design B Motors Greater Than 200 Horsepower<sup>a</sup>**

NUMBER OF POLES►	OPEN DRIP-PROOF MOTORS				TOTALLY ENCLOSED FAN-COOLED MOTORS			
	2	4	6	8	2	4	6	8
SYNCHRONOUS SPEED (RPM)►	3600	1800	1200	900	3600	1800	1200	900
MOTOR HORSEPOWER▼								
1	NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0
1.5	82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
2	84.0	84.0	85.5	85.5	84.0	84.0	86.5	82.5
3	84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
5	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
7.5	87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
10	88.5	89.5	90.2	89.5	89.5	89.5	89.5	88.5
15	89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
20	90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5
25	91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
30	91.0	92.4	92.4	91.0	91.0	92.4	91.7	91.0
40	91.7	93.0	93.0	91.0	91.7	93.0	93.0	91.0
50	92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7
60	93.0	93.6	93.6	92.4	93.0	93.6	93.6	91.7
75	93.0	94.1	93.6	93.6	93.0	94.1	93.6	93.0
100	93.0	94.1	94.1	93.6	93.6	94.5	94.1	93.0
125	93.6	94.5	94.1	93.6	94.5	94.5	94.1	93.6
150	93.6	95.0	94.5	93.6	94.5	95.0	95.0	93.6
200	94.5	95.0	94.5	93.6	95.0	95.0	95.0	94.1
250	94.5	95.4	95.4	94.5	95.4	95.0	95.0	94.5

NUMBER OF POLES►	OPEN DRIP-PROOF MOTORS				TOTALLY ENCLOSED FAN-COOLED MOTORS			
	2	4	6	8	2	4	6	8
SYNCHRONOUS SPEED (RPM)►	3600	1800	1200	900	3600	1800	1200	900
MOTOR HORSEPOWER▼								
300	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
350	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
400	95.4	95.4	NR	NR	95.4	95.4	NR	NR
450	95.8	95.8	NR	NR	95.4	95.4	NR	NR
500	95.8	95.8	NR	NR	95.4	95.8	NR	NR

<sup>a</sup> Nominal efficiencies shall be established in accordance with DOE 10 C.F.R. 431.

—NR— No requirement.))

**Table C405.8(1)**

**Minimum Nominal Full-load Efficiency for NEMA Design A, NEMA Design B and IEC Design N Motors (Excluding Fire Pump) Electric Motors at 60 Hz<sup>a, b</sup>**

Motor horsepower (Standard kilowatt equivalent)	Nominal full-load efficiency (%) as of June 1, 2016									
	2 pole		4 pole		6 pole		8 pole			
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open		
<u>1 (0.75)</u>	<u>77.0</u>	<u>77.0</u>	<u>85.5</u>	<u>85.5</u>	<u>82.5</u>	<u>82.5</u>	<u>75.5</u>	<u>75.5</u>		
<u>1.5 (1.1)</u>	<u>84.0</u>	<u>84.0</u>	<u>86.5</u>	<u>86.5</u>	<u>87.5</u>	<u>86.5</u>	<u>78.5</u>	<u>77.5</u>		
<u>2 (1.5)</u>	<u>85.5</u>	<u>85.5</u>	<u>86.5</u>	<u>86.5</u>	<u>88.5</u>	<u>87.5</u>	<u>84.0</u>	<u>86.5</u>		
<u>3 (2.2)</u>	<u>86.5</u>	<u>85.5</u>	<u>89.5</u>	<u>89.5</u>	<u>89.5</u>	<u>88.5</u>	<u>85.5</u>	<u>87.5</u>		
<u>5 (3.7)</u>	<u>88.5</u>	<u>86.5</u>	<u>89.5</u>	<u>89.5</u>	<u>89.5</u>	<u>89.5</u>	<u>86.5</u>	<u>88.5</u>		
<u>7.5 (5.5)</u>	<u>89.5</u>	<u>88.5</u>	<u>91.7</u>	<u>91.0</u>	<u>91.0</u>	<u>90.2</u>	<u>86.5</u>	<u>89.5</u>		
<u>10 (7.5)</u>	<u>90.2</u>	<u>89.5</u>	<u>91.7</u>	<u>91.7</u>	<u>91.0</u>	<u>91.7</u>	<u>89.5</u>	<u>90.2</u>		
<u>15 (11)</u>	<u>91.0</u>	<u>90.2</u>	<u>92.4</u>	<u>93.0</u>	<u>91.7</u>	<u>91.7</u>	<u>89.5</u>	<u>90.2</u>		
<u>20 (15)</u>	<u>91.0</u>	<u>91.0</u>	<u>93.0</u>	<u>93.0</u>	<u>91.7</u>	<u>92.4</u>	<u>90.2</u>	<u>91.0</u>		
<u>25 (18.5)</u>	<u>91.7</u>	<u>91.7</u>	<u>93.6</u>	<u>93.6</u>	<u>93.0</u>	<u>93.0</u>	<u>90.2</u>	<u>91.0</u>		
<u>30 (22)</u>	<u>91.7</u>	<u>91.7</u>	<u>93.6</u>	<u>94.1</u>	<u>93.0</u>	<u>93.6</u>	<u>91.7</u>	<u>91.7</u>		
<u>40 (30)</u>	<u>92.4</u>	<u>92.4</u>	<u>94.1</u>	<u>94.1</u>	<u>94.1</u>	<u>94.1</u>	<u>91.7</u>	<u>91.7</u>		
<u>50 (37)</u>	<u>93.0</u>	<u>93.0</u>	<u>94.5</u>	<u>94.5</u>	<u>94.1</u>	<u>94.1</u>	<u>92.4</u>	<u>92.4</u>		
<u>60 (45)</u>	<u>93.6</u>	<u>93.6</u>	<u>95.0</u>	<u>95.0</u>	<u>94.5</u>	<u>94.5</u>	<u>92.4</u>	<u>93.0</u>		
<u>75 (55)</u>	<u>93.6</u>	<u>93.6</u>	<u>95.4</u>	<u>95.0</u>	<u>94.5</u>	<u>94.5</u>	<u>93.6</u>	<u>94.1</u>		
<u>100 (75)</u>	<u>94.1</u>	<u>93.6</u>	<u>95.4</u>	<u>95.4</u>	<u>95.0</u>	<u>95.0</u>	<u>93.6</u>	<u>94.1</u>		
<u>125 (90)</u>	<u>95.0</u>	<u>94.1</u>	<u>95.4</u>	<u>95.4</u>	<u>95.0</u>	<u>95.0</u>	<u>94.1</u>	<u>94.1</u>		
<u>150 (110)</u>	<u>95.0</u>	<u>94.1</u>	<u>95.8</u>	<u>95.8</u>	<u>95.8</u>	<u>95.4</u>	<u>94.1</u>	<u>94.1</u>		
<u>200 (150)</u>	<u>95.4</u>	<u>95.0</u>	<u>96.2</u>	<u>95.8</u>	<u>95.8</u>	<u>95.4</u>	<u>94.5</u>	<u>94.1</u>		
<u>250 (186)</u>	<u>95.8</u>	<u>95.0</u>	<u>96.2</u>	<u>95.8</u>	<u>95.8</u>	<u>95.8</u>	<u>95.0</u>	<u>95.0</u>		
<u>300 (224)</u>	<u>95.8</u>	<u>95.4</u>	<u>96.2</u>	<u>95.8</u>	<u>95.8</u>	<u>95.8</u>				
<u>350 (261)</u>	<u>95.8</u>	<u>95.4</u>	<u>96.2</u>	<u>95.8</u>	<u>95.8</u>	<u>95.8</u>				
<u>400 (298)</u>	<u>95.8</u>	<u>95.8</u>	<u>96.2</u>	<u>95.8</u>						
<u>450 (336)</u>	<u>95.8</u>	<u>96.2</u>	<u>96.2</u>	<u>96.2</u>						
<u>500 (373)</u>	<u>95.8</u>	<u>96.2</u>	<u>96.2</u>	<u>96.2</u>						

<sup>a</sup> Nominal efficiencies shall be established in accordance with DOE 10 C.F.R. 431.

<sup>b</sup> For purposes of determining the required minimum nominal full-load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in this table, each such motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

1. A horsepower at or above the midpoint between the two consecutive horsepower shall be rounded up to the higher of the two horsepower.
2. A horsepower below the midpoint between the two consecutive horsepower shall be rounded down to the lower of the two horsepower.
3. A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kW = (1/0.746) horsepower. The conversion should be calculated to three significant decimal places, and the resulting horsepower shall be rounded in accordance with 1 or 2, whichever applies.

**Table C405.8(2)**  
**Minimum Nominal Full-load Efficiency for NEMA Design C and IEC Design**  
**H Motors at 60 Hz<sup>a, b</sup>**

Motor horsepower (Standard kilowatt equivalent)	Nominal full-load efficiency (%) as of June 1, 2016					
	4 pole		6 pole		8 pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1 (0.75)	85.5	85.5	82.5	82.5	75.5	75.5
1.5 (1.1)	86.5	86.5	87.5	86.5	78.5	77.5
2 (1.5)	86.5	86.5	88.5	87.5	84.0	86.5
3 (2.2)	89.5	89.5	89.5	88.5	85.5	87.5
5 (3.7)	89.5	89.5	89.5	89.5	86.5	88.5
7.5 (5.5)	91.7	91.0	91.0	90.2	86.5	89.5
10 (7.5)	91.7	91.7	91.0	91.7	89.5	90.2
15 (11)	92.4	93.0	91.7	91.7	89.5	90.2
20 (15)	93.0	93.0	91.7	92.4	90.2	91.0
25 (18.5)	93.6	93.6	93.0	93.0	90.2	91.0
30 (22)	93.6	94.1	93.0	93.6	91.7	91.7
40 (30)	94.1	94.1	94.1	94.1	91.7	91.7
50 (37)	94.5	94.5	94.1	94.1	92.4	92.4
60 (45)	95.0	95.0	94.5	94.5	92.4	93.0
75 (55)	95.4	95.0	94.5	94.5	93.6	94.1
100 (75)	95.4	95.4	95.0	95.0	93.6	94.1
125 (90)	95.4	95.4	95.0	95.0	94.1	94.1
150 (110)	95.8	95.8	95.8	95.4	94.1	94.1
200 (150)	96.2	95.8	95.8	95.4	94.5	94.1

NR - No requirement.

<sup>a</sup> Nominal efficiencies shall be established in accordance with DOE 10 C.F.R. 431.

<sup>b</sup> For purposes of determining the required minimum nominal full-load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in this table, each such motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

1. A horsepower at or above the midpoint between the two consecutive horsepower shall be rounded up to the higher of the two horsepower.
2. A horsepower below the midpoint between the two consecutive horsepower shall be rounded down to the lower of the two horsepower.
3. A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kW = (1/0.746) horsepower. The conversion should be calculated to three significant decimal places, and the resulting horsepower shall be rounded in accordance with 1 or 2, whichever applies.

**Table C405.8(3)**  
**Minimum Average Full Load Efficiency**  
**for Polyphase Small Electric Motors<sup>a</sup>**

OPEN MOTORS			
NUMBER OF POLES ==>	2	4	6
SYNCHRONOUS SPEED (RPM) ==>	3600	1800	1200
MOTOR HORSEPOWER ▼			
0.25	65.6	69.5	67.5
0.33	69.5	73.4	71.4
0.50	73.4	78.2	75.3
0.75	76.8	81.1	81.7
1	77.0	83.5	82.5

OPEN MOTORS			
NUMBER OF POLES ==>	2	4	6
SYNCHRONOUS SPEED (RPM) ==>	3600	1800	1200
MOTOR HORSEPOWER ▼			
1.5	84.0	86.5	83.8
2	85.5	86.5	N/A
3	85.5	86.9	N/A

<sup>a</sup> Average full load efficiencies shall be established in accordance with 10 C.F.R. 431.

**Table C405.8(4)**  
**Minimum Average Full Load Efficiency**  
**For Capacitor-start Capacitor-run**  
**and Capacitor-start Induction-run**  
**Small Electric Motors<sup>a</sup>**

OPEN MOTORS			
NUMBER OF POLES ==>	2	4	6
SYNCHRONOUS SPEED (RPM) ==>	3600	1800	1200
MOTOR HORSEPOWER ▼			
0.25	66.6	68.5	62.2
0.33	70.5	72.4	66.6
0.50	72.4	76.2	76.2
0.75	76.2	81.8	80.2
1	80.4	82.6	81.1
1.5	81.5	83.8	N/A
2	82.9	84.5	N/A
3	84.1	N/A	N/A

<sup>a</sup> Average full load efficiencies shall be established in accordance with 10 C.F.R. 431.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40509 Section C405.9—Vertical and horizontal transportation systems.**

**C405.9 Vertical and horizontal transportation systems and equipment.** Vertical and horizontal transportation systems and equipment shall comply with this section.

**C405.9.1 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 no less than 35 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 deenergize ventila-

tion fans and lighting systems when the elevator is stopped, unoccupied and with its doors closed for over 15 minutes.

**C405.9.2 Escalators and moving walks.** Escalators and moving walks shall comply with ASME A17.1/CSA B44 and shall have automatic controls configured to reduce speed to the minimum permitted speed in accordance with ASME A17.1/CSA B44 or applicable local code when not conveying passengers.

EXCEPTION: A ~~((power factor controller))~~ variable voltage drive system that reduces operating voltage in response to light loading conditions may be provided in place of the variable speed function.

**C405.9.2.1 Regenerative drive.** An escalator designed either for one-way down operation only or for reversible operation shall have a variable frequency regenerative drive that supplies electrical energy to the building electrical system when the escalator is loaded with passengers whose combined weight exceeds 750 pounds.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40510 Section C405.10—Controlled receptacles.**

**C405.10 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. In rooms larger than 200 square feet (19 m<sup>2</sup>), a controlled receptacle shall be located within 72 inches (1.8 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.

2. 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 5,000 square feet (465 m<sup>2</sup>) 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))~~ in a location with access to occupants. Any individual override switch shall control the controlled receptacles for a maximum area of 5,000 square feet (465 m<sup>2</sup>). Override switches for controlled receptacles are permitted to control the lighting within the same area.

EXCEPTION: Receptacles designated for specific equipment requiring 24-hour operation, for building maintenance functions, or for specific safety or security equipment are not required to be controlled by an automatic control device and are not required to be located within 72 inches (1.8 m) of a controlled receptacle.



AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40511** ~~((Electrical power and lighting systems commissioning and completion requirements.))~~ Section C405.11—Voltage drop in feeders and branch circuits. ~~((Electrical power and lighting systems shall be commissioned and completed in accordance with Section C408.))~~ Voltage drop in feeders and branch circuits. The total voltage drop across the combination of feeders and branch circuits shall not exceed five percent.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40512** ~~((Reserved.))~~ Section C405.12—Electrical commissioning.

C405.12 Commissioning. Controlled receptacles and lighting systems shall be commissioned in accordance with Section C408.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-40513** ~~((Section C405.13—Electrical power and lighting systems commissioning and completion requirements.))~~ Reserved.

~~((C405.13—Electrical power and lighting systems commissioning and completion requirements. Electrical power and lighting systems shall be commissioned and completed in accordance with Section C408.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40600** Section C406—~~((Additional))~~ Efficiency packages ~~((options)).~~

**C406.1** ~~((Requirements. Buildings shall comply with no less than two of the following:~~

~~1. More efficient HVAC performance in accordance with Section C406.2.~~

~~2. Reduced lighting power in accordance with Section C406.3.~~

~~3. Enhanced lighting controls in accordance with Section C406.4.~~

~~4. On-site supply of renewable energy in accordance with Section C406.5.~~

~~5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.~~

~~6. High-efficiency service water heating in accordance with Section C406.7.~~

7. Enhanced envelope performance in accordance with Section C406.8.

8. Reduced air infiltration in accordance with Section C406.9.))  
**Additional energy efficiency credit requirements.** New buildings and changes in space conditioning, change of occupancy and building additions in accordance with Chapter 5 shall comply with sufficient packages from Table C406.1 so as to achieve a minimum number of 6 credits. Mixed use buildings shall have a conditioned space area weighted average number of credits by building occupancy of at least 6 credits.

**EXCEPTIONS:**

1. Low energy spaces in accordance with Section C402.1.1.1 and equipment buildings in accordance with Section C402.1.2 shall comply with sufficient packages from Table C406.1 so as to achieve a minimum number of 3 credits from Sections C406.2 through C406.12, where applicable.
2. Building additions that have less than 1,000 square feet of conditioned floor area shall comply with sufficient packages from Table C406.1 so as to achieve a minimum number of 3 credits from Sections C406.2 through C406.12, where applicable.

**Table C406.1**  
**Efficiency Package Credits**

Code Section	Commercial Building Occupancy					
	Group R-1	Group R-2	Group B	Group E	Group M	All Other
	Additional Efficiency Credits					
1. More efficient HVAC performance in accordance with Section C406.2	2.0	3.0	3.0	2.0	1.0	2.0
2. Reduced lighting power: Option 1 in accordance with Section C406.3.1	1.0	1.0	2.0	2.0	3.0	2.0
3. Reduced lighting power: Option 2 in accordance with Section C406.3.2 <sup>a</sup>	2.0	3.0	4.0	4.0	6.0	4.0
4. Enhanced lighting controls in accordance with Section C406.4	NA	NA	1.0	1.0	1.0	1.0
5. On-site supply of renewable energy in accordance with C406.5	3.0	3.0	3.0	3.0	3.0	3.0
6. Dedicated outdoor air system in accordance with Section C406.6 <sup>b</sup>	4.0	4.0	4.0	NA	NA	4.0
7. High performance dedicated outdoor air system in accordance with Section C406.7	4.0	4.0	4.0	4.0	4.0	4.0
8. High-efficiency service water heating in accordance with Sections C406.8.1 and C406.8.2	4.0	5.0	NA	NA	NA	8.0
9. High performance service water heating in multi-family buildings in accordance with Section C406.9	7.0	8.0	NA	NA	NA	NA
10. Enhanced envelope performance in accordance with Section C406.10	3.0	6.0	3.0	3.0	3.0	4.0
11. Reduced air infiltration in accordance with Section C406.11	1.0	2.0	1.0	1.0	1.0	1.0
12. Enhanced commercial kitchen equipment in accordance with Section C406.12	5.0	NA	NA	NA	5.0	5.0 (Group A-2 only)

<sup>a</sup> Projects using this option may not use Item 2.

<sup>b</sup> This option is not available to buildings subject to the prescriptive requirements of Section C403.3.5.

**C406.1.1 Tenant spaces.** (~~(Tenant spaces)~~) Initial tenant improvement shall comply with sufficient packages from Table C406.1 so as to achieve a minimum number of three credits from Section C406.2, C406.3, C406.4, C406.6 or C406.7, where applicable. In buildings with multiple tenant spaces, each tenant space is permitted to comply individually. Where an entire building complies with Section C406.5, (~~(C406.8 or C406.9)~~) C406.10 or C406.11, tenant spaces within the building shall be deemed to comply with this section.

**EXCEPTION:** Previously occupied tenant spaces in existing buildings that comply with this code in accordance with Section C501.

AMENDATORY SECTION (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

## **WAC 51-11C-40602 Section C406.2—HVAC option.**

**C406.2 More efficient HVAC equipment and fan performance.** (~~(Buildings shall comply with Sections C406.2.1 through C406.2.3.)~~) No less than 90 percent of the total HVAC capacity serving the total conditioned floor area of the entire building, building addition, shell and core area in accordance with Section C406.1.1 or tenant space in accordance with Section C406.1.2 shall comply with Sections C406.2.1 through C406.2.3. For systems required to comply with Section C403.1.1, HVAC total system performance ratio, exceed the minimum requirement by 10 percent.

**EXCEPTION:** In low energy spaces complying with Section C402.1.1 and semi-heated spaces complying with Section C402.1.1.2, no less than 90 percent of the installed heating capacity is provided by electric infrared or gas-fired radiant heating equipment for localized heating applications. Stand-alone supply, return and exhaust fans shall comply with Section C406.2.3.

**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)~~) Equipment installed shall be types that are listed in Tables C403.2.3(1) through C403.2.3(~~(+9)~~) (12) or a combination thereof. Electric resistance heating does not meet this requirement.

**EXCEPTION:** (~~(Air-to-water heat pumps or heat recovery chillers are also permitted to be utilized for Option C406.2.)~~) Allowed equipment not listed in Tables C403.2.3(1) through C403.2.3(12):  
1. Air-to-water heat pumps.  
2. Heat recovery chillers.

**C406.2.2 Minimum equipment efficiency.** Equipment shall exceed the minimum efficiency requirements listed in Tables C403.2.3(1) through C403.2.3(~~(+9)~~) (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.

**EXCEPTIONS:**  
1. Equipment that is larger than the maximum capacity range indicated in Tables C403.2.3(1) through C403.2.3(~~((9))~~) (12) shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table.  
2. Equipment comply with the exception to Section C406.2.1 is not required to comply with the minimum equipment efficiency requirement.  
3. Compliance may be demonstrated by calculating a total weighted average percentage for all heating and cooling equipment combined. All equipment shall have efficiency that is no less than 5 percent better than the minimum required efficiency in Table C403.2.3(1) through C403.2.3(12), and the resulting weighted average percentage for all equipment performance requirements shall exceed 15 percent. Calculation shall include heating and cooling capacities for all equipment, percentage better or worse than minimum required efficiency per Tables C403.2.3(1) through C403.2.3(12) for each performance requirement (SEER, EER/IEER, COP, HSPF, E<sub>c</sub>, and AFUE), and the total weighted average efficiency percentage.  
4. Hot water boilers with input capacity greater than 2,500,000 Btu/h shall be considered to comply with this section with a minimum thermal efficiency of 95 percent E<sub>t</sub> in accordance with the test procedure in 10 C.F.R. Part 431.

**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 (~~(an energy)~~) a fan efficiency (~~(classification)~~) 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.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40603 Section C406.3—LPA option.**

**C406.3 Reduced lighting power.** ~~((Buildings shall comply with Sections C406.3.1 and, where applicable, C406.3.2.))~~ Interior lighting within the whole building, building addition or tenant space shall comply with Section C406.3.1 or Section C406.3.2. Dwelling units and sleeping units within the building shall comply with Section C406.3.3.

**C406.3.1 Reduced lighting power ((density)) Option 1.** The total connected interior lighting power ~~((watts) of the building))~~ calculated in accordance with Section C405.4.1 shall be ~~((75))~~ 90 percent or less of the lighting power values specified in Table C405.4.2(1) times the floor area for the building types, or by using ~~((75))~~ 90 percent of the total interior lighting power allowance calculated ~~((by the Space-by-Space Method))~~ in accordance with Section C405.4.2.

**C406.3.2 Reduced lighting power Option 2.** The total connected interior lighting power calculated in accordance with Section C405.4.1 shall be 80 percent or less of the lighting power values specified in Table C405.4.2(1) times the floor area of the building types, or by using 80 percent of the total interior lighting power allowance calculated in accordance with Section C405.4.2.

**C406.3.3 Lamp fraction.** ~~((Not))~~ No less than 95 percent ~~((of the interior lighting power (watts) from lamps in))~~ permanently installed light fixtures in dwelling units and sleeping units shall be provided by high efficacy lamps with a minimum efficacy of ~~((60))~~ 65 lumens per watt.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40604 Section C406.4—Lighting controls option.**

**C406.4 Enhanced digital lighting controls.** Interior 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.

1. Luminaires shall be configured for continuous dimming.
2. Each luminaire shall be individually addressed.

EXCEPTIONS TO 1. Multiple luminaires mounted on no more than 12 linear feet of a single lighting track and addressed as a single luminaire.  
ITEM 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.  
~~((3. Not more than eight luminaires within a daylight zone are permitted to be controlled by a single daylight responsive control.~~
4. Luminaires shall be controlled by a digital control system configured with the following capabilities:

- 4.1. Scheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.
- 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.
- 4.4. Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.
- 5. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.))

3. No more than eight luminaires within a *daylight zone* are permitted to be controlled by a single *daylight responsive control*.

4. Luminaires shall be controlled by a digital control system configured with the following capabilities:

4.1. Scheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.

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.

4.4. Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.

5. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40605 Section C406.5—On-site renewable energy option.**

**C406.5 On-site renewable energy.** Buildings shall be provided with on-site renewable energy systems with an annual energy production per square foot (~~of conditioned floor area of the building or not~~) of no less than the value specified in Table C406.5 based on the total conditioned floor area of the whole building. The on-site renewable used in this option shall be separate from on-site renewables used as part of Section C406.7 or used to qualify for any exception in this code.

**Table C406.5**  
**On-Site Renewable Energy System Rating**  
**(per square foot)**

Building Area Type	kBtu/year	kWh/year
Assembly	1.8	0.53
Dining	10.7	3.14
Hospital	3.6	1.06
Hotel/Motel	2.0	0.59
Multifamily residential	0.50	0.15
Office	0.82	0.24
Other	2.02	0.59
Retail	1.31	0.38
School/University	1.17	0.34
Supermarket	5.0	1.47

Building Area Type	kBtu/year	kWh/year
Warehouse	0.43	0.13

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40606 Section C406.6—DOAS option.**

**C406.6 Dedicated outdoor air system (DOAS).** Not less than 90((%)) per cent of the ((building)) total conditioned floor area of the whole building, building addition or tenant space, excluding floor area of unoccupied spaces that do not require ventilation per the *International Mechanical Code*, shall be served by DOAS installed in accordance with Section ((C403.6)) C403.3.5. This option is not available to ((both)) buildings subject to ((and not subject to)) the prescriptive requirements of Section ((C403.6)) C403.3.5.

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-40607 Section C406.7—((Service water heating)) High performance dedicated outdoor air system option.**

**C406.7 ((Reduced energy use in service water heating.** Buildings shall comply with Sections C406.7.1 and C406.7.2.

**C406.7.1 Building type.** Not less than 90 percent of the 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 buildings containing food preparation areas.
4. Group F: Laundries.
5. Group R-2: Buildings with residential occupancies.
6. Group A-3: Health clubs and spas.
7. Buildings with a service hot water load of 10 percent or more of total building energy loads, as shown with an energy analysis as described in Section C407.

**C406.7.2 Load fraction.** Not less than 60 percent of the annual building service hot water heating energy use, or not less than 100 percent of the annual building service hot water heating energy use in buildings subject to the requirements of Section C403.5.4, shall be provided by one or more of the following:

1. Service hot water system delivering heating requirements using heat pump technology with a minimum COP of 3.0.
2. Waste heat recovery from service hot water, heat recovery chillers, building equipment, process equipment, a combined heat and power system, or other approved system.
3. Solar water heating systems.) High performance dedicated outdoor air system (DOAS). Buildings which include DOAS complying with Section C403.3.5 or C406.6 shall also provide minimum sensible effec-

tiveness of heat recovery of 80 percent and DOAS total combined fan power less than 0.5 W/cfm of outdoor air. For the purpose of this section, total combined fan power includes all supply, exhaust, recirculation and other fans utilized for the purpose of ventilation.

AMENDATORY SECTION (Amending WSR 19-02-089, filed 1/2/19, effective 7/1/19)

**WAC 51-11C-40608 Section C406.8—((Envelope)) Service water heating option.**

**C406.8 ((Enhanced envelope performance.** ~~The Proposed Total Envelope UA of the building thermal envelope shall be 15 percent lower than the Allowed Total Envelope UA for a building of identical configuration and fenestration area in accordance with Section C402.1.5 and Equation 4-2.)~~ **Reduced energy use in service water heating.** Buildings with service hot water heating equipment that serves the whole building, building addition or tenant space shall comply with Sections C406.8.1 and C406.8.2.

**C406.8.1 Building type.** 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 buildings containing food preparation areas.
4. Group F: Laundries.
5. Group R-2.
6. Group A-3: Health clubs and spas.
7. Buildings with a service hot water load of 10 percent or more of total building energy loads, as shown with an energy analysis as described in Section C407 or as shown through alternate service hot water load calculations showing a minimum service water energy use of 15 k/Btu per square foot per year, as approved by the building official.

**C406.8.2 Load fraction.** Not less than 60 percent of the annual service hot water heating energy use, or not less than 100 percent of the annual service hot water heating energy use in buildings with water-cooled systems subject to the requirements of Section C403.9.5 or qualifying for one of its exceptions, shall be provided by one or more of the following:

1. Service hot water system delivering heating requirements using heat pump technology with a minimum COP of 3.0. For air-source equipment, the COP rating will be reported at the design leaving heat pump water temperature with an entering air temperature of 60°F (15.6°C) or lower. For water-source equipment, the COP rating will be reported at the design leaving load water temperature with an entering water temperature of 74°F (23.3°C) or lower.
2. Waste heat recovery from service hot water, heat recovery chillers, building equipment, process equipment, or other approved system. Qualifying heat recovery must be above and beyond heat recovery required by other sections of this code.
3. On-site renewable energy water-heating systems.

**WAC 51-11C-40609 Section C406.9—(~~(Air infiltration)~~) High performance service water heating in multifamily option.**

~~((C406.9 Reduced air infiltration. Air infiltration shall be verified by whole building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air leakage rate of the building envelope shall not exceed 0.25 cfm/ft<sup>2</sup> (2.0 L/s•m<sup>2</sup>) under a pressure differential of 0.3 in. water (75 Pa), with the calculated surface area being the sum of the above and below grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.~~

EXCEPTION: Where the conditioned floor area of the building is not less than 250,000 ft<sup>2</sup> (25,000 m<sup>2</sup>), air leakage testing shall be permitted to be conducted on representative above grade sections of the building provided the conditioned floor area of tested areas is no less than 25 percent of the conditioned floor area of the building and are tested in accordance with this section.))

**C406.9 High performance service water heating in multifamily buildings.** For buildings with not less than 90 percent of the conditioned floor area being Group R-2 occupancy, not less than 90 percent of the annual building service hot water energy use shall be provided by a heat pump system with a minimum COP of 3.0. This efficiency package is allowed to be taken in addition to Section C406.8.2.

NEW SECTION

**WAC 51-11C-40610 Section C406.10—Envelope option.**

**C406.10 Enhanced envelope performance.** The Proposed Total Envelope UA of the thermal envelope of the whole building or building addition shall be 15 percent lower than the Allowable Total Envelope UA for an area of identical configuration and fenestration area in accordance with Section C402.1.5 and Equation 4-2.

NEW SECTION

**WAC 51-11C-40611 Section C406.11—Air infiltration option.**

**C406.11 Reduced air infiltration.** Measured air infiltration of the total conditioned floor area of the whole building or fully isolated building addition shall comply with Section C406.11.1.

**C406.11.1 Air leakage testing and verification.** Air infiltration shall be verified by whole building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air leakage rate of the building envelope shall not exceed 0.17 cfm/ft<sup>2</sup> under a pressure differential of 0.3 in. water (75 Pa), with the calculated surface area being the sum of the above and below grade building envelope. A report that includes the tested sur-



face area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

EXCEPTION: Where the *conditioned floor area* of the building is not less than 250,000 ft<sup>2</sup> (25,000 m<sup>2</sup>), air leakage testing shall be permitted to be conducted on representative above grade sections of the building provided the *conditioned floor area* of tested areas is no less than 25 percent of the *conditioned floor area* of the building and are tested in accordance with this section.

## NEW SECTION

### **WAC 51-11C-40612 Section C406.12—Commercial kitchen option.**

**C406.12 Enhanced 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 with at least one gas or electric fryer, all fryers, dishwashers, steam cookers and ovens shall comply with all of the following:

1. Achieve the ENERGY STAR label in accordance with the specifications current as of January 1, 2018.
2. Be installed prior to the issuance of the certificate of occupancy.
3. Have the ENERGY STAR qualified model number listed on the construction documents submitted for permitting.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

### **WAC 51-11C-40701 Section C407.1—Scope.**

**C407.1 Scope.** This section establishes criteria for compliance using total building performance. All systems and loads shall be included in determining the total building performance including, but not limited to: Heating systems, cooling systems, service water heating, fan systems, lighting power, receptacle loads and process loads.

EXCEPTION: Energy used to recharge or refuel vehicles that are used for on-road and off-site transportation purposes.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

### **WAC 51-11C-40702 Section C407.2—Mandatory requirements.**

**C407.2 Mandatory requirements.** Compliance with this section requires (~~(that the criteria of Sections C402.5, C403.2, C404 and C405 be met)~~) compliance with those sections shown in Table C407.2.

The building permit application for projects utilizing this method shall include in one submittal all building and mechanical drawings and all information necessary to verify that the building envelope and mechanical design for the project corresponds with the annual energy analysis. If credit is proposed to be taken for lighting energy savings, then an electrical permit application shall also be submitted and approved prior to the issuance of the building permit. If credit

is proposed to be taken for energy savings from other components, then the corresponding permit application (e.g., plumbing, boiler, etc.) shall also be submitted and approved prior to the building permit application. Otherwise, components of the project that would not be approved as part of a building permit application shall be modeled the same in both the proposed building and the *standard reference design* and shall comply with the requirements of this code.

**Table C407.2**  
**Mandatory Compliance Measures for**  
**Total Building Performance Method**

<b><u>Section</u></b>	<b><u>Title</u></b>	<b><u>Comments</u></b>
<b><u>Envelope</u></b>		
<u>C402.5</u>	<u>Air leakage</u>	
<b><u>Mechanical</u></b>		
<u>C403.1.2</u>	<u>Calculation of heating and cooling loads</u>	
<u>C403.1.3</u>	<u>Data centers</u>	
<u>C403.2</u>	<u>System design</u>	
<u>C403.3.1</u>	<u>Equipment and system sizing</u>	
<u>C403.3.2</u>	<u>HVAC equipment performance requirements</u>	
<u>C403.3.6</u>	<u>Ventilation for Group R occupancy</u>	
<u>C403.4</u>	<u>HVAC system controls</u>	
<u>C403.4.1</u>	<u>Thermostatic controls</u>	<u>Except for C403.4.1.4</u>
<u>C403.4.2</u>	<u>Off-hour controls</u>	<u>Except for Group R</u>
<u>C403.4.7</u>	<u>Combustion heating equipment controls</u>	
<u>C403.4.8</u>	<u>Group R-1 hotel/motel guestrooms</u>	<u>See Section C403.7.6</u>
<u>C403.4.9</u>	<u>Group R-2 and R-3 dwelling units</u>	
<u>C403.4.10</u>	<u>Group R-2 sleeping units</u>	
<u>C403.4.11</u>	<u>Direct digital control systems</u>	
<u>C403.5.5</u>	<u>Economizer fault detection and diagnostics (FDD)</u>	
<u>C403.7</u>	<u>Ventilation and exhaust systems</u>	<u>Except for C403.7.6</u>
<u>C403.8</u>	<u>Fan and fan controls</u>	
<u>C403.9.1.1</u>	<u>Variable flow controls</u>	<u>For cooling tower fans <math>\geq 7.5</math> hp</u>
<u>C403.9.1.2</u>	<u>Limitation on centrifugal fan cooling towers</u>	<u>For open cooling towers</u>

<u>Section</u>	<u>Title</u>	<u>Comments</u>
<u>C403.10</u>	<u>Construction of HVAC elements</u>	
<u>C403.11</u>	<u>Mechanical systems located outside of the building thermal envelope</u>	
<b><u>Service Water Heating</u></b>		
<u>C404</u>	<u>Service water heating</u>	
<b><u>Lighting and Electrical</u></b>		
<u>C405.1</u>	<u>General</u>	
<u>C405.2</u>	<u>Lighting controls</u>	
<u>C405.3</u>	<u>Exit signs</u>	
<u>C405.4</u>	<u>Interior lighting power</u>	
<u>C405.5</u>	<u>Exterior building lighting power</u>	
<u>C405.6</u>	<u>Electrical transformers</u>	
<u>C405.7</u>	<u>Dwelling unit energy consumption</u>	
<u>C405.8</u>	<u>Electric motor efficiency</u>	
<u>C405.9</u>	<u>Vertical and horizontal transportation</u>	
<u>C405.10</u>	<u>Controlled receptacles</u>	
<u>C405.11</u>	<u>Voltage drop in feeders</u>	
<b><u>Other Requirements</u></b>		
<u>C407</u>	<u>Total building performance</u>	
<u>C408</u>	<u>System commissioning</u>	
<u>C409</u>	<u>Energy metering</u>	
<u>C410</u>	<u>Refrigeration requirements</u>	

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40703 Section C407.3—Performance-based compliance.**

**C407.3 Performance-based compliance.** ~~Compliance ((based on total building performance requires that a proposed building (proposed design) be shown to have an annual energy consumption based on site energy expressed in Btu and Btu per square foot of conditioned floor area that complies with one of the following three options:~~

~~1. Is less than or equal to 87 percent of the annual energy consumption of the standard reference design.~~

2. Is less than or equal to 90 percent of the annual energy consumption of the *standard reference design* and the project complies with one additional energy efficiency package option in Section C406. The *standard reference design* shall include the selected Section C406 additional efficiency package option unless the option selected is DOAS per Section C406.6. For office, retail, education, libraries and fire stations that comply with the DOAS requirements in Section C403.6 with or without exceptions, the *standard reference design* shall select the HVAC system per Table C407.5.1(2). Other building occupancy types that comply with the DOAS requirements in Section C403.6 shall select the *standard reference design* for the HVAC system from Table C407.5.1(3).

3. Is less than or equal to 93 percent of the annual energy consumption of the *standard reference design* and the project complies with two additional efficiency package options in Section C406. The *standard reference design* shall include the selected Section C406 additional efficiency package option unless the option selected is DOAS per Section C406.6. For office, retail, education, libraries and fire stations that comply with the DOAS requirements in Section C403.6 with or without exceptions, the *standard reference design* shall select the HVAC system per Table C407.5.1(2). Other building occupancy types that comply with the DOAS requirements in Section C403.6 shall select the *standard reference design* for the HVAC system from Table C407.5.1(3).)) with this section requires compliance with ASHRAE Standard 90.1 Appendix G, Performance Rating Method, in accordance with Standard 90.1 Section 4.2.1 with the following modifications:

1. The mandatory requirements of Section G1.2.1a of Standard 90.1 are not required to be met.

2. The reduction in annual carbon emissions of the proposed building design associated with on-site renewable energy shall not be more than 3 percent of the total carbon emissions of the baseline building design.

3. References to energy cost in Section 4.2.1.1 and Appendix G shall be replaced by carbon emissions calculated by multiplying site energy consumption by the carbon emission factor from Table C407.3(1).

4. The building performance factors in Table C4.2.1.1 shall be replaced with those in Table C407.3(2).

**C407.3.1 Limits on nonmandatory measures.** The Proposed Total Envelope UA of the proposed building shall be no more than 20 percent higher than the Allowed Total Envelope UA as defined in Section C402.1.5.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-40704 Section C407.4—((Documentation)) Reserved.**

~~((C407.4 Documentation. Documentation verifying that the methods and accuracy of compliance software tools conform to the provisions of this section shall be provided to the code official.~~

**C407.4.1 Compliance report.** Building permit submittals shall include a report that documents that the *proposed design* has annual energy consumption less than or equal to the annual energy consumption of the

~~standard reference design. The compliance documentation shall include the following information:~~

- ~~1. Address of the building;~~
- ~~2. An inspection checklist documenting the building component characteristics of the proposed design as listed in Table C407.5.1(1). The inspection checklist shall show the estimated annual energy consumption for both the standard reference design and the proposed design;~~
- ~~3. Name of individual completing the compliance report; and~~
- ~~4. Name and version of the compliance software tool.~~

**C407.4.2 Additional documentation.** ~~The code official shall be permitted to require the following documents:~~

- ~~1. Documentation of the building component characteristics of the standard reference design;~~
- ~~2. Thermal zoning diagrams consisting of floor plans showing the thermal zoning scheme for standard reference design and proposed design;~~
- ~~3. Input and output report(s) from the energy analysis simulation program containing the complete input and output files, as applicable. The output file shall include energy use totals and energy use by energy source and end-use served, total hours that space conditioning loads are not met and any errors or warning messages generated by the simulation tool as applicable;~~
- ~~4. An explanation of any error or warning messages appearing in the simulation tool output; and~~
- ~~5. A certification signed by the builder providing the building component characteristics of the proposed design as given in Table C407.5.1(1).))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40705 Section C407.5—(~~Calculation procedure~~) Re-served.**

~~((C407.5 Calculation procedure. Except as specified by this section, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques.~~

**C407.5.1 Building specifications.** ~~The standard reference design and proposed design shall be configured and analyzed as specified by Table C407.5.1(1). Table C407.5.1(1) shall include by reference all notes contained in Table C402.1.4.~~

**C407.5.2 Thermal blocks.** ~~The standard reference design and proposed design shall be analyzed using identical thermal blocks as specified in Section C407.5.2.1, C407.5.2.2 or C407.5.2.3.~~

**C407.5.2.1 HVAC zones designed.** ~~Where HVAC zones are defined on HVAC design drawings, each HVAC zone shall be modeled as a separate thermal block.~~

EXCEPTION: Different HVAC zones shall be allowed to be combined to create a single thermal block or identical thermal blocks to which multipliers are applied provided:

1. The space-use classification is the same throughout the thermal block.
2. All HVAC zones in the thermal block that are adjacent to glazed exterior walls face the same orientation or their orientations are within 45 degrees (0.79 rad) of each other.
3. All of the zones are served by the same HVAC system or by the same kind of HVAC system.

**C407.5.2.2 HVAC zones not designed.** Where HVAC zones have not yet been designed, thermal blocks shall be defined based on similar internal load densities, occupancy, lighting, thermal and temperature schedules, and in combination with the following guidelines:

1. Separate thermal blocks shall be assumed for interior and perimeter spaces. Interior spaces shall be those located more than 15 feet (4572 mm) from an exterior wall. Perimeter spaces shall be those located closer than 15 feet (4572 mm) from an exterior wall.

2. Separate thermal blocks shall be assumed for spaces adjacent to glazed exterior walls: A separate zone shall be provided for each orientation, except orientations that differ by no more than 45 degrees (0.79 rad) shall be permitted to be considered to be the same orientation. Each zone shall include floor area that is 15 feet (4572 mm) or less from a glazed perimeter wall, except that floor area within 15 feet (4572 mm) of glazed perimeter walls having more than one orientation shall be divided proportionately between zones.

3. Separate thermal blocks shall be assumed for spaces having floors that are in contact with the ground or exposed to ambient conditions from zones that do not share these features.

4. Separate thermal blocks shall be assumed for spaces having exterior ceiling or roof assemblies from zones that do not share these features.

**C407.5.2.3 Multifamily residential buildings.** Residential spaces shall be modeled using one thermal block per space except that those facing the same orientations are permitted to be combined into one thermal block. Corner units and units with roof or floor loads shall only be combined with units sharing these features.

**C407.5.3 Equipment efficiencies.** All HVAC equipment in the standard reference design shall be modeled at the minimum efficiency levels, both part load and full load, in accordance with Section C403.2.3. Chillers shall use Path A efficiencies as shown in Table C403.2.3(7). Where efficiency ratings include supply fan energy, the efficiency rating shall be adjusted to remove the supply fan energy. For Baseline Systems HVAC Systems 3, 4, 6, 8, 9, 10 and 11, calculate the minimum  $COP_{nfc}$  and  $COP_{nfh}$  using the equation for the applicable performance rating as indicated in Tables C403.2.3(1) through C403.2.3(3). Where a full- and part-load efficiency rating is provided in Tables C403.2.3(1) through C403.2.3(3), use Equation 4-12.

**(Equation 4-12)**

$$COP_{nfc} = 7.84E-8 \times EER \times Q + 0.338 \times EER$$

$$COP_{nfc} = 0.0076 \times SEER^2 + 0.3796 \times SEER$$

$$COP_{nfh} = 1.48E-7 \times COP_{47} \times Q + 1.062 \times COP_{47} \text{ (applies to heat pump heating efficiencies only)}$$

$$COP_{nfh} = 0.0296 \times HSPF^2 + 0.7134 \times HSPF$$

Where:

$COP_{nfc}$  = The packaged HVAC equipment cooling energy efficiency.

$COP_{nfh}$  = The packaged HVAC equipment heating energy efficiency.

Q = The AHRI-rated cooling capacity in Btu/h.

EER, SEER, COP and HSPF shall be at AHRI test conditions. Fan energy shall be modeled separately according to Table C407.5.1(1).))

**WAC 51-11C-407051 ~~Tables ((C407.5.1(1)—Specifications for the standard reference and proposed design)) for Section C407.5—Carbon emissions factors and building performance factors.~~**

**~~((Table C407.5.1(1)) Specifications for the Standard Reference and Proposed Designs~~**

<b>Building Component Characteristics</b>	<b>Standard Reference Design</b>	<b>Proposed Design</b>
Space-use classification	Same as proposed	The space-use classification shall be chosen in accordance with Table C405.4.2 for all areas of the building covered by this permit. Where the space-use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: Insulation entirely above deck Gross area: Same as proposed <i>U</i> -factor: From Table C402.1.4 Solar absorptance: 0.75 Emittance: 0.90	As proposed As proposed As proposed As proposed As proposed
Walls, above-grade	Type: Mass wall if proposed wall is mass; otherwise steel-framed wall Gross area: Same as proposed <i>U</i> -factor: From Table C402.1.4 Solar absorptance: 0.75 Emittance: 0.90	As proposed As proposed As proposed As proposed As proposed
Walls, below-grade	Type: Mass wall Gross area: Same as proposed <i>U</i> -Factor: From Table C402.1.4 with insulation layer on interior side of walls	As proposed As proposed As proposed
Floors, above-grade	Type: Joist/framed floor Gross area: Same as proposed <i>U</i> -factor: From Table C402.1.4	As proposed As proposed As proposed
Floors, slab-on-grade	Type: Unheated <i>F</i> -factor: From Table C402.1.4	As proposed As proposed
Opaque Doors	Type: Swinging Area: Same as proposed <i>U</i> -factor: From Table C402.1.4	As proposed As proposed As proposed
Vertical Fenestration Other than opaque doors	Area  1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 30 percent of above-grade wall area. 2. 30 percent of above-grade wall area; where the proposed vertical fenestration area is 30 percent or more of the above-grade wall area. <i>U</i> -factor: From Table C402.4 for the same framing material as proposed	As proposed         As proposed

Building Component Characteristics	Standard Reference Design	Proposed Design
	SHGC: From Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used External shading and PF: None	As proposed  As proposed
Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than 3 percent of gross area of roof assembly. 2. 3 percent of gross area of roof assembly; where the proposed skylight area is 3 percent or more of gross area of roof assembly. <i>U</i> -factor: From Table C402.4 SHGC: From Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed  As proposed  As proposed
Air leakage	For infiltration, the air leakage rate as determined below shall be modeled at 100% when the building fan system is off, and at 25% when the building fan system is on, unless otherwise approved by the building official for unusually pressurized buildings. Per PNNL Report 18898, Infiltration Modeling Guidelines for Commercial Building Energy Analysis, the building air leakage rates as determined in accordance with Section C402.5.1.2 at 0.30 in. w.g. (75 Pa) shall be converted for modeling in annual energy analysis programs by being multiplied by 0.112 unless other multipliers are approved by the building official (e.g., a tested air leakage of 0.40 cfm/ft <sup>2</sup> of total building envelope area at 0.30 in. w.g. (75 Pa) would be calculated at 0.045 cfm/ft <sup>2</sup> of building envelope area). The calculated infiltration rate shall be normalized to the input required by the modeling software.	The Proposed Design air-leakage rate shall be the same as the Standard Design.
Lighting, interior	The interior lighting power shall be determined in accordance with Table C405.4.2. As proposed when the occupancy of the space is not known.  Automatic lighting controls (e.g., programmable controls or automatic controls for daylight utilization) shall be modeled in the <i>standard reference design</i> as required by Section C405.	As proposed; where the occupancy of the space is not known, the lighting power density shall be based on the space classification as offices in Table C405.4.2(1).
Lighting, exterior	The lighting power shall be determined in accordance with Table C405.5.2(2). Areas and dimensions of tradable and nontradable surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. All end-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: Exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.



Building Component Characteristics	Standard Reference Design	Proposed Design
Schedules	Same as proposed	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
Outdoor airflow rates	Same as proposed, or no higher than those allowed by Section C403.2.6 (without exception 1), whichever is less.  Demand control ventilation: Shall be modeled as required by Section C403.6 including reduction to the minimum ventilation rate when unoccupied.	As proposed, in accordance with Section C403.2.6.  As proposed
Heating systems	Fuel type: Same as proposed design  Equipment type <sup>a</sup> : From Tables C407.5.1(2), C407.5.1(3), and C407.5.1(4)  Efficiency: From Tables C403.2.3(2), C403.2.3(3), C403.2.3(4) and C403.2.3(5)  Preheat coils: For HVAC system numbers 1 through 4, a preheat coil shall be modeled controlled to a fixed setpoint 20°F less than the design room heating temperature setpoint.  Capacity <sup>b</sup> : Sized proportionally to the capacities in the proposed design based on sizing runs, i.e., the ratio between the capacities used in the annual simulations and the capacities determined by the sizing runs shall be the same for both the proposed design and <i>standard reference design</i> , and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.  Weather conditions used in sizing runs to determine <i>standard reference design</i> equipment capacities may be based either on hourly historical weather files containing typical peak conditions or on design days developed using 99.6% heating design temperatures and 1% dry-bulb and 1% wet-bulb cooling design temperatures.	As proposed  As proposed  As proposed          As proposed
Cooling systems	Fuel type: Same as proposed design  Equipment type <sup>c</sup> : From Tables C407.5.1(2), C407.5.1(3), and C407.5.1(4)  Efficiency: From Tables C403.2.3(1), C403.2.3(2) and C403.2.3(3). Chillers shall use Path A efficiency.	As proposed  As proposed  As proposed

Building Component Characteristics	Standard Reference Design	Proposed Design
	<p>Capacity<sup>b</sup>: Sized proportionally to the capacities in the proposed design based on sizing runs, i.e., the ratio between the capacities used in the annual simulations and the capacities determined by the sizing runs shall be the same for both the proposed design and <i>standard reference design</i>, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design.</p> <p>Economizer<sup>d</sup>: In accordance with Section C403.3: The high-limit shutoff shall be a dry-bulb switch with a setpoint as determined by Table C403.3.3.3.</p>	<p>As proposed</p> <p>As proposed</p>
Energy recovery	<i>Standard reference design</i> systems shall be modeled where required in Section C403.5.	As proposed
Fan systems	<p>Airflow rate: System design supply airflow rates for the <i>standard reference design</i> shall be based on a supply air-to-room air temperature difference of 20°F or the required ventilation air or makeup air, whichever is greater. If return or relief fans are specified in the proposed design, the <i>standard reference design</i> shall also be modeled with fans serving the same functions and sized for the <i>standard reference design</i> system supply fan air quantity less the minimum outdoor air, or 90% of the supply fan air quantity, whichever is larger.</p> <p>Motor brake horsepower: System fan electrical power for supply, return, exhaust, and relief (excluding power to fan-powered VAV boxes) shall be calculated using the following formulas:  For systems 5, 7, 8 and 10 in Table C407.5.1(4);  <math>P_{fan} = CFM_s \times 0.3</math>  For all other systems, including DOAS;  <math>P_{fan} = bhp \times 746 / \text{Fan Motor Efficiency}</math>  Where:  <math>P_{fan}</math> = Electric power to fan motor (watts)  <math>bhp</math> = Brake horsepower of <i>standard reference design</i> fan motor from Table C403.2.12.1(1)–Option 2  Fan motor = The efficiency from Tables C405.8(1) through C405.8(4) for the efficiency next motor size greater than the <math>bhp</math> using the enclosed motor at 1800 rpm  <math>CFM_s</math> = The <i>standard reference design</i> system maximum design supply fan airflow rate in cfm.</p>	<p>As proposed</p> <p>As proposed</p>
On-site renewable energy	No on-site renewable energy shall be modeled in the <i>standard reference design</i> .	As proposed
Shading from adjacent structures/terrain	Same as proposed.	For the <i>standard reference design</i> and the proposed building, shading by permanent structures and terrain shall be taken into account for computing energy consumption whether or not these features are located on the building site. A permanent fixture is one that is likely to remain for the life of the proposed design.
Service water heating	<p>Fuel type: Same as proposed</p> <p>Efficiency: From Table C404.2 and per Section C404.2.1</p> <p>Capacity: Same as proposed</p>	<p>As proposed</p> <p>As proposed</p>



<b><u>Building Area Type</u></b>	<b><u>Building Performance Factor</u></b>
<u>Multifamily</u>	<u>0.58</u>
<u>Healthcare/hospital</u>	<u>0.54</u>
<u>Hotel/motel</u>	<u>0.64</u>
<u>Office</u>	<u>0.56</u>
<u>Restaurant</u>	<u>0.70</u>
<u>Retail</u>	<u>0.47</u>
<u>School</u>	<u>0.36</u>
<u>Warehouse</u>	<u>0.48</u>
<u>All others</u>	<u>0.54</u>

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-407052 ((Table C407.5.1(2)/(3) HVAC systems map.))**  
**Reserved.**

**((Table C407.5.1(2) HVAC Systems Map for Buildings Governed by Section C403.6<sup>d</sup>**

<b>Condenser Cooling Source<sup>a</sup></b>	<b>Heating System Classification<sup>b</sup></b>	<b>Standard Reference Design HVAC System Type</b>
Water/ground	Electric resistance	System 5
	Heat pump	System 6
	Fossil fuel	System 7
Air/none	Electric resistance	System 9
	Heat pump	System 9
	Fossil fuel	System 11

a Select "water/ground" if the proposed design system condenser is water or evaporatively cooled; select "air/none" if the condenser is air cooled. Closed-circuit dry coolers shall be considered air cooled. Systems utilizing district cooling shall be treated as if the condenser water type were "water." If no mechanical cooling is specified or the mechanical cooling system in the proposed design does not require heat rejection, the system shall be treated as if the condenser water type were "Air." For proposed designs with ground-source or groundwater-source heat pumps, the standard reference design HVAC system shall be water-source heat pump (System 6).

b Systems utilizing district heating (steam or hot water) or district cooling and systems with no heating capability shall be treated as if the heating system type were "fossil fuel" for the purpose of Standard Reference Design HVAC system selection. Otherwise, select the path that corresponds to the proposed design heat source: Electric resistance, heat pump (including air source and water source), or fuel fired. For systems with mixed fuel heating sources, the system or systems that use the secondary heating source type (the one with the smallest total installed output capacity for the spaces served by the system) shall be modeled identically in the standard reference design and the primary heating source type shall be used to determine *standard reference design* HVAC system type.

c Reserved.

d This table covers those building types required by Section C403.6 to install Dedicated Outdoor Air Systems: Office, retail, education, libraries and fire stations.

**Table C407.5.1(3)**  
**HVAC Systems Map for All Other Buildings**

<b>Condenser Cooling Source<sup>a</sup></b>	<b>Heating System Classification<sup>b</sup></b>	<b>Standard Reference Design HVAC System Type<sup>c</sup></b>		
		<b>Single-Zone Residential System</b>	<b>Single-Zone Nonresidential System</b>	<b>All Other</b>
Water/ground	Electric resistance	System 5	System 5	System 1
	Heat pump	System 6	System 6	System 6
	Fossil fuel	System 7	System 7	System 2
Air/none	Electric resistance	System 8	System 9	System 3
	Heat pump	System 8	System 9	System 3

Condenser-Cooling Source <sup>a</sup>	Heating-System Classification <sup>b</sup>	Standard-Reference-Design HVAC System-Type <sup>c</sup>		
		Single-Zone Residential-System	Single-Zone Nonresidential-System	All-Other
	Fossil-fuel	System-10	System-11	System-4

- a Select "water/ground" if the proposed design system condenser is water or evaporatively cooled; select "air/none" if the condenser is air cooled. Closed-circuit dry coolers shall be considered air cooled. Systems utilizing district cooling shall be treated as if the condenser water type were "water." If no mechanical cooling is specified or the mechanical cooling system in the proposed design does not require heat rejection, the system shall be treated as if the condenser water type were "Air." For proposed designs with ground-source or groundwater-source heat pumps, the standard reference design HVAC system shall be water-source heat pump (System 6).
- b Systems utilizing district heating (steam or hot water) or district cooling and systems with no heating capability shall be treated as if the heating system type were "fossil-fuel" for the purpose of Standard Reference Design HVAC system selection. Otherwise, select the path that corresponds to the proposed design heat source: Electric resistance, heat pump (including air source and water source), or fuel-fired. For systems with mixed-fuel heating sources, the system or systems that use the secondary heating source type (the one with the smallest total installed output capacity for the spaces served by the system) shall be modeled identically in the standard reference design and the primary heating source type shall be used to determine *standard reference design* HVAC system type.
- c Select the *standard reference design* HVAC system category: The system under "single-zone Group R system" shall be selected if the HVAC system in the proposed design is a single-zone system and serves a residential space. The system under "single-zone other than Group R system" shall be selected if the HVAC system in the proposed design is a single-zone system and serves other than Group R spaces. The system under "all other" shall be selected for all other cases.)

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-407053 ((Table C407.5.1(4) Specifications for the standard reference design HVAC system description.)) Reserved.**

**((Table C407.5.1(4) Specifications for the Standard Reference Design HVAC System Descriptions**

System No.	System-Type	Fan-Control	Cooling-Type	Heating-Type
1	Variable air volume with parallel fan-powered boxes <sup>a</sup>	VAV <sup>d</sup>	Chilled water <sup>e</sup>	Electric resistance
2	Variable air volume with reheat <sup>b</sup>	VAV <sup>d</sup>	Chilled water <sup>e</sup>	Hot water fossil fuel boiler <sup>f</sup>
3	Packaged variable air volume with parallel fan-powered boxes <sup>a</sup>	VAV <sup>d</sup>	Direct expansion <sup>c</sup>	Electric resistance
4	Packaged variable air volume with reheat <sup>b</sup>	VAV <sup>d</sup>	Direct expansion <sup>c</sup>	Hot water fossil fuel boiler <sup>f</sup>
5	Two-pipe fan-coil	Constant volume <sup>i,j</sup>	Chilled water <sup>e</sup>	Electric resistance
6	Water-source heat pump	Constant volume <sup>i,j</sup>	Direct expansion <sup>c</sup>	Electric heat pump and boiler <sup>g</sup>
7k	Four-pipe fan-coil	Constant volume <sup>i,j</sup>	Chilled water <sup>e</sup>	Hot water fossil fuel boiler <sup>f</sup>
8k	Packaged terminal heat pump	Constant volume <sup>i,j</sup>	Direct expansion <sup>c</sup>	Electric heat pump <sup>h</sup>
9k	Packaged rooftop heat pump	Constant volume <sup>i,j</sup>	Direct expansion <sup>c</sup>	Electric heat pump <sup>h</sup>
10k	Packaged terminal air conditioner	Constant volume <sup>i,j</sup>	Direct expansion	Hot water fossil fuel boiler <sup>f</sup>
11k	Packaged rooftop air conditioner	Constant volume <sup>i,j</sup>	Direct expansion	Fossil fuel furnace

For SI: 1 foot = 304.8 mm, 1 cfm/ft<sup>2</sup> = 0.0004719, 1 Btu/h = 0.293/W, °C = [(°F) - 32]/1.8].

- a **VAV with parallel boxes:** Fans in parallel VAV fan-powered boxes shall be sized for 50 percent of the peak design flow rate and shall be modeled with 0.35 W/cfm fan power. Minimum volume setpoints for fan-powered boxes shall be equal to the minimum rate for the space required for ventilation consistent with Section C403.4.4, Exception 4. Supply air temperature shall be reset based on zone demand. Design airflow rates shall be sized for the maximum reset supply air temperature. The air temperature for cooling shall be reset higher by 5°F under the minimum cooling load conditions.
- b **VAV with reheat:** Minimum volume setpoints for VAV reheat boxes shall be 0.4 cfm/ft<sup>2</sup> of floor area. Supply air temperature shall be reset based on zone demand. Design airflow rates shall be sized for the maximum reset supply air temperature. The air temperature for cooling shall be reset higher by 5°F under the minimum cooling load conditions.
- c **Direct expansion:** The fuel type for the cooling system shall match that of the cooling system in the proposed design.
- d **VAV:** When the proposed design system has a supply, return or relief fan motor horsepower (hp) requiring variable flow controls as required by Section C403.2.11.5, the corresponding fan in the VAV system of the standard reference design shall be modeled assuming a variable speed drive. For smaller fans, a forward-curved centrifugal fan with inlet vanes shall be modeled. If the proposed design's system has a direct digital control system at the zone level, static pressure setpoint reset based on zone requirements in accordance with Section C403.4.1 shall be modeled.
- e **Chilled water:** For systems using purchased chilled water, the chillers are not explicitly modeled. Otherwise, the standard reference design's chiller plant shall be modeled with chillers having the number as indicated in Table C407.5.1(5) as a function of standard reference building chiller plant load and type as indicated in Table C407.5.1(6) as a function of individual chiller load. Where chiller fuel source is mixed, the system in the standard reference design shall have chillers with the same fuel types and with capacities having the same proportional capacity as the proposed design's chillers for each fuel type. Chilled water supply temperature shall be modeled at 44°F design supply temperature and 56°F return temperature. Piping losses shall not be modeled in either building model. Chilled water supply water temperature shall be reset in accordance with Section C403.4.2.4. Pump system power for each pumping system shall be the same as the proposed design; if the proposed design has no chilled water pumps, the standard reference design pump power shall be 22 W/gpm (equal to a pump operating against a 75-foot head, 65-percent combined impeller and motor efficiency). The chilled water system shall be modeled as primary-only variable flow with flow maintained at the design rate through each chiller using a bypass. Chilled water pumps shall be modeled as riding the pump curve or with variable-speed drives when required in Section C403.4.2.4. The heat rejection device shall be an axial fan cooling tower with variable speed fans if required in Section C403.4.3. Condenser water design supply temperature shall be 85°F or 10°F approach to design wet-bulb temperature, whichever is lower, with a design temperature rise of 10°F. The tower shall be controlled to maintain a 70°F leaving water temperature where weather permits, floating up to leaving water temperature at design conditions. Pump system power for each pumping system shall be the same as the proposed design; if the proposed design has no condenser water pumps, the standard reference design pump power shall be 19 W/gpm (equal to a pump operating against a 60-foot head, 60-percent combined impeller and motor efficiency). Each chiller shall be modeled with separate condenser water and chilled water pumps interlocked to operate with the associated chiller.
- f **Fossil fuel boiler:** For systems using purchased hot water or steam, the boilers are not explicitly modeled. Otherwise, the boiler plant shall use the same fuel as the proposed design and shall be natural draft. The standard reference design boiler plant shall be modeled with a single boiler if the standard reference design plant load is 600,000 Btu/h and less and with two equally sized boilers for plant capacities exceeding 600,000 Btu/h. Boilers shall be staged as required by the load. Hot water supply temperature shall be modeled at 180°F design supply temperature and 130°F return temperature. Piping losses shall not be modeled in either building model. Hot water supply water temperature shall be reset in accordance with Section C403.4.2.4. Pump system power for each pumping system shall be the same as the proposed design; if the proposed design has no hot water pumps, the standard reference design pump power shall be 19 W/gpm (equal to a pump operating against a 60-foot head, 60-percent combined impeller and motor efficiency). The hot water system shall be modeled as primary only with continuous variable flow. Hot water pumps shall be modeled as riding the pump curve or with variable speed drives when required by Section C403.4.2.4.
- g **Electric heat pump and boiler:** Water-source heat pumps shall be connected to a common heat pump water loop controlled to maintain a heating setpoint of 60°F and cooling setpoint of 90°F. Heat rejection from the loop shall be provided by an axial fan closed-circuit evaporative fluid cooler with variable speed fans if required in Section C403.4.2.1 or C403.2.13. Heat addition to the loop shall be provided by a boiler that uses the same fuel as the proposed design and shall be natural draft. If no boilers exist in the proposed design, the standard reference building boilers shall be fossil fuel. The standard reference design boiler plant shall be modeled with a single boiler if the standard reference design plant load is 600,000 Btu/h or less and with two equally sized boilers for plant capacities exceeding 600,000 Btu/h. Boilers shall be staged as required by the load. Piping losses shall not be modeled in either building model. Pump system power shall be the same as the proposed design; if the proposed design has no pumps, the standard reference design pump power shall be 22 W/gpm, which is equal to a pump operating against a 75-foot head, with a 65-percent combined impeller and motor efficiency. Loop flow shall be variable with flow shutoff at each heat pump when its compressor cycles off as required by Section C403.4.2.3. Loop pumps shall be modeled as riding the pump curve or with variable speed drives when required by Section C403.4.2.4.
- h **Electric heat pump:** Electric air-source heat pumps shall be modeled with electric auxiliary heat and an outdoor air thermostat. The system shall be controlled to energize auxiliary heat only when outdoor air temperature is less than 40°F. The air-source heat pump shall be modeled to continue to operate while auxiliary heat is energized. The air-source heat pump shall be modeled to operate down to a minimum outdoor air temperature of 35°F for System No. 8 or 0°F for System No. 9. If the Proposed Design utilizes the same system type as the Standard Design (PTHP or PSZ-HP), the Proposed Design shall be modeled with the same minimum outdoor air temperature for heat pump operation as the Standard Design. For temperatures below the stated minimum outdoor air temperatures, the electric auxiliary heat shall be controlled to provide the full heating load.
- i **Constant volume:** For building types governed by Section C403.6, fans shall be controlled to cycle with load; i.e., fan operation cycled on calls for heating and cooling. If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy shall not be modeled explicitly. For all other buildings, fans shall be controlled in the same manner as in the proposed design; i.e., fan operation whenever the space is occupied or fan operation cycled on calls for heating and cooling. If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy shall not be modeled explicitly.
- j **Fan speed control:** Fans shall operate as one- or two-speed as required by Section C403.2.11.5, regardless of the fan speed control used in the proposed building.
- k **Outside air:** For building types governed by Section C403.6, outside air shall be supplied by a separate dedicated outside air system (DOAS) operating in parallel with terminal equipment. The terminal equipment fan system cycle calls for heating and cooling. DOAS shall include an Energy Recovery Ventilation System with a minimum effectiveness in accordance with Section C403.5.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-407054 ((Table C407.5.1(5) Number of chillers.)) Re-served.**

**((Table C407.5.1(5) Number of Chillers**

<b>Total Chiller Plant Capacity</b>	<b>Number of Chillers</b>
≤ 300 tons	1
> 300 tons, < 600 tons	2, sized equally
≥ 600 tons	2 minimum, with chillers added so that no chiller is larger than 800 tons, all sized equally

For SI: 1 ton = 3517 W.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-407055 ((Table C407.5.1(6) Water chiller types.))**  
**Reserved.**

**((Table C407.5.1(6)  
Water Chiller Types**

<b>Individual Chiller Plant Capacity</b>	<b>Electric Chiller Type</b>	<b>Fossil Fuel Chiller Type</b>
≤ 100 tons	Water-cooled Reciprocating	Single-effect absorption, direct fired
> 100 tons, < 300 tons	Water-cooled Screw	Double-effect absorption, direct fired
≥ 300 tons	Water-cooled Centrifugal	Double-effect absorption, direct fired

For SI: 1 ton = 3517 W.))

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40706 Section C407.6—((Calculation software tool))**  
**Reserved.**

~~((C407.6 Calculation software tools. Calculation procedures used to comply with this section shall be software tools capable of calculating the annual energy consumption of all building elements that differ between the standard reference design and the proposed design and shall include the following capabilities.~~

- ~~1. Building operation for a full calendar year (8,760 hours).~~
- ~~2. Climate data for a full calendar year (8,760 hours) and shall reflect approved coincident hourly data for temperature, solar radiation, humidity and wind speed for the building location.~~
- ~~3. Ten or more thermal zones.~~
- ~~4. Thermal mass effects.~~

5. Hourly variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads.

6. Part-load performance curves for mechanical equipment.

7. Capacity and efficiency correction curves for mechanical heating and cooling equipment.

8. Printed code official inspection checklist listing each of the proposed design component characteristics from Table C407.5.1(1) determined by the analysis to provide compliance, along with their respective performance ratings (e.g., R-value, U-factor, SHGC, HSPF, AFUE, SEER, EF, etc.).

9. Air-side economizers with integrated control.

10. Standard reference design characteristics specified in Table C407.5.1(1).

**C407.6.1 Specific approval.** Performance analysis tools meeting the applicable subsections of Section C407 and tested according to ASHRAE Standard 140 shall be permitted to be approved. 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.

**C407.6.2 Input values.** Where calculations require input values not specified by Sections C402, C403, C404 and C405, those input values shall be taken from an approved source.

**C407.6.3 Exceptional calculation methods.** Where the simulation program does not model a design, material, or device of the proposed design, an Exceptional Calculation Method shall be used where approved by the code official. Where there are multiple designs, materials, or devices that the simulation program does not model, each shall be calculated separately and Exceptional Savings determined for each. The total Exceptional Savings shall not constitute more than half of the difference between the baseline building performance and the proposed building performance. Applications for approval of an exceptional method shall include:

1. Step-by-step documentation of the Exceptional Calculation Method performed detailed enough to reproduce the results.

2. Copies of all spreadsheets used to perform the calculations.

3. A sensitivity analysis of energy consumption when each of the input parameters is varied from half to double the value assumed.

4. The calculations shall be performed on a time step basis consistent with the simulation program used.

5. The Performance Rating calculated with and without the Exceptional Calculation Method.)

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

#### **WAC 51-11C-40801 Section C408.1—General.**

**C408.1 General.** A building commissioning process led by a certified commissioning professional and functional testing requirements shall be completed for mechanical ((and refrigeration)) systems in Section((s)) C403 ((and C410,))i service water heating systems in Section



~~C404((, electrical power)); controlled receptacle and lighting control systems in Section C405 ((and)); equipment, appliances and systems installed to comply with Sections C406 or C407; energy metering in Section C409; and refrigeration systems in Section C410.~~

EXCEPTION:

Buildings, or portions thereof, which are exempt from Sections C408.2 through ~~((C408.6)) C408.7~~ may be excluded from the commissioning process.

~~1. Mechanical systems are exempt from the commissioning process where the building's total mechanical equipment capacity is less than 240,000 Btu/h cooling capacity and less than 300,000 Btu/h heating capacity.~~

~~2. Service water heating systems are exempt from the commissioning process in buildings where the largest service water heating system capacity is less than 200,000 Btu/h and where there are no pools or permanent spas.~~

~~3. Lighting control systems are exempt from the commissioning process in buildings where both the total installed lighting load is less than 20 kW and the lighting load controlled by occupancy sensors or automatic daylighting controls is less than 10 kW.~~

~~4. Refrigeration systems are exempt from the commissioning process in buildings if they are limited to self-contained units.~~

**C408.1.1 Commissioning in construction documents.** ~~Construction documents ((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)) process. The construction documents shall minimally include the following:~~

~~1. A narrative description of the activities that will be accomplished during the commissioning process. At a minimum, the commissioning process is required to include:~~

~~1.1. Development and execution of the commissioning plan, including all subsections of Section C408.1.2;~~

~~1.2. The *certified commissioning professional's* review of the building documentation and close out submittals in accordance with Section C103.6; and~~

~~1.3. The commissioning report in accordance with Section C408.1.3.~~

~~2. Roles, responsibilities, and required qualifications of the *certified commissioning professional*.~~

~~3. A listing of the specific equipment, appliances, or systems to be tested.~~

**C408.1.2 Commissioning plan.** A commissioning plan shall be developed by the project's certified commissioning professional and shall outline the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. ~~((Items 1 through 4 shall be included with the construction documents, and items 5 through 8 shall be submitted prior to the first mechanical inspection. For projects where no mechanical inspection is required, items 5 through 8 shall be submitted prior to the first electrical inspection.))~~

~~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, systems testing and balancing, functional performance testing, and verification of the building documentation requirements in Section C103.6.~~

~~2. Roles and responsibilities of the commissioning team, including the name and statement of qualifications of the *certified commissioning professional*.~~

~~3. ((A schedule of activities including systems testing and balancing, functional performance testing, and verification of the building documentation requirements in Section C103.6.~~

~~4. Where the certified commissioning professional is an employee of one of the registered design professionals of record or an employee or subcontractor of the project contractor, an In-House Commissioning Disclosure and Conflict Management Plan shall be submitted with the commissioning plan. This plan shall disclose the certified commissioning professional's contractual relationship with other team members and provide a conflict management plan demonstrating that the certi-~~

~~fied commissioning professional is free to identify any issues discovered and report directly to the owner.~~

5.)) A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.

~~((6. Functions to be tested.~~

~~7. Conditions under which the test will be performed.~~

~~8. Measurable criteria for performance.))~~

**C408.1.2.1 In-house commissioning disclosure and conflict management plan.** Where the certified commissioning professional's contract or employment is other than directly with the building owner, an in-house commissioning disclosure and conflict management plan shall be a part of the commissioning process. A copy shall be included in the commissioning plan. This plan shall disclose the certified commissioning professional's contractual relationship with other team members and provide a conflict management plan demonstrating that the certified commissioning professional is free to identify any issues discovered and report directly to the owner.

**C408.1.2.2 Functional performance testing.** Functional performance testing shall be conducted for mechanical systems in Sections C403; service water heating systems in Section C404; controlled receptacles and lighting control systems in Section C405; equipment, appliances, systems installed to comply with Section C406 or C407; energy metering in Section C409; and refrigeration systems in Section C410. Written procedures which clearly describe the individual systematic test procedures, the expected system response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion shall be followed. This testing shall include control systems which will be tested to document that control devices, components, equipment, and systems are calibrated and adjusted to operate in accordance with approved construction documents. Testing shall affirm the conditions required within Sections C408.2 through C408.7 under system testing.

**C408.1.2.3 Functional performance testing - Sampling.** For projects with 7 or fewer similar systems, each system shall be tested. For projects with more than 7 systems, testing shall be done for each unique combination of control types. Where multiples of each unique combination of control types exist, no fewer than 20 percent of each combination shall be tested unless the code official or design professional requires a higher percentage to be tested. Where 30 percent or more of the tested system fail, all remaining identical combinations shall be tested.

**C408.1.2.4 Deficiencies.** Deficiencies found during testing shall be resolved including corrections and retesting.

**C408.1.3 ((Final)) Commissioning report.** A ((final)) commissioning report shall be completed and certified by the *certified commissioning professional* and delivered to the building owner or owner's authorized agent. The report shall be organized with mechanical, service water heating, controlled receptacle and lighting control systems, ((~~service water heating and~~)) energy metering, and refrigeration findings in separate sections to allow independent review. The report shall record the activities and results of the commissioning process and be developed from the final commissioning plan with all of its attached appendices. The report shall include:

1. Results of functional performance tests.

2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.
4. Commissioning plan.
5. Testing, adjusting and balancing report.

EXCEPTION: Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.

**C408.1.4. Commissioning process completion requirements.** Prior to the final mechanical, plumbing and electrical inspections or obtaining a certificate of occupancy, the *certified commissioning professional* (~~((or approved agency))~~) shall provide evidence of (~~((systems))~~) building commissioning (~~((and completion))~~) in accordance with the provisions of this section.

~~((Copies of all documentation shall be given to the owner and made available to the code official upon request in accordance with Section C408.1.4.3.~~

**C408.1.4.1 Commissioning progress report for code compliance.** A preliminary report of commissioning test procedures and results shall be completed and certified by the *certified commissioning professional* or *approved agency* and provided to the building owner or owner's authorized agent. The report shall be organized with mechanical, lighting, service water heating and metering findings in separate sections to allow independent review. The report shall be identified as "Preliminary Commissioning Report" and shall identify:

1. Itemization of deficiencies found during testing required by this code 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, with anticipated date of completion.
3. Climatic conditions required for performance of the deferred tests.
4. Status of the project's record documents, manuals and systems operation training with respect to requirements in Section C103.6.

~~**C408.1.4.2 Acceptance of report.**~~ **C408.1.4.1 Commissioning compliance.** Buildings, or portions thereof, shall not be considered acceptable for a final inspection pursuant to Section (~~((C104.2))~~) C104.2.6 until the *code official* has received a letter of transmittal from the building owner acknowledging that the building owner or owner's authorized agent has received the (~~((Preliminary))~~) Commissioning Report. Completion of (~~((the))~~) Commissioning Compliance Checklist (Figure (~~((C408.1.4.2))~~) C408.1.4.1) is deemed to satisfy this requirement. Phased acceptance of the Commissioning Compliance Checklist for portions of the work specific to the trade that is being inspected is permissible where accepted by the code official and where the certified commissioning professional remains responsible for completion of the commissioning process. If there are unresolved deficiencies when the final inspection is scheduled, the Commissioning Report shall be submitted and shall describe the unresolved deficiencies.

~~**((C408.1.4.3)) C408.1.4.2 Copy of report.**~~ The *code official* shall be permitted to require that a copy of the Preliminary Commissioning Report be made available for review by the *code official*.

**WAC 51-11C-408012 Figure ((C408.1.4.2)) C408.1.4.1—Commissioning compliance checklist.**

**Figure ((C408.1.4.2)) C408.1.4.1  
Commissioning Compliance Checklist**

<b>((Project Information</b>	<b>Project Name:</b>
	<b>Project Address:</b>
	<b>Certified Commissioning Professional:</b>
	<b>Certifying Body:</b>
<b>Commissioning Plan (Section 408.1.2)</b>	<input type="checkbox"/> <b>Commissioning Plan was used during construction</b>
<b>Commissioned Systems</b>  (Section C408.2, C408.3, C408.4 and C408.6)	<input type="checkbox"/> <b>Mechanical Systems were included in the Commissioning Process (Section C408.2)</b>  Building mechanical systems have been tested to demonstrate the installation and operation of components, systems and system-to-system interfacing relationships in accordance with approved plans and specifications  <input type="checkbox"/> There are unresolved deficiencies with the mechanical systems. These are described in the Preliminary Commissioning Report submitted to the owner. The following items are not in compliance with the energy code:
	<input type="checkbox"/> <b>Electrical Power or Lighting Systems were included in the Commissioning Process (Section C408.4)</b>  Electrical power and automatic lighting controls have been tested to demonstrate the installation and operation of components, systems and system-to-system interfacing relationships in accordance with approved plans and specifications  <input type="checkbox"/> There are unresolved deficiencies with the electrical power and/or automatic lighting controls. These are described in the Preliminary Commissioning Report submitted to the owner. The following items are not in compliance with the energy code:
	<input type="checkbox"/> <b>Service Water Heating Systems were included in the Commissioning Process (Section C408.5)</b>  Service water heating systems have been tested to demonstrate that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved plans and specifications  <input type="checkbox"/> There are unresolved deficiencies with the service water heating systems. These are described in the Preliminary Commissioning Report submitted to the owner. The following items are not in compliance with the energy code:
	<input type="checkbox"/> <b>Additional Systems included in the Commissioning Process (Section C408.5)</b>  <input type="checkbox"/> There are unresolved deficiencies with systems required by Section C406 or Section C407. These are described in the Preliminary Commissioning Report submitted to the owner. The following items are not in compliance with the energy code:
	<input type="checkbox"/> <b>Metering Systems were included in the Commissioning Process (Section C408.6)</b>  Energy source meters, energy end-use meters, the energy metering data acquisition system and required display are calibrated, adjusted and operate to minimally meet code requirements  <input type="checkbox"/> There are unresolved deficiencies with the metering system. These are described in the Preliminary Commissioning Report submitted to the owner. The following items are not in compliance with the energy code:
<b>Supporting Documents</b>  6 ection C103.6)	<input type="checkbox"/> <b>Manuals, record documents and training have been completed or are scheduled</b>  <ul style="list-style-type: none"> <li>• System documentation has been provided to the owner or scheduled date:</li> <li>• Record documents have been submitted to owner or scheduled date:</li> <li>• Training has been completed or scheduled date:</li> </ul>
<b>Preliminary Commissioning Report</b>	<input type="checkbox"/> <b>Preliminary Commissioning Report submitted to owner and includes items below</b>

(Section C408.1.4.1)	<input type="checkbox"/> Itemization of deficiencies found during testing that are part of the energy code and that have not been corrected at the time of report preparation <input type="checkbox"/> Deferred tests, which cannot be performed at the time of report preparation, with anticipated date of completion <input type="checkbox"/> Status of the project's record documents, manuals and systems operation training with respect to requirements in Section C103.6
<b>Certification</b>	<input type="checkbox"/> I hereby certify that all requirements for Commissioning have been completed in accordance with the Washington State Energy Code, including all items above <div style="text-align: right;"> <div>_____</div> <div>Building Owner or Owner's Authorized Agent</div> <div>_____</div> <div>Date))</div> </div>
<b>Project Information</b>	<b>Project Name:</b>
	<b>Project Address:</b>
	<b>Certified Commissioning Professional:</b>
	<b>Type of ISO Certification and Number:</b>
<b>Supporting Documents</b>	<input type="checkbox"/> <b>Manuals, record documents and training have been completed or are scheduled</b> (Section C103.6) <ul style="list-style-type: none"> <li>• <u>Building operations and maintenance information (C103.6.2) have been submitted to the owner or scheduled date:</u></li> <li>• <u>Manuals (C103.6.2.1) have been submitted to the owner or scheduled date:</u></li> <li>• <u>Compliance documentation (C103.6.3) has been provided to the owner or scheduled date:</u></li> <li>• <u>System operation training (C103.6.4) has been provided to the owner or scheduled date:</u></li> </ul>
<b>Commissioning Plan</b>	<input type="checkbox"/> <b>Commissioning Plan was used during construction</b> (Section C408.1.2)
<b>Commissioning Report</b>	<input type="checkbox"/> <b>Commissioning Report has been submitted</b> (Section C408.1.3)
<b>Commissioned Systems</b>	<input type="checkbox"/> <b>Mechanical Systems were included in the commissioning process</b> (Section C408.2) <input type="checkbox"/> <u>Testing, adjusting and balancing is complete</u> (Section C408.2.2). <input type="checkbox"/> <u>There are unresolved deficiencies with the mechanical systems. These are described in the attached Commissioning Report submitted to the owner.</u>
	<input type="checkbox"/> <b>Service Water Heating Systems were included in the commissioning process</b> (Section C408.3) <input type="checkbox"/> <u>There are unresolved deficiencies with the service water heating systems. These are described in the attached Commissioning Report submitted to the owner.</u>
	<input type="checkbox"/> <b>Controlled receptacles and lighting control systems were included in the commissioning process</b> (Section C408.4) <input type="checkbox"/> <u>There are unresolved deficiencies with the electrical power and/or automatic lighting controls. These are described in the attached Commissioning Report submitted to the owner.</u>
	<input type="checkbox"/> <b>Additional Systems included in the commissioning process</b> (Section C408.5) <input type="checkbox"/> <u>There are unresolved deficiencies with systems required by Section C406 or Section C407. These are described in the attached Commissioning Report submitted to the owner.</u>
	<input type="checkbox"/> <b>Metering Systems were included in the commissioning process</b> (Section C408.6) <input type="checkbox"/> <u>There are unresolved deficiencies with the metering system. These are described in the attached Commissioning Report submitted to the owner.</u>
	<input type="checkbox"/> <b>Refrigeration Systems were included in the commissioning process</b> (Section C408.7) <input type="checkbox"/> <u>There are unresolved deficiencies with the systems required by Section C410. These are described in the attached Commissioning Report submitted to the owner.</u>
	<input type="checkbox"/> I hereby certify that all requirements for Section C408 System Commissioning have been completed in accordance with the Washington State Energy Code, including all items above. <div style="text-align: right;"> <div>_____</div> <div>Certified Commissioning Professional</div> <div>_____</div> <div>Date</div> </div>
	<input type="checkbox"/> I hereby certify that all requirements for Section C408 System Commissioning have been completed in accordance with the Washington State Energy Code, including all items above. <div style="text-align: right;"> <div>_____</div> <div>Building Owner or Owner's Authorized Agent</div> <div>_____</div> <div>Date</div> </div>

**WAC 51-11C-40802 Section C408.2—Mechanical systems commissioning.**

**C408.2 Mechanical and refrigeration systems commissioning.** Mechanical and refrigeration equipment and controls subject to Sections C403 and C410 shall be included in the commissioning process required by Section C408.1. The commissioning process shall minimally include all energy code requirements for which the code states that equipment or controls shall "be capable of" or "configured to" perform specific functions.

EXCEPTION: Mechanical systems are exempt from the commissioning process where the ((building's)) installed total mechanical equipment capacity is less than 240,000 Btu/h cooling capacity and less than 300,000 Btu/h heating capacity.

**C408.2.1 Reserved.**

**C408.2.2 Systems adjusting and balancing.** HVAC systems shall be balanced in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the project specifications. Test and balance activities shall include air system and hydronic system balancing.

**C408.2.2.1 Air systems balancing.** Each supply air outlet and zone terminal device shall be equipped with means for air balancing in accordance with the requirements of Chapter 6 of the *International Mechanical Code*. 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 (0.74 kW), fan speed shall be adjusted to meet design flow conditions.

EXCEPTION: Fans with fan motors of 1 hp (0.74 kW) or less.

**C408.2.2.2 Hydronic systems balancing.** Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow. Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or 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.

EXCEPTION: The following equipment is not required to be equipped with means for balancing or measuring flow:  
1. Pumps with pump motors of 5 hp (3.7 kW) or less.  
2. Where throttling results in no greater than five percent of the nameplate horsepower draw above that required if the impeller were trimmed.

**C408.2.3 ((Functional performance)) System testing.** ~~Functional performance testing ((specified in Sections C408.2.3.1 through C408.2.3.3 shall be conducted. Written procedures which clearly describe the individual systematic test procedures, the expected systems' response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion shall be followed. Testing shall affirm operation during actual or simulated winter and summer design conditions and during full outside air conditions.~~

**C408.2.3.1 Equipment.** ~~Equipment functional performance testing)) shall demonstrate the ((installation and operation of)) components, systems,~~

and system-to-system interfacing relationships are installed and operate in accordance with approved ((plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed)) construction documents. Testing shall include ((all modes and)) the sequence of operation, ((including)) and be conducted 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; and
4. Mode of operation upon a loss of power and restoration of power.

~~((C408.2.3.2 Controls. HVAC control systems shall be tested to document that control devices, components, equipment, and systems are calibrated and adjusted and operate in accordance with approved plans and specifications. Sequences of operation shall be functionally tested to document they operate in accordance with approved plans and specifications.~~

~~**C408.2.3.3 Economizers.** Air economizers shall undergo a functional test to determine that they operate in accordance with manufacturer's specifications.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40803 Section C408.3—((Lighting)) Service water heating systems commissioning.**

~~((C408.3 Electrical power and lighting systems commissioning. Electrical power and lighting systems subject to Section C405 shall be included in the commissioning process required by Section C408.1. The commissioning process shall minimally include all energy code requirements for which the code requires specific daylight responsive controls, "control functions," and where the code states that equipment shall be "configured to" perform specific functions.~~

**EXCEPTION:**

Lighting control systems are exempt from the commissioning process in buildings where:

1. The total installed lighting load is less than 20 kW.

2. Where the lighting load controlled by occupancy sensors or automatic daylighting controls is less than 10 kW.

~~**C408.3.1 Functional testing.** Prior to passing final inspection, the *certified commissioning professional* 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. Written procedures which clearly describe the individual systematic test procedures, the expected systems' response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion shall be followed. Functional testing shall comply with Section C408.3.1.1 through C408.3.1.3 for the applicable control type.~~

~~**C408.3.1.1 Occupant sensor controls.** Where occupancy sensors are provided, the following procedures shall be performed:~~

1. Certify that the occupancy sensor has been located and aimed in accordance with manufacturer recommendations.

2. For projects with seven or fewer occupancy sensors, each sensor shall be tested. For projects with more than seven occupancy sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, no fewer than the greater of one or 10 percent of each combination shall be tested unless the code official or design professional requires a higher percentage to be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested.

3. For each occupancy sensor to be tested, verify the following:

3.1. Where occupancy sensors include status indicators, verify correct operation.

3.2. The controlled lights turn off or down to the permitted level within the required time.

3.3. For auto-on occupancy sensors, the lights turn on to the permitted level within the required time.

3.4. For manual on sensors, the lights turn on only when manually activated.

3.5. The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

**C408.3.1.2 Time switch controls.** Where automatic time switches are provided, the following procedures shall be performed:

1. Confirm that the automatic time switch control is programmed with accurate weekday, weekend and holiday schedules, and set-up and preference program settings.

2. Provide documentation to the owner of automatic time switch programming, including weekday, weekend, holiday schedules and set-up and preference program settings.

3. Verify the correct time and date in the time switch.

4. Verify that any battery backup is installed and energized.

5. Verify that the override time limit is set to not more than two hours.

6. Simulate occupied conditions. Verify and document the following:

6.1. All lights can be turned on and off by their respective area control switch.

6.2. The switch only operates lighting in the enclosed space in which the switch is located.

7. Simulate unoccupied condition. Verify the following:

7.1. All nonexempt lighting turns off.

7.2. Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shut off occurs.

8. Additional testing as specified by the certified commissioning professional.

**C408.3.1.3 Daylight responsive controls.** Where daylight responsive controls are provided, the following procedures shall be performed:

1. All control devices have been properly located, field-calibrated and set for accurate setpoints and threshold light levels.

2. Daylight controlled lighting loads adjusted to light level setpoints in response to available daylight.

3. The locations of calibration adjustment equipment are readily accessible only to authorized personnel.

**C408.3.2 Documentation requirements.** The construction documents shall specify that documents certifying that the installed lighting controls



meet documented performance criteria of Section C405 be provided to the building owner within 90 days from the date of receipt of the certificate of occupancy.) **C408.3 Service water heating systems commissioning.** Service water heating equipment and controls subject to Section C404 shall be included in the commissioning process required by Section C408.1. The commissioning process shall minimally include equipment and components installed to meet all energy code requirements for devices to "start," "automatically turn off," "automatically adjust," "limit operation," and "limit the temperature" and "be configured to."

**C408.3.1 System testing.** Functional performance testing shall demonstrate that heaters, piping, distribution systems, and system-to-system interfacing relationships are installed and operate in accordance with approved construction documents. Testing shall include the sequence of operation, and be conducted under at least 50 percent water heating load, part-load and the following conditions:

1. Normal operation;
2. Redundant or automatic back-up mode;
3. Performance of alarms; and
4. Mode of operation upon a loss of power and restoration of power.

AMENDATORY SECTION (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

**WAC 51-11C-40804 Section C408.4—((Service water heating)) Controlled receptacle and lighting control system((s)) commissioning.**

**C408.4 ((Service water heating)) Controlled receptacle and lighting control system((s)) commissioning.** ((Service water heating equipment and controls subject to Section C404 shall be included in the commissioning process required by Section C408.1. The commissioning process shall minimally include all energy code requirements for which the code states that equipment or controls shall "be capable of" or "configured to" perform specific functions.

EXCEPTION: Service water heating systems are exempt from the commissioning process in buildings where the largest service water heating system capacity is less than 200,000 Btu/h (58.6 W) and where there are no pools or permanent spas.))

Controlled receptacles and lighting control systems subject to Section C405 shall be included in the commissioning process required by Section C408.1. The configuration and function of controlled receptacles and lighting control systems required by this code shall be tested and shall comply with Section C408.4.1.

EXCEPTION: Lighting control systems are exempt from the commissioning process in buildings where:  
1. The total installed lighting load is less than 20 kW; and  
2. The lighting load controlled by occupancy sensors or automatic daylighting controls is less than 10 kW.

**C408.4.1 ((Functional performance)) System testing.** Functional performance testing ((specified in Sections C408.4.1.1 through C408.4.1.3 shall be conducted. Written procedures which clearly describe the individual systematic test procedures, the expected systems' response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion shall be followed. Testing shall affirm operation with the system under 50 percent water heating load.

**C408.4.1.1 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:))~~ shall demonstrate that occupant sensors, time switches, manual overrides, night sweep-off, daylight responsive control, and controlled receptacles are installed and operate in accordance with approved construction documents. Testing shall include the sequence of operation and be conducted under the following conditions:

1. Normal operation;
2. Redundant or automatic back-up mode;
- ~~((2.))~~ 3. Performance of alarms; and
- ~~((3.))~~ 4. Mode of operation upon a loss of power and restoration of power.

~~((C408.4.1.2 Controls. Service water heating controls shall be tested to document that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications. Sequences of operation shall be functionally tested to document they operate in accordance with approved plans and specifications.~~

**C408.4.1.3 Pools and spas.** ~~Service water heating equipment, time switches, and heat recovery equipment which serve pools and permanent spas shall undergo a functional test to determine that they operate in accordance with manufacturer's specifications.))~~

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-408045 Section C408.5—Other systems commissioning.**

**C408.5 Systems installed to meet Section C406 or C407.** ~~Equipment, components, controls or configuration settings for ((mechanical, service water heating, electrical power or lighting))~~ systems which are included in the project to comply with Section C406 or C407 shall be included in the commissioning process required by Section C408.1.

**C408.5.1 System testing.** Functional performance testing for these appliances, equipment, components, controls and/or configuration settings shall demonstrate operation, function and maintenance serviceability for each of the commissioned systems in accordance with the approved construction documents.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40805 Section C408.6—Metering system commissioning.**

**C408.6 Metering system commissioning.** Energy metering systems required by Section C409 shall comply with Section C408.6 and be included in the commissioning process required by Section C408.1. The commissioning process shall include all energy metering equipment and controls required by Section C409.

**C408.6.1 ((Functional performance)) System testing.** Functional performance testing shall ~~((be conducted by following written procedures which clearly describe the individual systematic test procedures, the expected systems' response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion. Functional testing shall document that energy source meters, energy end-use meters, the energy metering data acquisition system, and required energy consumption display are calibrated, adjusted and operate in accordance with approved plans and specifications))~~ demonstrate that energy source meters, end-use meters, data acquisition systems, and energy displays are installed and operate in accordance with approved construction documents. At a minimum, testing shall confirm that:

1. The metering system devices and components work properly under low and high load conditions.
2. The metered data is delivered in a format that is compatible with the data collection system.
3. The energy display is ~~((accessible))~~ in a location with access to building operation and management personnel.
4. The energy display meets code requirements regarding views required in Section C409.4.3. The display shows energy data in identical units (e.g., kWh).

#### NEW SECTION

**WAC 51-11C-40807 Section C408.7—Refrigeration system commissioning.**

**C408.7 Refrigeration system commissioning.** All installed refrigeration systems subject to Section C410 shall be included in the commissioning process required by Section C408.1.

EXCEPTIONS:      1. Self-contained refrigeration systems are exempt from the commissioning process.  
                     2. Total installed capacity for refrigeration is equal to or less than 240 kBtu/h.

**C408.7.1 System testing.** Functional performance testing shall demonstrate that compressors, heat exchangers, piping, distribution systems, and system-to-system interfacing relationships are installed and operate in accordance with approved construction documents. Testing shall include the sequence of operation and be conducted under full-load at, part-load and the following conditions:

1. Normal mode;
2. Redundant or automatic back-up mode;
3. Performance of alarms; and
4. Mode of operation upon a loss of power and restoration of power.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40901 Section C409.1—General.**

**C409.1 General.** All new buildings and additions, regardless of size, shall have the capability of and be configured to meter on-site renewable energy production in accordance with Section C409.2.4 and the end-use energy usage for electric vehicle charging in accordance with Section C409.3.3. New buildings and additions with a gross conditioned floor area over 50,000 square feet shall comply with Section C409. Buildings shall be equipped to measure, monitor, record and display energy consumption data for each energy source and end use category per the provisions of this section, to enable effective energy management.

EXCEPTIONS:      1. Tenant spaces smaller than 50,000 square feet within buildings if the tenant space has its own utility service and utility meters.  
                      2. Buildings in which there is no gross conditioned floor area over 25,000 square feet, including building common area, that is served by its own utility services and meters.

**C409.1.1 Alternate metering methods.** Where approved by the building official, energy use metering systems may differ from those required by this section, provided that they are permanently installed and that the source energy measurement, end use category energy measurement, data storage and data display have similar accuracy to and are at least as effective in communicating actionable energy use information to the building management and users, as those required by this section.

**C409.1.2 Conversion factor.** Any threshold stated in kW shall include the equivalent BTU/h heating and cooling capacity of installed equipment at a conversion factor of 3,412 Btu per kW at 50 percent demand.

**C409.1.3 Dwelling units.** See Sections C404.9 and C405.7 for additional metering requirements for Group R-2 dwelling units.

AMENDATORY SECTION (Amending WSR 13-04-056, filed 2/1/13, effective 7/1/13)

**WAC 51-11C-40902 Section C409.2—Energy source metering.**

**C409.2 Energy source metering.** Buildings shall have a meter at each energy source. For each energy supply source listed in Section C409.2.1 through C409.2.4, meters shall collect data for the whole building or for each separately metered portion of the building where not exempted by the exception to Section C409.1.

EXCEPTIONS:      1. Energy source metering is not required where end use metering for an energy source accounts for all usage of that energy type within a building, and the data acquisition system accurately totals the energy delivered to the building or separately metered portion of the building.  
                      2. Solid fuels such as coal, firewood or wood pellets that are delivered via mobile transportation do not require metering.

**C409.2.1 Electrical energy.** This category shall include all electrical energy supplied to the building and its associated site, including site lighting, parking, recreational facilities, and other areas that serve the building and its occupants.

**C409.2.2 Gas and liquid fuel supply energy.** This category shall include all natural gas, fuel oil, propane and other gas or liquid fuel energy supplied to the building and site.

**C409.2.3 District energy.** This category shall include all net energy extracted from district steam systems, district chilled water loops, district hot water systems, or other energy sources serving multiple buildings.

**C409.2.4 Site-generated renewable energy.** This category shall include all net energy generated from on-site solar, wind, geothermal, tidal or other natural sources. For buildings exempt from data collection systems, the data from these meters is permitted to either be stored locally using a manual totalizing meter or other means at the meter or fed into a central data collection system.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-40903 Section C409.3—End-use metering.**

**C409.3 End-use metering.** Meters shall be provided to collect energy use data for each end-use category listed in Sections C409.3.1 through ~~((C409.3.2))~~ C409.3.7. These meters shall collect data for the whole building or for each separately metered portion of the building where not exempted by the exception to Section C409.1. Not more than 10 percent of the total connected load of any of the end-use metering categories in Sections C409.3.1 through C409.3.6 is permitted to be excluded from that end-use data collection. Not more than 10 percent of the total connected load of any of the end-use metering categories in Sections C409.3.1 through C409.3.6 is permitted to consist of loads not part of that category. Multiple meters may be used for any end-use category, provided that the data acquisition system totals all of the energy used by that category. Full-floor tenant space submetering data shall be provided to the tenant in accordance with Section C409.7, and the data shall not be required to be included in other end-use categories.

**EXCEPTIONS:**

1. HVAC and service water heating equipment serving only an individual dwelling unit or sleeping unit does not require end-use metering.
2. Separate metering is not required for fire pumps, stairwell pressurization fans or other life safety systems that operate only during testing or emergency.
3. End use metering is not required for individual tenant spaces not exceeding 2,500 square feet in floor area when a dedicated source meter meeting the requirements of Section C409.4.1 is provided for the tenant space.
4. Health care facilities with loads in excess of 150 kVA are permitted to have submetering that measures electrical energy usage in accordance with the normal and essential electrical systems except that submetering is required for the following load categories:
  - 4.1. HVAC system energy use in accordance with the requirements of Section C409.3.1.
  - 4.2. Service water heating energy use in accordance with the requirements of Section C409.3.2.
  - 4.3. Process load system energy in accordance with the requirements of Section C409.3.5 for each significant facility not used in direct patient care including, but not limited to, food service, laundry and sterile processing facilities, where the total connected load of the facility exceeds 100 kVA.
5. End-use metering is not required for electrical circuits serving only sleeping rooms and guest suites within Group R-1 occupancies. This exception does not apply to common areas or to equipment serving multiple sleeping rooms.

**C409.3.1 HVAC system energy use.** This category shall include all energy including electrical, gas, liquid fuel, district steam and district chilled water that is used by boilers, chillers, pumps, fans and other equipment used to provide space heating, space cooling, dehumidification and ventilation to the building, but not including energy that serves process loads, service water heating or miscellaneous loads as

defined in Section C409.3. Multiple HVAC energy sources, such as gas, electric and steam, are not required to be summed together.

EXCEPTIONS: 1. ((AH)) 120 volt equipment.  
2. ((208/120 volt equipment in a building where the main service is 480/277 volt power.)) An HVAC branch circuit where the total MCA of equipment served equates to less than 10 kVA.  
3. ~~((Electrical energy fed through variable frequency drives that are connected to the energy metering data acquisition center.))~~  
Individual fans or pumps that are not on a variable frequency drive.

**C409.3.2 Service water heating energy use.** This category shall include all energy used for heating of domestic and service hot water, but not energy used for space heating.

EXCEPTION: Service water heating energy use less than 50 ((kW)) kVA does not require end-use metering.

**C409.3.3 Lighting system energy use.** This category shall include all energy used by interior and exterior lighting, including lighting in parking structures and lots, but not including plug-in task lighting.

**C409.3.4 Electric vehicle charging energy use.** This category shall include all energy used for electric vehicle charging. For buildings exempt from data collection systems, the data from these meters is permitted to either be stored locally using a manual totalizing meter or other means at the meter or fed into a central data collection system.

**C409.3.5 Plug load system energy use.** This category shall include all energy used by appliances, computers, plug-in task lighting, and other equipment or equipment covered by other end-use metering categories listed in Section C409.3. In a building where the main service is 480/277 volt, each 208/120 volt panel is permitted to be assumed to serve only plug load for the purpose of Section C409, unless it serves nonresidential refrigeration or cooking equipment.

EXCEPTION: Where the total connected load of all plug load circuits is less than 50 kVA, end-use metering is not required.

**C409.3.6 Process load system energy use.** This category shall include all energy used by any nonbuilding process load including, but not limited to, nonresidential refrigeration and cooking equipment, laundry equipment, industrial equipment, and stage lighting.

EXCEPTION: Where the process load energy use is less than 50 kVA end-use metering is not required.

**C409.3.7 Full-floor tenant space electrical submetering.** In a multi-tenant building where more than 90 percent of the leasable area of a floor is occupied by a single tenant, an electrical energy use display shall be provided to the tenant in accordance with the requirements of Section C409.4.3. Electrical loads from areas outside of the tenant space or from equipment that serves areas outside the tenant space shall not be included in the tenant space submetering. A single display is permitted to serve multiple floors occupied by the same tenant.

AMENDATORY SECTION (Amending WSR 16-13-089, filed 6/15/16, effective 7/16/16)

**WAC 51-11C-40904 Section C409.4—Measurement devices, data acquisition system and energy display.**

**C409.4 Measurement devices, data acquisition system and energy display.**

**C409.4.1 Meters.** Meters and other measurement devices required by this section shall have local displays or be configured to automatically communicate energy data to a data acquisition system. Source meters may be any digital-type meters. Current sensors or flow meters are allowed for end use metering, provided that they have an accuracy of +/- 5%. All required metering systems and equipment shall provide at least hourly data that is fully integrated into the data acquisition and display system per the requirements of Section C409.

**C409.4.2 Data acquisition system.** The data acquisition system shall store the data from the required meters and other sensing devices in a single database for a minimum of 36 months. For each energy supply and end use category required by C409.2 and C409.3, it shall provide real-time energy consumption data and logged data for any hour, day, month or year.

**C409.4.3 Energy display.** For each building subject to Section C409.2 and C409.3, either a ~~((readily accessible and))~~ visible display in a location with ready access, or a single web page or other electronic document ~~((accessible))~~ available for access to building management or to a third-party energy data analysis service shall be provided in the building accessible by building operation and management personnel. The display shall graphically provide the current energy consumption rate for each whole building energy source, plus each end use category, as well as the ~~((average))~~ total and peak values for any day, week ~~((or)), month, and year.~~

**C409.4.4 Commissioning.** ~~((The entire))~~ Energy metering and energy consumption management systems shall be commissioned in accordance with Section C408. ~~((Deficiencies found during testing shall be corrected and retested and the commissioning report shall be updated to confirm that the entire metering and data acquisition and display system is fully functional.))~~

AMENDATORY SECTION (Amending WSR 16-24-070, filed 12/6/16, effective 5/1/17)

**WAC 51-11C-41000 Section C410—Refrigeration system requirements.**

**C410.1 General ~~((prescriptive))~~.** Walk-in coolers, walk-in freezers, refrigerated warehouse coolers, refrigerated warehouse freezers, and refrigerated display cases shall comply with this Section.

Refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C402. Section C402.1.5 Component performance alternative, may be used if granted prior approval by the jurisdiction.

**C410.1.1 Refrigeration equipment performance.** Refrigeration equipment shall have an energy use in kWh/day not greater than the values of Tables ~~((C410.2))~~ C410.1(1) and ~~((C410.2))~~ C410.1(2) when tested and rated in accordance with AHRI Standard 1200. 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.

**Table C410.1.1(1)**  
**Minimum Efficiency Requirements: Commercial Refrigeration**

EQUIPMENT TYPE	APPLICATION	ENERGY USE LIMITS (kWh per day) <sup>a</sup>	TEST PROCEDURE
Refrigerator with solid doors	Holding Temperature	$0.10 \times V + 2.04$	AHRI 1200
Refrigerator with transparent doors		$0.12 \times V + 3.34$	
Freezers with solid doors		$0.40 \times V + 1.38$	
Freezers with transparent doors		$0.75 \times V + 4.10$	
Refrigerator/freezers with solid doors		The greater of $0.12 \times V + 3.34$ or 0.70	
Commercial refrigerators	Pulldown	$0.126 \times V + 3.51$	

<sup>a</sup> V = Volume of the chiller for frozen compartment as defined in AHAM-HRF-1.

**Table C410.1.1(2)**  
**Minimum Efficiency Requirements: Commercial Refrigerators and Freezers**

EQUIPMENT TYPE				ENERGY USE LIMITS (kWh per day) <sup>a,b</sup>	TEST PROCEDURE
Equipment Class <sup>c</sup>	Family Code	Operating Mode	Rating Temperature		
VOP.RC.M	Vertical open	Remote condensing	Medium	$0.82 \times TDA + 4.07$	AHRI 1200
SVO.RC.M	Semivertical open	Remote condensing	Medium	$0.83 \times TDA + 3.18$	
HZO.RC.M	Horizontal open	Remote condensing	Medium	$0.35 \times TDA + 2.88$	
VOP.RC.L	Vertical open	Remote condensing	Low	$2.27 \times TDA + 6.85$	
HZO.RC.L	Horizontal open	Remote condensing	Low	$0.57 \times TDA + 6.88$	
VCT.RC.M	Vertical transparent door	Remote condensing	Medium	$0.22 \times TDA + 1.95$	
VCT.RC.L	Vertical transparent door	Remote condensing	Low	$0.56 \times TDA + 2.61$	
SOC.RC.M	Service over counter	Remote condensing	Medium	$0.51 \times TDA + 0.11$	
VOP.SC.M	Vertical open	Self-contained	Medium	$1.74 \times TDA + 4.71$	
SVO.SC.M	Semivertical open	Self-contained	Medium	$1.73 \times TDA + 4.59$	
HZO.SC.M	Horizontal open	Self-contained	Medium	$0.77 \times TDA + 5.55$	
HZO.SC.L	Horizontal open	Self-contained	Low	$1.92 \times TDA + 7.08$	
VCT.SC.I	Vertical transparent door	Self-contained	Ice cream	$0.67 \times TDA + 3.29$	
VCS.SC.I	Vertical solid door	Self-contained	Ice cream	$0.38 \times V + 0.88$	
HCT.SC.I	Horizontal transparent door	Self-contained	Ice cream	$0.56 \times TDA + 0.43$	
SVO.RC.L	Semivertical open	Remote condensing	Low	$2.27 \times TDA + 6.85$	



EQUIPMENT TYPE				ENERGY USE LIMITS (kWh per day) <sup>a,b</sup>	TEST PROCEDURE
Equipment Class <sup>c</sup>	Family Code	Operating Mode	Rating Temperature		
VOP.RC.I	Vertical open	Remote condensing	Ice cream	2.89 x TDA + 8.7	
SVO.RC.I	Semivertical open	Remote condensing	Ice cream	2.89 x TDA + 8.7	
HZO.RC.I	Horizontal open	Remote condensing	Ice cream	0.72 x TDA + 8.74	
VCT.RC.I	Vertical transparent door	Remote condensing	Ice cream	0.66 x TDA + 3.05	
HCT.RC.M	Horizontal transparent door	Remote condensing	Medium	0.16 x TDA + 0.13	
HCT.RC.L	Horizontal transparent door	Remote condensing	Low	0.34 x TDA + 0.26	
HCT.RC.I	Horizontal transparent door	Remote condensing	Ice cream	0.4 x TDA + 0.31	
VCS.RC.M	Vertical solid door	Remote condensing	Medium	0.11 x V + 0.26	
VCS.RC.L	Vertical solid door	Remote condensing	Low	0.23 x V + 0.54	
VCS.RC.I	Vertical solid door	Remote condensing	Ice cream	0.27 x V + 0.63	
HCS.RC.M	Horizontal solid door	Remote condensing	Medium	0.11 x V + 0.26	
HCS.RC.L	Horizontal solid door	Remote condensing	Low	0.23 x V + 0.54	
HCS.RC.I	Horizontal solid door	Remote condensing	Ice cream	0.27 x V + 0.63	
SOC.RC.L	Service over counter	Remote condensing	Low	1.08 x TDA + 0.22	
SOC.RC.I	Service over counter	Remote condensing	Ice cream	1.26 x TDA + 0.26	
VOP.SC.L	Vertical open	Self-contained	Low	4.37 x TDA + 11.82	
VOP.SC.I	Vertical open	Self-contained	Ice cream	5.55 x TDA + 15.02	
SVO.SC.L	Semivertical open	Self-contained	Low	4.34 x TDA + 11.51	
SVO.SC.I	Semivertical open	Self-contained	Ice cream	5.52 x TDA + 14.63	
HZO.SC.I	Horizontal open	Self-contained	Ice cream	2.44 x TDA + 9.0	
SOC.SC.I	Service over counter	Self-contained	Ice cream	1.76 x TDA + 0.36	
HCS.SC.I	Horizontal solid door	Self-contained	Ice cream	0.38 x V + 0.88	

<sup>a</sup> V = Volume of the case, as measured in accordance with Appendix C of AHRI 1200.

<sup>b</sup> TDA = Total display area of the case, as measured in accordance with Appendix D of AHRI 1200.

<sup>c</sup> Equipment class designations consist of a combination [(in sequential order separated by periods (AAA).(BB).(C))] of:

(AAA) An equipment family code where:

VOP = Vertical open

SVO = Semi-vertical open

HZO = Horizontal open

VCT = Vertical transparent doors

VCS = Vertical solid doors

- HCT = Horizontal transparent doors
- HCS = Horizontal solid doors
- SOC = Service over counter
- (BB) An operating mode code:
  - RC = Remote condensing
  - SC = Self-contained
- (C) A rating temperature code:
  - M = Medium temperature (38°F)
  - L = Low temperature (0°F)
  - I = Ice cream temperature (15°F)

For example, "VOP.RC.M" refers to the "vertical-open, remote-condensing, medium-temperature" equipment class.

**C410.2 Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers.** *Refrigerated warehouse coolers, refrigerated warehouse freezers, and all walk-in coolers and walk-in freezers including site assembled, site constructed and pre-fabricated units shall comply with the following:*

1. Automatic door-closers shall be provided that fully 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 be provided with 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 be provided with wall, ceiling, and door insulation of not less than R-25 or have wall, ceiling and door assembly U-factors no greater than U-0.039. *Walk-in freezers and refrigerated warehouse freezers* shall be provided with wall, ceiling and door insulation of not less than R-32 or have wall, ceiling and door assembly U-factors no greater than U-0.030.

EXCEPTION: Insulation is not required for glazed portions of doors or at structural members associated with the walls, ceiling or door frame.

4. The floor of walk-in coolers shall be provided with floor insulation of not less than R-25 or have a floor assembly U-factor no greater than U-0.40. The floor of *walk-in freezers* shall be provided with floor insulation of not less than R-28 or have a floor assembly U-factor no greater than U-0.035.

EXCEPTION: Insulation is not required in the floor of a walk-in cooler that is mounted directly on a slab on grade.

5. Transparent fixed window and reach-in doors for *walk-in freezers* and windows in *walk-in freezer* doors shall be provided with triple-pane glass, with the interstitial spaces filled with inert gas or be provided with heat-reflective treated glass.

6. Transparent fixed window and reach-in doors for *walk-in coolers* and windows for *walk-in coolers* doors shall be provided with double-pane or triple-pane glass, with interstitial space filled with inert gas, or be provided with heat-reflective treated glass.

7. Evaporator fan motors that are less than 1 hp (0.746 kW) and less than 460 volts shall be provided with 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 that are not provided with antisweat heater controls shall have a total door rail, glass and frame heater power draw of not greater than 7.1 W/ft<sup>2</sup> (76 W/m<sup>2</sup>) of door opening for *walk-in freezers* and not greater than 3.0 W/ft<sup>2</sup> (32 W/m<sup>2</sup>) of door opening for *walk-in coolers*.

10. Where antisweat heater controls are provided, they shall be capable of reducing the energy use of the antisweat heater as a func-

tion 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 either be provided with light sources with an efficacy of not less than 40 lumens per watt, including ballast losses, or shall be provided with a device that automatically turns off the lights within 15 minutes of when the *walk-in cooler or walk-in freezer* space is not occupied.

**C410.2.1 ((Reserved.)) Performance standards.** Site-assembled and site-constructed *walk-in coolers* and *walk-in freezers* shall meet the requirements of Tables C410.2.1.1(1), C410.2.1.1(2), and C410.2.1.1(3).

**Table C410.2.1.1(1)**  
**Walk-in Cooler and Freezer Display**  
**Doors Efficiency Requirements**

<u>Class Description</u>	<u>Class</u>	<u>Maximum Energy Consumption (kWh/day)<sup>a</sup></u>
<u>Display door, medium temperature</u>	<u>DD, M</u>	<u><math>0.04 \times A_{dd} + 0.41</math></u>
<u>Display door, low temperature</u>	<u>DD, L</u>	<u><math>0.15 \times A_{dd} + 0.29</math></u>

<sup>a</sup>  $A_{dd}$  is the surface area of the display door.

**Table C410.2.1.1(2)**  
**Walk-in Cooler and Freezer Nondis-**  
**play Doors Efficiency Requirements**

<u>Class Description</u>	<u>Class</u>	<u>Maximum Energy Consumption (kWh/day)<sup>a</sup></u>
<u>Passage door, medium temperature</u>	<u>PD, M</u>	<u><math>0.05 \times A_{nd} + 1.7</math></u>
<u>Passage door, low temperature</u>	<u>PD, L</u>	<u><math>0.14 \times A_{nd} + 4.8</math></u>
<u>Freight door, medium temperature</u>	<u>FD, M</u>	<u><math>0.04 \times A_{nd} + 1.9</math></u>
<u>Freight door, low temperature</u>	<u>FD, L</u>	<u><math>0.12 \times A_{nd} + 5.6</math></u>

<sup>a</sup>  $A_{nd}$  is the surface area of the display door.

**Table C410.2.1.1(3)**  
**Walk-in Cooler and Freezer Refriger-**  
**ation Systems Efficiency Require-**  
**ments**

<u>Class Description</u>	<u>Class</u>	<u>Minimum Annual Walk-in Energy Factor AWEF (Btu/hW-h)</u>
<u>Dedicated condensing, medium temperature, indoor system</u>	<u>DC.M.I</u>	<u>5.61</u>
<u>Dedicated condensing, medium temperature, indoor system, &gt;9,000 Btu/h capacity</u>	<u>DC.M.I, &gt;9,000</u>	<u>5.61</u>

<b>Class Description</b>	<b>Class</b>	<b><u>Minimum Annual Walk-in Energy Factor AWEF (Btu/hW-h)</u></b>
<u>Dedicated condensing, medium temperature, outdoor system</u>	<u>DC.MI</u>	<u>7.60</u>
<u>Dedicated condensing, medium temperature, outdoor system, &gt;9,000 Btu/h capacity</u>	<u>DC.M.I. &gt;9,000</u>	<u>7.60</u>

**C410.2.2 Refrigerated display cases.** Site-assembled or site-constructed refrigerated display cases shall comply with the following:

1. Lighting and glass doors in refrigerated display cases shall be controlled by one of the following:

1.1. Time switch controls to turn off lights during nonbusiness hours. Timed overrides for display cases shall turn the lights on for up to 1 hour and shall automatically time out to turn the lights off.

1.2. Motion sensor controls on each display case section that reduce lighting power by at least 50 percent within 3 minutes after the area within the sensor range is vacated.

2. Low-temperature display cases shall incorporate temperature-based defrost termination control with a time-limit default. The defrost cycle shall terminate first on an upper temperature limit breach and second upon a time limit breach.

3. Antisweat heater controls shall 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.

**C410.3 Refrigeration systems.** Refrigerated display cases, *walk-in coolers* or *walk-in freezers* that are served by remote compressor and remote condensers not located in a *condensing unit*, shall comply with Sections C410.4.1, C410.4.2, and ((C403.5.3)) C403.9.7.

EXCEPTION: Systems where the working fluid in the refrigeration cycle goes through both subcritical and supercritical states (transcritical) or that use ammonia refrigerant are exempt.

**C410.3.1 Condensers serving refrigeration systems.** Fan-powered condensers shall comply with the following:

1. The design *saturated condensing temperatures* for air-cooled condensers shall not exceed the design dry-bulb temperature plus 10°F (5.6°C) for *low-temperature refrigeration systems*, and the design dry-bulb temperature plus 15°F (8°C) for *medium temperature refrigeration systems* where the *saturated condensing temperature* for blend refrigerants shall be determined using the average of liquid and vapor temperatures as converted from the condenser drain pressure.

2. Condenser fan motors that are less than 1 hp (0.75 kW) shall use electronically commutated motors, permanent split-capacitor-type motors or 3-phase motors.

3. Condenser fans for air-cooled condensers, evaporatively cooled condensers, air- or water-cooled fluid coolers or cooling towers shall reduce fan motor demand to not more than 30 percent of design wattage at 50 percent of design air volume, and incorporate one of the following continuous variable speed fan control approaches:

3.1. Refrigeration system condenser control for air-cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient dry-bulb temperature.

3.2. Refrigeration system condenser control for evaporatively cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient wet-bulb temperature.

4. Multiple fan condensers shall be controlled in unison.

5. The minimum condensing temperature setpoint shall be not greater than 70°F (21°C).

**C410.3.2 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. Single-compressor systems that do not have variable capacity capability.
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 subcooled 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 C403.2.10.

3. Compressors that incorporate internal or external crankcase heaters shall provide a means to cycle the heaters off during compressor operation.

**C410.4 Commissioning.** Refrigeration systems shall be commissioned in accordance with Section C408.

EXCEPTION: Self-contained units.

## NEW SECTION

### **WAC 51-11C-41100 Section C411—Solar readiness.**

**C411.1 General.** A solar zone shall be provided on nonresidential buildings that are 20 stories or less in height above grade plan. The solar zone shall be located on the roof of the building or on another structure elsewhere on the site. The solar zone shall be in accordance with Sections C411.2 through C411.8 and the *International Fire Code*.

EXCEPTION: A solar zone is not required where the solar exposure of the building's roof area is less than 75 percent of that of an unshaded area, as defined in Section C411.5, in the same location, as measured by one of the following:

1. Incident solar radiation expressed in kWh/ft<sup>2</sup>-yr using typical meteorological year (TMY) data.
2. Annual sunlight exposure expressed in cumulative hours per year using TMY data.
3. Shadow studies indicating that the roof area is more than 25 percent in shadow, on September 21st at 10 a.m., 11 a.m., 12 p.m., 1 p.m., and 2 p.m. solar time.

**C411.2 Minimum area.** The minimum area of the solar zone shall be determined by one of the following methods, whichever results in the smaller area:

1. 40 percent of roof area. The roof area shall be calculated as the horizontally projected gross roof area less the area covered by skylights, occupied roof decks and planted areas.

2. 20 percent of electrical service size. The electrical service size is the rated capacity of the total of all electrical services to the building, and the required solar zone size shall be based upon 10 peak watts of photovoltaic per square foot.

EXCEPTION: Subject to the approval of the code official, buildings with extensive rooftop equipment that would make full compliance with this section impractical shall be permitted to reduce the size of the solar zone required by Section C411.2 to the maximum practicable area.

**C411.3 Contiguous area.** The solar zone is permitted to be comprised of separated subzones. Each subzone shall be at least 5 feet wide in the narrowest dimension.

**C411.4 Obstructions.** The solar zone shall be free of pipes, vents, ducts, HVAC equipment, skylights and other obstructions, except those serving photovoltaic systems within the solar zone. The solar zone is permitted to be located above any such obstructions, provided that the racking for support of the future system is installed at the time of construction, the elevated solar zone does not shade other portions of the solar zone, and its height is permitted by the *International Building Code*. Photovoltaic or solar water heating systems are permitted to be installed within the solar zone.

**C411.5 Shading.** The solar zone shall be set back from any existing or new object on the building or site that is located south, east or west of the solar zone a distance at least two times the object's height above the nearest point on the roof surface. Such objects include, but are not limited to, taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees, and roof plantings. No portion of the solar zone shall be located on a roof slope greater than 2:12 that faces within 45 degrees of true north.

**C411.6 Access.** Areas contiguous to the solar zone shall provide access pathways and provisions for emergency smoke ventilation as required by the *International Fire Code*.

**C411.7 Structural integrity.** The as-designed dead load and live load for the solar zone shall be clearly marked on the record drawings and shall accommodate future photovoltaic system arrays at an assumed dead load of 4 pounds per square foot in addition to other required live and dead loads. A location for future inverters shall be designated either within or adjacent to the solar zone, with a minimum area of 2 square feet for each 1000 square feet of solar zone area, and shall accommodate an assumed dead load of 175 pounds per square foot. Where photovoltaic systems are installed in the solar zone, structural analysis shall be based upon calculated loads, not upon these assumed loads.

**C411.8 Photovoltaic interconnection.** Interconnection of the future photovoltaic system shall be provided for at the main service panel, either ahead of the service disconnecting means or at the end of the bus opposite the service disconnecting means, in one of the following forms:

1. A space for the mounting of a future overcurrent device, sized to accommodate the largest standard rated overcurrent device that is less than 20 percent of the bus rating.

2. Lugs sized to accommodate conductors with an ampacity of at least 20 percent of the bus rating, to enable the mounting of an external overcurrent device for interconnection.

The electrical construction documents shall indicate all of the following:

1. Solar zone boundaries and access pathways.
2. Location for future inverters and metering equipment.
3. Route for future wiring between the photovoltaic panels and the inverter, and between the inverter and the main service panel.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

## **WAC 51-11C-50000 Chapter 5 [CE]—Existing buildings.**

### **C501 General.**

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

**C501.2 Existing buildings.** Except as specified in this chapter, this code shall not be used to require the removal, *alteration* or abandonment of, nor prevent the continued use and maintenance of, an existing building or building system lawfully in existence at the time of adoption of this code.

**C501.3 Maintenance.** Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems which are required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

**C501.4 Compliance.** *Alterations, repairs, additions* and changes of occupancy to, or relocation of, existing buildings and structures shall comply 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 Mechanical Code, Uniform Plumbing Code, and NFPA 70.

**C501.4.1 U-factor requirements for retrofits.** For existing building projects where an addition or building envelope retrofit area is combined with existing-to-remain building areas to demonstrate compliance with this code as a whole building, the U-factors applied to existing-to-remain envelope assemblies shall be in accordance with record documents.

**EXCEPTIONS:**

1. If accurate record documents are not available, U-factors for the existing envelope assemblies may be in accordance with the edition of the Washington State Energy Code that was in effect at the time the building was permitted.
2. U-factors for the existing envelope assemblies as approved by the code official.

**C501.4.2 Calculations of mechanical heating and cooling loads for retrofits.** For the installation of new or replacement mechanical equipment that serves existing building areas, design loads associated with heating, cooling and ventilation of the existing building areas served shall be determined in accordance with Section C403.1.1.

R-values and U-factors used to determine existing thermal envelope performance for the purpose of calculating design loads shall be in accordance with record documents or existing conditions.

**EXCEPTIONS:**

1. If accurate record documents are not available, U-factors for the existing envelope assemblies may be in accordance with the edition of the Washington State Energy Code that was in effect at the time the building was permitted.
2. U-factors for the existing envelope assemblies as approved by the code official.

**C501.5 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

**C501.6 Historic buildings.** The building official may modify the specific requirements of this code for historic buildings and require alternate provisions which will result in a reasonable degree of energy efficiency. This modification may be allowed for those buildings or structures that are listed in the state or national register of historic places; designated as a historic property under local or state designation law or survey; certified as a contributing resource with a national register listed or locally designated historic district; or with an opinion or certification that the property is eligible to be listed on the national or state registers of historic places either individually or as a contributing building to a historic district by the state historic preservation officer or the keeper of the national register of historic places.

**C501.7 Commissioning.** Existing building systems shall be commissioned in accordance with Section C408. For the purposes of meeting the commissioning thresholds in Section C408.1, only the new and altered system capacities are considered when determining whether the project is exempt from some portion of the commissioning process.

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-50200 Section C502—Additions.**

**C502.1 General.** Additions to an existing building, building system or portion thereof shall conform to the provisions of this code as they relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code. Additions shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this code if the addition alone complies or if the existing building and addition comply with this code as a single building. Additions shall comply with Sections C402, C403, C404, C405, C409.5, C410 and C502.2.

**C502.2 Prescriptive compliance.** Additions shall comply with Sections C502.2.1 through C502.2.6.2.

**C502.2.1 Vertical fenestration.** Additions with vertical fenestration that results in a total building vertical fenestration area less than or equal to that specified in Section C402.4.1 shall comply with Sec-



tion C402.4. *Additions with vertical fenestration* that results in a total building vertical fenestration area greater than that specified in Section C402.4.1 shall comply with one of the following:

1. Vertical fenestration alternate per Section C402.4.1.1 or C402.4.1.3 for the addition area of the building only.

2. Component performance (~~(option)~~) alternative with target area adjustment per Section C402.1.5 (~~(or the total building performance option in Section C407)~~) for the addition area of the building only.

3. Existing building and addition area are combined to demonstrate compliance with the component performance alternative for the whole building.

4. Total building performance in accordance with Section C407 for the addition area of the building only.

5. Total building performance for the whole building.

**C502.2.2 Skylight area.** *Additions with skylights* that result in a total building skylight area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.4. *Additions with skylights that result in a total building skylight area greater than that specified in Section C402.4.1 shall comply with* (~~(the component performance option with the target area adjustment per Section C402.1.5 or the total building performance option in Section C407)~~) one of the following:

1. Vertical fenestration alternate per Section C402.4.1.1 or C402.4.1.3 for the addition area of the building only.

2. Component performance alternative with target area adjustment per Section C402.1.5 for the addition area of the building only.

3. Existing building and addition area are combined to demonstrate compliance with the component performance alternative for the whole building.

4. Total building performance in accordance with Section C407 for the addition area of the building only.

5. Total building performance for the whole building.

**C502.2.3 Building mechanical systems.** New mechanical systems and equipment serving the building heating, cooling or ventilation needs, that are part of the addition, shall comply with Section C403.

**C502.2.4 Service water heating systems.** New service water-heating equipment, controls and service water heating piping shall comply with Section C404.

**C502.2.5 Pools and permanent spas.** New pools and permanent spas shall comply with Section C404.11.

**C502.2.6 Lighting and power systems.** New lighting systems that are installed as part of the addition shall comply with Section C405.

**C502.2.6.1 Interior lighting power.** The total interior lighting power for the addition shall comply with Section C405.4.2 for the addition alone, or the existing building and the addition shall comply as a single building.

**C502.2.6.2 Exterior lighting power.** The total exterior lighting power for the addition shall comply with Section C405.5.1 for the addition alone, or the existing building and the addition shall comply as a single building.

**C502.2.7 Refrigeration systems.** New refrigerated spaces and refrigeration equipment shall comply with Section C410.

**For Section 503, Alterations, See page 282.**

**For Section 505, Change of occupancy or use, See page 289.**

AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-600000 Chapter 6 [CE]—Referenced standards.** This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section C106.

<b>AAMA</b>	American Architectural Manufacturers Association 1827 Walden Office Square Suite 550 Schaumburg, IL 60173-4268		
Standard reference number	Title		Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A (( <del>C440—14</del> ) <u>C440—17</u> )	North American Fenestration Standard/ Specifications for Windows, Doors and Unit Skylights	.....	Table C402.4.2
<b>AHAM</b>	Association of Home Appliance Manufacturers 1111 19th Street, N.W., Suite 402 Washington, D.C. 20036		
Standard reference number	Title		Referenced in code section number
ANSI/AHAM RAC-1—2008	Room Air Conditioners	.....	Table (( <del>C403.2.3</del> ) <u>C403.3.2(3)</u> )
AHAM (( <del>HRF-1—2007</del> ) <u>HRF-1—2017</u> )	Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers	.....	Table C410.1(1)
<b>AHRI</b>	Air Conditioning, Heating, and Refrigeration Institute 4100 North Fairfax Drive, Suite 200 Arlington, VA 22203		
Standard reference number	Title		Referenced in code section number
ISO/AHRI/ASHRAE 13256-1 (( <del>(2014)</del> ) <u>(2017)</u> )	Water-source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-air and Brine-to-air Heat Pumps	.....	Table (( <del>C403.2.3</del> ) <u>C403.3.2(2)</u> )
ISO/AHRI/ASHRAE 13256-2 (( <del>(2014)</del> ) <u>(2017)</u> )	Water-source Heat Pumps - Testing and Rating for Performance - Part 2: Water-to-water and Brine-to-water Heat Pumps	.....	Table (( <del>C403.2.3</del> ) <u>C403.3.2(2)</u> )
(( <del>210/240—08 with Addenda 1 and 2</del> ) <u>210/240—2016</u> )	Unitary Air Conditioning and Air-source Heat Pump Equipment	.....	Table (( <del>C403.2.3</del> ) <u>C403.3.2(1)</u> , Table (( <del>C403.2.3</del> ) <u>C403.3.2(2)</u> )
(( <del>310/380—04</del> ) <u>310/380—2014</u> )	Standard for Packaged Terminal Air Conditioners and Heat Pumps	.....	Table (( <del>C403.2.3</del> ) <u>C403.3.2(3)</u> )
(( <del>340/360—2007 with Addendum 2</del> ) <u>340/360—2015</u> )	Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment	.....	Table (( <del>C403.2.3</del> ) <u>C403.3.2(1)</u> , Table (( <del>C403.2.3</del> ) <u>C403.3.2(2)</u> )

<del>((365—09))</del> <u>365—2009</u>	Commercial and Industrial Unitary Air-conditioning Condensing Units	.....	Table <del>((C403.2.3))</del> <u>C403.3.2(1)</u> , Table <del>((C403.2.3))</del> <u>C403.3.2(6)</u>
<del>((390—03))</del> <u>390—2015</u>	Performance Rating of Single Package Vertical Air Conditioners and Heat Pumps	.....	Table <del>((C403.2.3))</del> <u>C403.3.2(3)</u>
<del>((400—04))</del> <u>400—2015</u>	Liquid to Liquid Heat Exchangers with Addendum 2	.....	Table <del>((C403.2.3))</del> <u>C403.3.2(9)</u>
440—08	Room Fan Coil	.....	C403.2.8
460—05	Performance Rating Remote Mechanical Draft Air-cooled Refrigerant Condensers	.....	Table <del>((C403.2.3))</del> <u>C403.3.2(8)</u>
<del>((550/590—2011 with Addendum 1))</del> <u>550/590—2015</u>	Water Chilling Packages Using the Vapor Compression Cycle—with Addenda	.....	C403.2.3.1, Table C403.2.3(7), Table C406.2(6)
560—00	Absorption Water Chilling and Water-heating Packages	.....	Table C403.2.3(7)
<u>920—2015</u>	<u>Performance Rating of DX-Dedicated Outdoor Air System Units</u>	<u>.....</u>	<u>C202, Table C403.3.2(11),</u> <u>Table C403.3.2(12)</u>
<del>((1160—08))</del> <u>1160—2014</u>	Performance Rating of Heat Pump Pool Heaters	.....	Table C404.2
<del>((1200-2010))</del> <u>1200—2013</u>	Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets	.....	C410.1, Table C410.1(1), Table C410.1(2)
<b>AMCA</b>	Air Movement and Control Association International 30 West University Drive Arlington Heights, IL 60004-1806		
Standard reference number	Title		Referenced in code section number
205—12	Energy Efficiency Classification for Fans	.....	<del>((C403.2.11.3))</del> <u>C403.8.3</u>
220—8 (2012)	Laboratory Methods for Testing Air Curtain Units for Aerodynamic Performance Rating	.....	C402.5.7
500D—12	Laboratory Methods for Testing Dampers for Rating	.....	C402.4.5.1, C402.4.5.2
<b>ANSI</b>	American National Standards Institute 25 West 43rd Street Fourth Floor New York, NY 10036		
Standard reference number	Title		Referenced in code section number
ANSI/ASME A17.1—2010	Safety code for elevators and escalators	.....	C405.12.1
Z21.10.3/CSA 4.3—11	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—12	Gas-fired Central Furnaces	.....	Table <del>((C403.2.3))</del> <u>C403.3.2(4)</u>
Z83.8/CSA 2.6—09	Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-fired Duct Furnaces	.....	Table <del>((C403.2.3))</del> <u>C403.3.2(4)</u>
<b>APSP</b>	The Association of Pool and Spa Professionals 2111 Eisenhower Avenue Alexandria, VA 22314		

Standard reference number	Title	Referenced in code section number
<del>((14-11))</del> <u>14—2014</u>	American National Standards for Portable Electric Spa Efficiency . . . . .	C404.12
<b>ASHRAE</b>	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 1791 Tullie Circle, N.E. Atlanta, GA 30329-2305	
Standard reference number	Title	Referenced in code section number
ANSI/ASHRAE/ACCA Standard 127-2007	Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners . . . . .	Table <del>((C403.2.3))</del> <u>C403.3.2(9)</u>
Standard 183—2007	Peak Cooling and Heating Load Calculations in Buildings, Except Low-rise Residential Buildings . . . . .	<del>((C403.2.1))</del> <u>C403.1.2</u>
<del>((ASHRAE—2012))</del> <u>ASHRAE—2016</u>	ASHRAE HVAC Systems and Equipment Handbook— <del>((2012))</del> <u>2016</u> . . . . .	<del>((C403.2.1))</del> <u>C403.1.2</u>
ISO/AHRI/ASHRAE 13256-1 (2011)	Water-source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-air and Brine-to-air Heat Pumps . . . . .	Table <del>((C403.2.3))</del> <u>C403.3.2(2)</u>
ISO/AHRI/ASHRAE 13256-2 (2011)	Water-source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-water and Brine-to-water Heat Pumps . . . . .	Table <del>((C403.2.3))</del> <u>C403.3.2(2)</u>
90.1—2013	Energy Standard for Buildings Except Low-rise Residential Buildings (ANSI/ASHRAE/IESNA 90.1—2010) . . . . .	Table C402.1.3, Table C402.1.4, C406.2 <del>((Table C407.6.1))</del>
<del>((140—2011</del>	<del>Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs</del> . . . . .	<del>C407.6.1))</del>
<u>90.4—2016</u>	<u>Energy Standard for Data Centers</u> . . . . .	<u>C403.1.3</u>
146—2011	Testing and Rating Pool Heaters . . . . .	Table C404.2
<b>ASME</b>	American Society of Mechanical Engineers Two Park Avenue New York, NY 10016-5990	
Standard reference number	Title	Referenced in code section number
ASME A17.1/CSA <del>((B44-2013))</del> <u>B44—2016</u>	Safety Code for Elevators and Escalators . . . . .	C405.9.2
<b>ASTM</b>	ASTM International 100 Barr Harbor Drive West Conshohocken, PA 19428-2859	
Standard reference number	Title	Referenced in code section number
C <del>((90—13))</del> <u>90—14</u>	Specification for Load-bearing Concrete Masonry Units . . . . .	Table C402.1.3
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

C ((1371—04a(2010)e1)) <u>1371—15</u>	Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers	.....	Table C402.4
C 1549—09	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using A Portable Solar Reflectometer	.....	Table C402.4
D ((1003—11e1)) <u>1003—13</u>	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics	.....	C402.4.2.2
E 283—04(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
E ((408—71 (2008))) <u>408—13</u>	Test Methods for Total Normal Emittance of Surfaces Using Inspection-meter Techniques	.....	Table C402.4
E 779—10	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization	.....	C402.5.1.2.3
E ((903—96)) <u>903—12</u>	Standard Test Method Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)	.....	Table C402.4
E 1677—11	Standard Specification for an Air-retarder (AR) Material or System for Low-rise Framed Building Walls	.....	C402.5.1.2.2
E 1918—06 (2015)	Standard Test Method for Measuring Solar Reflectance of Horizontal or Low-sloped Surfaces in the Field	.....	Table C402.4
E 1980—11	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces	.....	Table C402.2.1.1
E 2178—13	Standard Test Method for Air Permanence of Building Materials	.....	C402.4
E 2357—11	Standard Test Method for Determining Air Leakage of Air Barrier Assemblies	.....	C402.5.1.2.2
<b>CSA</b>	Canadian Standards Association 5060 Spectrum Way Mississauga, Ontario, Canada L4W 5N6		
Standard reference number	Title		Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standard/ Specification for Windows, Doors and Unit Skylights	.....	Table C402.4.2
<b>CTI</b>	Cooling Technology Institute 2611 FM 1960 West, Suite A-101 Houston, TX 77068		
Standard reference number	Title		Referenced in code section number
ATC 105 (00)	Acceptance Test Code for Water Cooling Tower	.....	Table ((C403.2.3)) <u>C403.3.2(8)</u>
ATC 105S—11	Acceptance Test Code for Closed Circuit Cooling Towers	.....	Table ((C403.2.3)) <u>C403.3.2(8)</u>
ATC 106—11	Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers	.....	Table ((C403.2.3)) <u>C403.3.2(8)</u>
STD 201—11	Standard for Certification of Water Cooling Towers Thermal Performances	.....	Table ((C403.2.3)) <u>C403.3.2(8)</u>
<b>DASMA</b>	Door and Access Systems Manufacturers Association		

	1300 Sumner Avenue Cleveland, OH 44115-2851	
Standard reference number	Title	Referenced in code section number
105—92 (R2004)—13	Test Method for Thermal Transmittance and Air Infiltration of Garage Doors . . . . .	Table C402.4.2
<b>DOE</b>	U.S. Department of Energy c/o Superintendent of Documents U.S. Government Printing Office Washington, D.C. 20402-9325	
Standard reference number	Title	Referenced in code section number
10 C.F.R., Part 430— ((+998)) <u>2015</u>	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 (( <del>C403.2.3</del> )) C403.3.2(4), Table(( <del>C403.2.3</del> )) C403.3.2(5), Table C404.2
10 C.F.R., Part 430, Subpart B, Appendix N—((+998)) <u>2015</u>	Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers . . . . .	C202
10 C.F.R., Part 431— ((2004)) <u>2015</u>	Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and Efficiency Standards; Final Rules . . . . .	Table (( <del>C403.2.3</del> )) C403.3.2(5), Table C406.2(5)
NAECA 87—(88)	National Appliance Energy Conservation Act 1987 [(Public Law 100-12 (with Amendments of 1988-P.L. 100-357)] . . . . .	Tables (( <del>C403.2.3</del> )) C403.3.2 (1), (2), (4)
<b>IAPMO</b>	International Association of Plumbing and Mechanical Officials 4755 E. Philadelphia Street Ontario, CA 91761	
Standard reference number	Title	Referenced in code section number
UPC—2015	Uniform Plumbing Code . . . . .	C201.3, C501.4
<b>ICC</b>	International Code Council, Inc. 500 New Jersey Avenue, N.W., 6th Floor Washington, D.C. 20001	
Standard reference number	Title	Referenced in code section number
IBC—15	International Building Code . . . . .	C201.3, C303.2, C402.4.3
IFC—15	International Fire Code . . . . .	C201.3, C501.4
IFGC—15	International Fuel Gas Code . . . . .	C201.3, C501.4

IMC—15	International Mechanical Code	.....	C106.3, C201.3, C402.5.3, ((C403.2.4.3, C403.2.6, C403.2.6.2, C403.2.6.4, C403.2.6.4.1, C403.2.8.2, C403.2.8.3, C403.2.8.3.1, C403.2.8.3.2, C403.2.11.4, C403.2.11.5, C403.4.4, C403.4.4.3, C403.5.1)) C403.2.2.1, C403.2.2.2, C403.3.5, C403.3.5.1, C403.6.1, C403.6.5, C403.6.10, C403.7.1, C403.7.2, C403.7.5, C403.7.5.1, C403.7.6, C403.7.7.3, C403.7.8.1, C403.7.8.4, C403.8.4, C403.8.5.1, Table C403.10.1, C403.10.1.2, Table C403.10.1.2, C403.10.2.2, C403.12, C406.6, C408.2.2.1, C501.4
<b>IEEE</b>	The Institute of Electrical and Electronic Engineers, Inc. 3 Park Avenue New York, NY 10016		
Standard reference number	Title		Referenced in code section number
IEEE 515.1—2012	IEEE Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications	.....	C404.6.2
<b>IESNA</b>	Illuminating Engineering Society of North America 120 Wall Street, 17th Floor New York, NY 10005-4001		
Standard reference number	Title		Referenced in code section number
ANSI/ASHRAE/IESNA 90.1—2013	Energy Standard for Buildings Except Low-rise Residential Buildings	.....	Table C402.1.3, Table C402.1.4, Table C407.5.1
<b>ISO</b>	International Organization for Standardization 1, rue de Varembe, Case postale 56, CH-1211 Geneva, Switzerland		
Standard reference number	Title		Referenced in code section number
ISO/AHRI/ASHRAE 13256-1 (2011)	Water-source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-air and Brine-to-air Heat Pumps	.....	((C403.2.3)) C403.3.2(2)
ISO/AHRI/ASHRAE 13256-2 (2011)	Water-Source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-water and Brine-to-water Heat Pumps	.....	((C403.2.3)) C403.3.2(2)
<b>NEMA</b>	National Electric Manufacturers Association 1300 North 17th Street Suite 1752 Rosslyn, VA 22209		
Standard reference number	Title		Referenced in code section number

TP-1-2002	Guide for Determining Energy Efficiency for Distribution Transformers	.....	C405.9
MGI—((1993)) <u>2014</u>	Motors and Generators	.....	C202
<b>NFRC</b>	National Fenestration Rating Council, Inc. 6305 Ivy Lane, Suite 140 Greenbelt, MD 20770		
Standard reference number	Title		Referenced in code section number
100—((2009)) <u>2017</u>	Procedure for Determining Fenestration Product U-factors	.....	C303.1.2, C402.2.2
200—((2009)) <u>2017</u>	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence	.....	C303.1.3, C402.4.1.1
<u>202—2017</u>	<u>Procedure for Determining Fenestration Product Visible Transmittance at Normal Incidence</u>	.....	<u>C202</u>
<u>NFRC 203—2017</u>	<u>Procedure for Determining Visible Transmittance of Tubular Daylighting Devices</u>	.....	<u>C202, C402.4.2</u>
400—((2009)) <u>2017</u>	Procedure for Determining Fenestration Product Air Leakage	.....	Table C402.4.2
<b>SMACNA</b>	Sheet Metal and Air Conditioning Contractors National Association, Inc. 4021 Lafayette Center Drive Chantilly, VA 20151-1209		
Standard reference number	Title		Referenced in code section number
SMACNA—2012	HVAC Air Duct Leakage Test Manual	.....	(( <del>C403.2.8.1.3</del> )) <u>C403.10.2.3</u>
<b>UL</b>	Underwriters Laboratories 333 Pfingsten Road Northbrook, IL 60062-2096		
Standard reference number	Title		Referenced in code section number
710—12	Exhaust Hoods for Commercial Cooking Equipment	.....	C403.2.8
727—06	Oil-fired Central Furnaces—with Revisions through April 2010	.....	Table (( <del>C403.2.3</del> )) <u>C403.3.2(4)</u>
731—95	Oil-fired Unit Heaters—with Revisions through April 2010	.....	Table (( <del>C403.2.3</del> )) <u>C403.3.2(4)</u>
<b>US-FTC</b>	United States-Federal Trade Commission 600 Pennsylvania Avenue N.W. Washington, D.C. 20580		
Standard reference number	Title		Referenced in code section number
C.F.R. Title 16 (((May 31, 2005)) <u>2015</u> )	R-value Rule	.....	C303.1.4
<b>WDMA</b>	Window and Door Manufacturers Association 1400 East Touhy Avenue, Suite 470 Des Plaines, IL 60018		
Standard reference number	Title		Referenced in code section number



AMENDATORY SECTION (Amending WSR 16-03-072, filed 1/19/16, effective 7/1/16)

**WAC 51-11C-80500 Appendix D—((Renewable energy)) Calculation of HVAC total system performance ratio.**

~~((AE101.1 On-site renewable energy systems. Each new commercial building or addition larger than 5,000 square feet of gross conditioned floor area shall include a renewable energy generation system consisting of at least 70 watts rated peak photovoltaic energy production, or 240 kBtu of annual solar water heating energy production, per 1,000 square feet of conditioned floor area or fraction thereof. For buildings over 5 stories in height, the conditioned area for this calculation shall be based on the conditioned area of the largest 5 above-grade stories in the building. If the on-site renewable energy option in C406 is selected, this energy shall be in addition to that required by C406.~~

EXCEPTION: Alternate means of achieving equivalent energy savings are permissible where approved by the code official, if the calculated net annual energy savings equals or exceeds the calculated annual energy production of the required on-site renewable energy system.))

**D101 Scope.** This appendix establishes criteria for demonstrating compliance using the HVAC total system performance ratio (HVAC TSPR) for office, retail, library and education occupancies. For those occupancies, HVAC systems shall comply with Section C403 and this appendix as required by Section C403.1.1.

**D201 Compliance.** Compliance based on HVAC total system performance ratio requires that the provisions of Section C403.3 are met and the HVAC total system performance ratio of the proposed design is more than or equal to the HVAC total system performance ratio of the standard reference design. The HVAC TSPR is calculated according to the following formula:

HVAC TSPR = annual heating and cooling load/annual carbon emissions from energy consumption of the building HVAC systems

Where:

Annual carbon emissions from energy consumption of the building HVAC systems = sum of the annual carbon emissions in pounds for heating, cooling, fans, energy recovery, pumps, and heat rejection calculated by multiplying site energy consumption by the carbon emission factors from Table C407.1

Annual heating and cooling load = sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btus.

**Table C407.1 (Reprinted from Chapter 4)**

### **Carbon Emissions Factors**

<b><u>Type</u></b>	<b><u>CO2e (lb/unit)</u></b>	<b><u>Unit</u></b>
<u>Electricity</u>	<u>0.70</u>	<u>kWh</u>
<u>Natural gas</u>	<u>11.70</u>	<u>Therm</u>
<u>Oil</u>	<u>19.2</u>	<u>Gallon</u>
<u>Propane</u>	<u>10.5</u>	<u>Gallon</u>
<u>Other<sup>a</sup></u>	<u>195.00</u>	<u>mmBtu</u>
<u>On-site renewable energy</u>	<u>0.00</u>	

<sup>a</sup> District energy systems may use alternative emissions factors supported by calculations approved by the *code official*.

### **D300 Simulation program.**

#### **D301 General.**

#### **D302 Calculation of the HVAC TSPR for the Standard Reference Design.**

The simulation program shall calculate the HVAC TSPR based only on the input for the *proposed design* and the requirements of this appendix. The calculation procedure shall not allow the user to directly modify the building component characteristics of the *standard reference design*.

**D303 Specific approval.** Performance analysis tools meeting the applicable subsections of Appendix D and tested according to ASHRAE Standard 140 shall be permitted to be *approved*. 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.

**D400 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://buildingenergyscore.energy.gov/resources>

**D500 Documentation.** Documentation conforming to the provisions of this section shall be provided to the *code official*.

#### **D501 Compliance report.** Building permit submittals shall include:

1. A report produced by the simulation software that includes the following:

1.1 Address of the building.

1.2 Name of individual completing the compliance report.

1.3 Name and version of the compliance software tool.

1.4 The dimensions, floor heights and number of floors for each *block*.

1.5 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.

1.6 By *block* or by surface for each *block*, the fenestration area.

1.7 By *block*, a list of the HVAC equipment simulated in the proposed design including the equipment type, fuel type, equipment efficiencies and system controls.

1.8 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 D601.11 including:

- 2.1 Fans.
- 2.2 Hydronic pumps.
- 2.3 Air handlers.
- 2.4 Packaged cooling equipment.
- 2.5 Furnaces.
- 2.6 Heat pumps.
- 2.7 Boilers.
- 2.8 Chillers.
- 2.9 Cooling towers.
- 2.10 Electric resistance coils.
- 2.11 Condensing units.
- 2.12 Motors for fans and pumps.
- 2.13 Energy recovery devices.

For each piece of equipment identified above, include the following as applicable:

- 2.14 Equipment name or tag consistent with that found on the design documents.
- 2.15 Efficiency level.
- 2.16 Capacity.
- 2.17 Input power for fans and pumps.

3. Floor plan of the building identifying how portions of the building are assigned to the simulated blocks and areas of the building that are not covered under the requirements of Section C403.1.1.

**D600 Calculation procedure.** Except as specified by this appendix, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques.

**D601 Simulation of the proposed building design.** The proposed design shall be configured and analyzed as specified in this section.

**D601.1 Utility rates.** For the purpose of calculating the HVAC TSPR the following simple utility rate determined by the Washington state department of commerce shall be used:

- \$0.112/kWh of electricity.
- \$1.158/therm of fossil fuel.

**D601.2 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 predefined 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.

**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.

**D601.2.1 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 (office, library, education 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 2 feet, unique *blocks* should be created for the floors with varying heights.

4. 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*.

5. 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 (USHGC) on each façade of a given floor cannot differ by more than 15 percent of the average USHGC 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.

6. For a building model with multiple *blocks*, the *blocks* should be configured together to have the same adjacencies as the actual building design.

**D601.3 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 5 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 2 facades. The remaining area or each floor shall be modeled as a core zone with no exterior walls.

#### **D601.4 Occupancy.**

**D601.4.1 Occupancy type.** The occupancy type for each *block* shall be consistent with the building area type as determined in accordance with Section C405.4.2.1. Portions of the building that are building area types other than office, school (education), library, or retail shall not be included in the simulation.

**D601.4.2 Occupancy schedule, density, and heat gain.** The occupant density, heat gain, and schedule shall be for office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C.

#### **D601.5 Envelope components.**

**D601.5.1 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.

**D601.5.2 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.

**D601.5.3 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.

**D601.5.4 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.

**D601.5.5 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.

**D601.5.6 Vertical fenestration.** The window area and area weighted *U*-factor and SHGC shall be modeled for each façade based on the proposed design. Each exterior surface in a block must comply with Section D601.2.1 item 5. Windows will be combined in to a single window centered on each façade based on the area and sill height input by the user.

**D601.5.7 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 in to a single skylight centered on the roof of each zone based on the area and sill height input by the user.

**D601.6 Lighting.** Interior lighting power density shall be equal to the allowance in Table C405.4.2(1) for office, retail, library, or school. The lighting schedule shall be for 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.

**D601.7 Miscellaneous equipment.** The miscellaneous equipment schedule power and shall be for 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.

**D601.8 Elevators.** Elevators shall not be modeled.

**D601.9 Service water heating equipment.** Service water heating shall not be modeled.

**D601.10 On-site renewable energy systems.** On-site renewable energy systems shall not be modeled.

**D601.11 HVAC equipment.** HVAC systems shall meet the requirements of Section C403.

**D601.11.1 Supported HVAC systems.** At a minimum, the HVAC systems shown in Table D601.11.1 shall be supported by the simulation program.

**Table D601.11.1**  
**Proposed Building HVAC Systems Sup-**  
**ported by HVAC TSPR Simulation Soft-**  
**ware**

<u>System No.</u>	<u>System Name</u>	<u>System Abbreviation</u>
<u>1</u>	<u>Packaged Terminal Air Conditioner</u>	<u>PTAC</u>
<u>2</u>	<u>Packaged Terminal Air Heat Pump</u>	<u>PTHP</u>
<u>3</u>	<u>Packaged Single Zone Gas Furnace</u>	<u>PSZGF</u>
<u>4</u>	<u>Packaged Single Zone Heat Pump (air to air only)</u>	<u>PSZHP</u>
<u>5</u>	<u>Variable Refrigerant Flow (air cooled only)</u>	<u>VRF</u>
<u>6</u>	<u>Four Pipe Fan Coil</u>	<u>FPFC</u>
<u>7</u>	<u>Water Source Heat Pump</u>	<u>WSHP</u>
<u>8</u>	<u>Ground Source Heat Pump</u>	<u>GSHP</u>
<u>9</u>	<u>Packaged Variable Air Volume (dx cooling)</u>	<u>PVAV</u>
<u>10</u>	<u>Variable Air Volume (hydronic cooling)</u>	<u>VAV</u>
<u>11</u>	<u>Variable Air Volume with Fan Powered Terminal Units</u>	<u>VAVFPTU</u>
<u>12</u>	<u>Dedicated Outdoor Air System (in conjunction with systems 1-8)</u>	<u>DOAS</u>

**D601.11.2 Proposed building HVAC system simulation.** The HVAC systems shall be modeled as in the *proposed design* with clarifications and simplifications as described in Table D601.11.2. 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 D601.2.1 item 2. Where multiple system components serve a block, average values weighed by the appropriate metric as described in this section shall be used. Heat loss from ducts and pipes shall not be modeled.

**EXCEPTION:** Where the building permit applies to only a portion of an HVAC system and remaining components will be designed under a future building permit, the future components shall be modeled to meet, but not exceed, the requirements of Section C403.

**Table D601.11.2**  
**Proposed Building System Parameters**

<u>Category</u>	<u>Parameter</u>	<u>Fixed or User Defined</u>	<u>Required</u>	<u>Applicable Systems</u>
<u>HVAC System Type</u>	<u>System Type</u>	<u>User Defined</u>	<u>Selected from Table D601.11.1</u>	<u>All</u>

<u>Category</u>	<u>Parameter</u>	<u>Fixed or User Defined</u>	<u>Required</u>	<u>Applicable Systems</u>
<u>System Sizing</u>	<u>Design Day Information</u>	<u>Fixed</u>	99.6 percent heating design and 1 percent dry-bulb and 1 percent wet-bulb cooling design	<u>All</u>
	<u>Zone Coil Capacity</u>	<u>Fixed</u>	Sizing factors used are 1.25 for heating equipment and 1.15 for cooling equipment	<u>All</u>
	<u>Supply Airflow</u>	<u>Fixed</u>	Based on a supply-air-to-room-air temperature <i>set-point</i> difference of 20°F	<u>1-11</u>
		<u>Fixed</u>	Equal to required outdoor air ventilation	<u>12</u>
<u>Outdoor Ventilation Air</u>	<u>Outdoor Ventilation Air Flow Rate</u>	<u>Fixed</u>	As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed DCV control	<u>All</u>
<u>System Operation</u>	<u>Space Temperature Setpoints</u>	<u>Fixed</u>	As specified in ASHRAE Standard 90.1 Normative Appendix C	<u>1-11</u>
	<u>Fan Operation - Occupied</u>	<u>User Defined</u>	Runs continuously during occupied hours or cycled to meet load	<u>1-11</u>
	<u>Fan Operation - Occupied</u>	<u>Fixed</u>	Fan runs continuously during occupied hours	<u>12</u>
	<u>Fan Operation - Night Cycle</u>	<u>Fixed</u>	Fan cycles on to meet setback temperatures	<u>1-11</u>
<u>Packaged Equipment Efficiency</u>	<u>DX Cooling Efficiency</u>	<u>User Defined</u>	Cooling COP without fan energy calculated in accordance with ASHRAE Standard 90.1 Section 11.5.2c. <sup>b</sup>	<u>1, 2, 3, 4, 5, 7, 8, 9, 11, 12</u>
	<u>Heat Pump Efficiency</u>	<u>User Defined</u>	Heating COP without fan energy calculated in accordance with ASHRAE Standard 90.1 Section 11.5.2c. <sup>c</sup>	<u>2, 4, 5, 7, 8</u>
	<u>Furnace Efficiency</u>	<u>User Defined</u>	Furnace thermal efficiency <sup>c</sup>	<u>3, 11</u>
<u>Heat Pump Supplemental Heat</u>	<u>Control</u>	<u>Fixed</u>	Supplemental electric heat locked out above 40°F. Runs in conjunction with compressor between 40°F and 0°F.	<u>2, 4</u>
<u>System Fan Power</u>	<u>Design Fan Power (W/cfm)</u>	<u>User Defined</u>	Input electric power for all fans is required to operate at <i>fan system design conditions</i> divided by the supply airflow rate	<u>All</u>
	<u>Single Zone System Fan Power During Deadband (W/cfm)</u>	<u>User Defined</u>	W/cfm during deadband for VAV or multispeed single zone fans	<u>3, 4, 5, 6, 7, 8</u>

<u>Category</u>	<u>Parameter</u>	<u>Fixed or User Defined</u>	<u>Required</u>	<u>Applicable Systems</u>
<u>Variable Air Volume Systems</u>	<u>Part Load Fan Controls</u>	<u>User Defined</u>	<u>VFD included. User specifies presence of static pressure reset</u>	<u>9, 10, 11</u>
	<u>Supply Air Temperature Controls</u>	<u>User Defined</u>	<u>If not SAT reset constant at 55°F. SAT reset results in 60°F SAT during low load conditions</u>	<u>9, 10, 11</u>
	<u>Minimum Terminal Unit Airflow Percentage</u>	<u>User Defined</u>	<u>Average minimum terminal unit airflow percentage for block weighted by cfm</u>	<u>9, 10, 11</u>
	<u>Terminal Unit Heating Source</u>	<u>User Defined</u>	<u>Electric or hydronic</u>	<u>9, 10, 11</u>
	<u>Fan Powered Terminal Unit (FPTU) Type</u>	<u>User Defined</u>	<u>Series or parallel FPTU</u>	<u>11</u>
	<u>Parallel FPTU Fan</u>	<u>Fixed</u>	<u>Sized for 50 percent peak primary air at 0.35 W/cfm</u>	<u>11</u>
	<u>Series FPTU Fan</u>	<u>Fixed</u>	<u>Sized for 50 percent peak primary air at 0.35 W/cfm</u>	<u>11</u>
<u>Economizer</u>	<u>Economizer Presence</u>	<u>User Defined</u>	<u>Yes or No</u>	<u>3, 4, 9, 10, 11</u>
	<u>Economizer High Limit</u>	<u>Fixed</u>	<u>75°F fixed dry-bulb</u>	<u>3, 4, 9, 10, 11</u>
<u>Energy Recovery</u>	<u>Sensible Effectiveness</u>	<u>User Defined</u>	<u>Heat exchanger sensible effectiveness at design heating and cooling conditions</u>	<u>3, 4, 9, 10, 11, 12</u>
	<u>Latent Effectiveness</u>	<u>User Defined</u>	<u>Heat exchanger latent effectiveness at design heating and cooling conditions</u>	<u>3, 4, 9, 10, 11, 12</u>
	<u>Economizer Bypass</u>	<u>User Defined</u>	<u>If ERV is bypassed during economizer conditions</u>	<u>3, 4, 9, 10, 11, 12</u>
	<u>Energy Recovery Temp Control</u>	<u>User Defined</u>	<u>If bypass, target supply air temperature</u>	<u>3, 4, 9, 10, 11, 12</u>
	<u>Fan Power Reduction during Bypass (W/cfm)</u>	<u>User Defined</u>	<u>If ERV system include bypass, static pressure setpoint and variable speed fan, fan power can be reduced during economizer conditions</u>	<u>3, 4, 9, 10, 11, 12</u>
<u>Demand Controlled Ventilation</u>	<u>DCV Application</u>	<u>User Defined</u>	<u>Percent of block floor area under DCV control</u>	<u>3, 4, 9, 10, 11, 12</u>
<u>DOAS</u>	<u>DOAS Fan Power W/cfm</u>	<u>User Defined</u>	<u>Fan input power in W/cfm of supply airflow<sup>a</sup></u>	<u>12</u>
	<u>DOAS Supplemental Heating and Cooling</u>	<u>User Defined</u>	<u>Heating source, cooling source</u>	<u>12</u>
	<u>DOAS Supply Air Temperature Control</u>	<u>User Defined</u>	<u>SAT setpoint if DOAS includes supplemental heating or cooling and active temperature controls</u>	<u>12</u>
<u>Heating Plant</u>	<u>Boiler Efficiency<sup>d</sup></u>	<u>User Defined</u>	<u>Boiler thermal efficiency</u>	<u>1, 6, 7, 9, 10, 11, 12</u>
	<u>Heating Water Pump Power (W/gpm)</u>	<u>User Defined</u>	<u>Pump input W/gpm heating water flow</u>	<u>1, 6, 7, 9, 10, 11, 12</u>
	<u>Heating Water Loop Temperature</u>	<u>Fixed</u>	<u>180°F supply, 130°F return</u>	<u>1, 6, 9, 10, 11</u>



<u>Category</u>	<u>Parameter</u>	<u>Fixed or User Defined</u>	<u>Required</u>	<u>Applicable Systems</u>
<u>Chilled Water Plant</u>	<u>Chiller Compressor Type</u>	<u>User Defined</u>	<u>Screw/scroll, centrifugal or reciprocating</u>	<u>6,10, 11, 12</u>
	<u>Chiller Condenser Type</u>	<u>User Defined</u>	<u>Air cooled or water cooled</u>	<u>6, 10, 11, 12</u>
	<u>Chiller Full Load Efficiency<sup>d</sup></u>	<u>User Defined</u>	<u>Chiller COP</u>	<u>6, 10, 11, 12</u>
	<u>Chilled Water Loop Configuration</u>	<u>User Defined</u>	<u>Variable flow primary only, constant flow primary - variable flow secondary</u>	<u>6, 10, 11, 12</u>
	<u>Chilled Water Pump Power (W/gpm)</u>	<u>User Defined</u>	<u>Pump input W/gpm chilled water flow</u>	<u>6, 10, 11, 12</u>
	<u>Chilled Water Temperature Reset Included</u>	<u>User Defined</u>	<u>Yes/No</u>	<u>6, 10, 11, 12</u>
	<u>Chilled Water Temperature Reset Schedule (if included)</u>	<u>Fixed</u>	<u>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</u>	<u>6, 10, 11, 12</u>
	<u>Condenser Water Pump Power (W/gpm)</u>	<u>User Defined</u>	<u>Pump input W/gpm condenser water flow</u>	<u>6, 7, 8, 9, 10, 11, 12</u>
	<u>Condenser Water Pump Control</u>	<u>User Defined</u>	<u>Constant speed or variable speed</u>	<u>6, 7, 10, 11, 12</u>
	<u>Cooling Tower Efficiency</u>	<u>User Defined</u>	<u>gpm/hp tower fan</u>	<u>6, 10, 11, 12</u>
<u>Cooling Tower</u>	<u>Cooling Tower Fan Control</u>	<u>User Defined</u>	<u>Constant or variable speed</u>	<u>6, 10, 11, 12</u>
	<u>Cooling Tower Approach and Range</u>	<u>User Defined</u>	<u>Design cooling tower approach and range temperature</u>	<u>6, 10, 11, 12</u>
<u>Heat Pump Loop Flow Control</u>	<u>Loop Flow and Heat Pump Control Valve</u>	<u>Fixed</u>	<u>Two position valve with VFD on pump. Loop flow at 3 gpm/ton</u>	<u>7, 8</u>
<u>Heat Pump Loop Temperature Control</u>		<u>Fixed</u>	<u>Set to maintain temperature between 50°F and 70°F</u>	<u>7</u>
<u>GLHP Well Field</u>		<u>Fixed</u>	<u>Bore depth = 250 feet Bore length 200 feet/ton for greater of cooling or heating load Bore spacing = 15 feet Bore diameter = 5 inches 3/4 inch Polyethylene pipe Ground and grout conductivity = 4.8 Btu-in/h-ft<sup>2</sup>-°F</u>	<u>8</u>

<sup>a</sup> Where multiple fan systems serve a single *block*, fan power is based on weighted average using on supply air cfm.

<sup>b</sup> Where multiple cooling systems serve a single *block*, COP is based on a weighted average using cooling capacity.

<sup>c</sup> Where multiple heating systems serve a single *block*, thermal efficiency or heating COP is based on a weighted average using heating capacity.

<sup>d</sup> Where multiple boilers or chillers serve a heating water or chilled water loop, efficiency is based on a weighted average for using heating or cooling capacity.

**D602 Simulation of the standard reference design.** The *standard reference design* shall be configured and analyzed as specified in this section.

**D602.1 Utility rates.** Same as proposed.

**D602.2 Blocks.** Same as proposed.

**D602.3 Thermal zoning.** Same as proposed.

**D602.4 Occupancy type, schedule, density, and heat gain.** Same as proposed.

**D602.5 Envelope components.** Same as proposed.

**D602.6 Lighting.** Same as proposed.

**D602.7 Miscellaneous equipment.** Same as proposed.

**D602.8 Elevators.** Not modeled. Same as proposed.

**D602.9 Service water heating equipment.** Not modeled. Same as proposed.

**D602.10 On-site renewable energy systems.** Not modeled. Same as proposed.

**D602.11 HVAC equipment.** The *standard reference design* HVAC equipment consists of separate space conditioning systems and dedicated outside air systems as described in Table D602.11 for the appropriate building occupancies.

**Table D602.11**  
**Standard Reference Design HVAC Systems**

<u>Parameter</u>	<u>Building Type</u>			
	<u>Large Office<sup>a</sup></u>	<u>Small Office and Libraries<sup>a</sup></u>	<u>Retail</u>	<u>School</u>
<u>System Type</u>	<u>Water-source Heat Pump</u>	<u>Packaged air-source Heat Pump</u>	<u>Packaged air-source Heat Pump</u>	<u>Packaged air-source Heat Pump</u>
<u>Fan Control<sup>b</sup></u>	<u>Cycle on Load</u>	<u>Cycle on Load</u>	<u>Cycle on Load</u>	<u>Cycle on Load</u>
<u>Space Condition Fan Power (W/cfm)</u>	<u>0.528</u>	<u>0.528</u>	<u>0.522</u>	<u>0.528</u>
<u>Heating/Cooling Sizing Factor<sup>c</sup></u>	<u>1.25/1.15</u>	<u>1.25/1.15</u>	<u>1.25/1.15</u>	<u>1.25/1.15</u>
<u>Supplemental Heating Availability</u>	<u>NA</u>	<u>&lt;40°F</u>	<u>&lt;40°F</u>	<u>&lt;40°F</u>
<u>Modeled cooling COP (Net of Fan)<sup>d</sup></u>	<u>4.46</u>	<u>3.83</u>	<u>4.25</u>	<u>3.83</u>
<u>Modeled heating COP (Net of Fan)<sup>d</sup></u>	<u>4.61</u>	<u>3.81</u>	<u>3.57</u>	<u>3.81</u>
<u>Cooling Source</u>	<u>DX (Heat Pump)</u>	<u>DX (Heat Pump)</u>	<u>DX (Heat Pump)</u>	<u>DX (Heat Pump)</u>
<u>Heat Source</u>	<u>Heat Pump</u>	<u>Heat Pump</u>	<u>Heat Pump</u>	<u>Heat Pump</u>
<u>OSA Economizer<sup>e</sup></u>	<u>No</u>	<u>No</u>	<u>Yes</u>	<u>Yes</u>
<u>Occupied Ventilation Source<sup>f</sup></u>	<u>DOAS</u>	<u>DOAS</u>	<u>DOAS</u>	<u>DOAS</u>
<u>DOAS Fan Power (W/cfm of Outside Air)</u>	<u>0.819</u>	<u>0.819</u>	<u>0.730</u>	<u>0.742</u>

<b>Parameter</b>	<b>Building Type</b>			
	<b>Large Office<sup>a</sup></b>	<b>Small Office and Libraries<sup>a</sup></b>	<b>Retail</b>	<b>School</b>
<b>System Type</b>	<b>Water-source Heat Pump</b>	<b>Packaged air-source Heat Pump</b>	<b>Packaged air-source Heat Pump</b>	<b>Packaged air-source Heat Pump</b>
<u>DOAS Temperature Control<sup>g, h</sup></u>	<u>Bypass</u>	<u>Wild</u>	<u>Bypass</u>	<u>Bypass</u>
<u>ERV Efficiency (Sensible Only)</u>	<u>70 percent</u>	<u>70 percent</u>	<u>70 percent</u>	<u>70 percent</u>
<u>WSHP Loop Heat Rejection</u>	<u>Cooling Tower<sup>i</sup></u>	<u>NA</u>	<u>NA</u>	<u>NA</u>
<u>WSHP Loop Heat Source</u>	<u>Gas Boiler<sup>j</sup></u>	<u>NA</u>	<u>NA</u>	<u>NA</u>
<u>WSHP Loop Temperature Control<sup>k</sup></u>	<u>50°F to 70°F</u>	<u>NA</u>	<u>NA</u>	<u>NA</u>
<u>WSHP Circulation Pump W/gpm<sup>l</sup></u>	<u>16</u>	<u>NA</u>	<u>NA</u>	<u>NA</u>
<u>WSHP Loop Pumping Control<sup>m</sup></u>	<u>HP Valves &amp; Pump VSD</u>	<u>NA</u>	<u>NA</u>	<u>NA</u>

<sup>a</sup> Offices less than 50,000 square feet use "Small Office" parameters; otherwise use "Large Office" parameters.

<sup>b</sup> Space conditioning system shall cycle on to meet heating and cooling setpoint schedules as specified in ASHRAE Standard 90.1 Normative Appendix C. One space conditioning system is modeled in each zone. Conditioning system fan operation is not necessary for ventilation delivery.

<sup>c</sup> The equipment capacities (i.e., system coil capacities) for the *standard reference design* building design shall be based on design day sizing runs and shall be oversized by 15 percent for cooling and 25 percent for heating.

<sup>d</sup> COPs shown are direct heating or cooling performance and do not include fan energy use. See ASHRAE 90.1 Appendix G (G3.1.2.1) for separation of fan from COP in packaged equipment for units where the efficiency rating includes fan energy (e.g., SEER, EER, HSPF, COP).

<sup>e</sup> Economizer on space conditioning systems shall be simulated when outdoor air conditions allow free cooling. Economizer high limit shall be based on differential dry-bulb control. DOAS system continues to operate during economizer mode.

<sup>f</sup> Airflow equal to the outside air ventilation requirements is supplied and exhausted through a separate DOAS system including a supply fan, exhaust fan and sensible only heat exchanger. No additional heating or cooling shall be provided by the DOAS. A single DOAS system will be provided for each *block*. The DOAS supply and return fans shall run whenever the HVAC system is scheduled to operate in accordance with ASHRAE 90.1 Normative Appendix C.

<sup>g</sup> "Wild" DOAS control indicates no active control of the supply air temperature leaving the DOAS system. Temperature will fluctuate based only on entering and leaving conditions and the effectiveness of ERV.

<sup>h</sup> "Bypass" DOAS control includes modulating dampers to bypass ERV with the intent to maintain supply air temperature at a maximum of 60°F when outside air is below 75°F. Once outside air is above 75°F, bypass dampers will be fully closed.

<sup>i</sup> Includes a single axial fan cooling tower with variable speed fans at 40.2 gpm/hp, sized for an approach of 10°F and a range of 10°F.

<sup>j</sup> Includes a single natural draft boiler with 80 percent E<sub>t</sub>.

<sup>k</sup> Loop boiler and heat rejection shall be controlled to maintain loop temperature entering heat pumps between 50°F and 70°F.

<sup>l</sup> Pump motor input power shall be 16 W/gpm.

<sup>m</sup> Loop flow shall be variable with variable speed drive pump and unit fluid flow shutoff at each heat pump when its compressor cycles off.

## NEW SECTION

### **WAC 51-11C-90000 Appendix E—Renewable energy.**

**Informational Note:** *The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

**E101.1 On-site renewable energy systems.** Each new commercial building or addition larger than 5,000 square feet of gross conditioned floor area shall include a renewable energy generation system consisting of at least 70 watts rated peak photovoltaic energy production, or 240 kBtu of annual solar water heating energy production, per 1,000 square feet of conditioned floor area or fraction thereof. For buildings over 5 stories in height, the conditioned area for this calculation shall be based on the conditioned area of the largest 5 above-grade stories in the building. If the on-site renewable energy option in C406 is selected, this energy shall be in addition to that required by C406.

**EXCEPTION:** Alternate means of achieving equivalent energy savings are permissible where approved by the code official, if the calculated net annual energy savings equals or exceeds the calculated annual energy production of the required on-site renewable energy system.

## NEW SECTION

### **WAC 51-11C-90500 Appendix F—Outcome-based energy budget.**

**Informational Note:** *The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

**F101.1 General.** This section is an outcome-based energy budget compliance requirement pursuant to RCW 19.27A.160 to incrementally move toward achieving by 2031 a 70 percent reduction in annual net energy use compared with 2006 baseline. As an outcome-based energy budget, this requirement uses a building's actual energy use to determine compliance.

**F101.2 Scope.** Buildings permitted under this section shall document one year of net energy use below an energy budget within 3 years after occupancy and every 5 years thereafter. Buildings and sites shall also be designed with the ability to offset in the future all estimated energy needs through renewable energy generation with minimum 40 percent on-site, maximum 40 percent off-site, and maximum 20 percent through green power purchase. Buildings that exceed the energy budget by up to 20 percent shall offset the excess amount through a green power purchase agreement. Buildings that exceed the energy budget by more than 20 percent shall, using a posted performance bond or financial securi-

ty, offset the excess amount over 20 percent by installing renewable energy or with an energy retrofit.

**F101.3 Building permit submittal.** Building designs shall establish on the Washington State Outcome-Based Energy Budget form (Figure F101.3):

1. The anticipated building energy use is lower than the energy budget.

2. The energy generation ability in the future is greater than or equal to the anticipated building energy use.

**F101.3.1 Anticipated building energy use.** The total yearly energy use from all metered fuel sources is the anticipated building energy use. Any energy used from district energy, combined heat and power, renewable energy, or captured waste heat systems must be metered. Buildings with any nonmetered energy sources are not permitted for compliance with this section. All secondary spaces and services (examples: Exterior building and site lighting, surface parking, garages, exterior swimming pools, and vehicle recharging stations) associated with the building shall be included in the overall energy use total. The anticipated site Energy Use Intensity (EUI) for each fuel source shall be reported in units of kWh/ft<sup>2</sup>/yr or kBtu/ft<sup>2</sup>/yr using the conversions listed below:

Metered Fuel Source	to kWh:	to kBtu:
Electric	kWh × 1	kWh × 3.412
Gas	Therm × 29.308	Therm × 100
Propane	Cubic Foot × 0.738	Cubic Foot × 2.5185
Fuel Oil	Gallon × 43.872	Gallon × 149.6905

**F101.3.2 Building use and occupancy types.** Building use and occupancy types permitted are indicated in Table F101.3.2.

**F101.3.3 Maximum site energy budget.** Table F101.3.2 indicates the site EUI budget for each building use and occupancy type along with the building enclosure requirements for all use and occupancy types.

**F101.3.3.1 Mixed-use buildings.** For buildings that contain more than one building use or occupancy type, the overall energy budget shall be based on the individual floor area percentage totals of each use times the individual energy budget and summing the results of all individual areas.

**F101.3.3.2 Energy budget level options.** Development teams may commit to a future, more stringent energy budget level from Table F101.3.2. Actual energy use and energy generation ability will be evaluated on this lower budget level.

**F101.3.3.3 Energy modeling.** A proposed building energy model is required for compliance with Section F101.3.2. A baseline energy model is not required. The proposed design model must show estimated energy use below the energy.

**F101.3.4 Energy generation ability.** Permit documents shall indicate the location, space allocated, and connection pathways for future installation of all potential energy generation systems. Only items defined by the Washington State Energy Code as on-site renewable energy shall be used to meet energy generation requirements.

**F101.3.4.1 Energy generation categories.** The development team shall complete the Washington State Outcome-Based Energy Budget form (Figure F101.3) to show the total renewable energy generation ability in the following categories:

1. Building integral: Renewable energy generation sources attached to the building. This value, combined with the on-site value, shall be at least 40 percent of the energy budget.

2. On-site: Renewable energy generation sources located on the building site property. This value, combined with the building integral value, shall be at least 40 percent of the energy budget.

3. Off-site: Renewable energy generation sources not located on the building site. This amount is limited to 40 percent of the energy budget. A specific off-site location does not need to be identified.

4. Green Power: Renewable energy purchased through the electric utility provider for the building. This amount is limited to 20 percent of the energy budget.

**F101.3.4.2 Energy generation ability for building sites within a 2030 District.** The development team for building sites within a designated 2030 District recognized by Architecture 2030 may use the Architecture 2030 Challenge 70 percent energy reduction target from the 2003 baseline as the energy budget. Building locations meeting this criteria and choosing this energy budget are exempt from the building integral and on-site requirements in Section F101.3.4.1. Green power remains capped at 20 percent. The generation requirements may be split, in any amount, among the building integral, on-site, or off-site categories. Actual energy use will be evaluated against the Architecture 2030 Challenge 70 percent energy reduction budget.

**F101.4 Actual energy use submittal.** The building owner or representative shall submit energy use documentation summary from all energy source providers or from an energy benchmarking service to the building code official. Code compliance is achieved with net energy use below the energy budget for any continuous 12-month span within the first 3 years of occupancy.

**F101.4.1 Energy use monitoring period and occupancy.** The energy use monitoring time frame shall start on the first full-month billing cycle of the utility or energy source provider(s) 6 months after a certificate of occupancy is issued. Buildings shall be deemed substantially occupied when a minimum 85 percent of the floor area, including all common areas, is occupied. The energy monitoring start time may be delayed up to an additional 6 months from certificate of occupancy (up to 12 months total) if 85 percent occupancy is not yet achieved. Buildings not 85 percent occupied after 12 months shall start the monitoring period for the portions occupied with an energy budget based on the spaces occupied and all common areas combined.

**F101.4.2 Change of occupancy use during monitoring period.** If an area within the building changes from one occupancy use to another with a different target EUI energy budget or if the building occupancy level drops below 85 percent, the target EUI energy budget shall be recalculated to become the new energy budget against which the building energy use shall be compared for compliance.

**F101.4.3 Energy metering.** All building spaces and uses subject to an energy budget or a portion of the energy budget shall be metered separately for all energy uses.

**F101.4.4 Energy budget responsibility.** The building owner is responsible for the compliance of the whole building. At the building owner's discretion, responsibility for the energy use budget may be divided and transferred into portions attributable to the occupant, operator or controller of each energy budget space. Common area spaces not under the control of an occupant or tenant may not be transferred.

**F101.4.5 Energy budget liability.** A member of the design or construction team may not be held liable for the failure of a building to meet the energy budget requirement established for the project provided the design or construction team made a good-faith attempt to achieve the energy budget requirement set for the building.

**F101.5 Actual energy use above the energy budget.** Buildings exceeding the energy budget are not in compliance with the energy code and the building owner shall complete one of the following measures within 1 year:

1. Owners of buildings with actual energy use that exceeds the energy budget by up to 20 percent may offset the excess energy amount through annual green power purchase agreement from the utility provider at a rate of 1.1 times the excess energy amount until future code compliance is demonstrated.

2. Owners of buildings with actual energy use that exceeds the energy budget by more than 20 percent and up to 40 percent shall complete item 1 and either install on-building, on-site, or off-site energy generation equipment or invest in an energy conservation retrofit using the performance bond or financial security for energy amount remaining above 20 percent.

3. Owners of buildings with actual energy use that exceeds the energy budget by more than 40 percent shall complete item 1, item 2, and post a replacement performance bond or financial security equal to the first bond or security amount.

**F101.5.1 Continued energy monitoring.** Upon completing the necessary compliance measure(s) in Section F101.5 the building owner is provided another 3-year time frame to achieve and document net energy use below the energy budget for any continuous 12-month span. Owners of buildings that remain more than 20 percent above the energy budget shall repeat the measures in Section F101.5, up to 3 times maximum, using the performance bond or financial security to install energy generation equipment or to install an energy retrofit and post a new performance bond equal to the first.

**F101.5.2 Tradable certificate for energy savings.** As an alternate to the requirements of Section F101.5 a building owner may, when this market-based instrument becomes available, purchase a Tradable Certificate for Energy Savings (TCES) or "white certificates" from a building or entity with energy savings. The building owner shall purchase TCES's equal to 1.1 times the amount that the building's actual energy use exceeds the energy budget.

**F101.6 Performance bond or financial security.** A building developer must secure and submit to the code official a performance bond or an irrevocable financial security letter of credit from a state of Washington financial institution prior to certificate of occupancy issuance. The bond or security shall have a value equal to the cost of installing a photovoltaic (PV) system with a generating capacity equal to 20 percent of the energy budget or \$4.00 per square foot of gross conditioned floor area, whichever is lower. The bond or security shall

be used only to install renewable energy on the building or for investment into energy conservation measures as part of an energy retrofit. The bond or security may also be held for one additional 3-year energy-monitoring period if green power is purchased. Upon demonstrated compliance with the energy budget, the bond or security requirement shall be released.

**F101.6.1 Failure to submit energy use data.** Building owners that fail to submit energy use data at the end of the 3-year monitoring period shall forfeit the full amount of the performance bond or financial security as payment to the local jurisdiction. Building owners that fail to submit energy use data at the end of each continuing five-year monitoring period shall be fined an amount equal to the original bond or financial security by the local jurisdiction.

**F101.7 Continued energy budget certification.** After achieving code compliance buildings shall be required every 5 years to document a continuous 12-month span with net energy use that is lower than the required energy budget. Owners of buildings with actual energy use that is at least 2.5 percent below their energy budget (from year permitted baseline, not voluntary year) may sell, when a future market-based instrument becomes available, their unused energy equivalents in the form of a "white certificate" or Tradable Certificate for Energy Savings.

**F101.8 Local amendments.** Local jurisdictions may amend the current code cycle EUI maximum energy budget by adopting a more stringent future code year value stated in Table F101.3.2.

**Table F101.3.2**  
**Washington State Outcome-Based Energy Budget**

**Zone 4C:**

	Site EUI	Base	Current	Future			
Building Occupancy/ Use	ft <sup>2</sup> /year	2003	2018	2021	2024	2027	2030
A-3							
Library	kWh kBtu	30.5 104	14.6 49.9	13.3 45.3	11.9 40.6	10.5 35.9	9.1 31.2
B							
Office/Bank	kWh kBtu	19.7 67.3	8.5 28.9	7.8 26.7	7.2 24.5	6.6 22.4	5.9 20.2
Medical Office (nondiagnostic)	kWh kBtu	14.8 50.4	7.1 24.2	6.4 21.9	5.8 19.6	5.1 17.4	4.4 15.1
E							
School K-12	kWh kBtu	17.1 58.4	8.2 28.0	7.4 25.4	6.7 22.8	5.9 20.2	5.1 17.5
I-2							
Hospital (in-patient)	kWh kBtu	51.6 176.1	24.8 84.5	22.5 76.6	20.1 68.7	17.8 60.8	15.5 52.8
M							
Grocery/Food Market	kWh kBtu	66.6 227.4	32.0 109.1	29.0 98.9	26.0 88.7	23.0 78.5	20.0 68.2
Retail	kWh kBtu	25.7 87.5	12.3 42.0	11.2 38.1	10.0 34.1	8.9 30.2	7.7 26.3



	Site EUI	Base	Current	Future			
Building Occupancy/ Use	ft <sup>2</sup> /year	2003	2018	2021	2024	2027	2030
S-1							
Parking							
Enclosed Garage <sup>a</sup>	kWh	3.8	2.3	2.0	1.7	1.4	1.1
	kBtu	13.0	8.0	7.0	5.9	4.9	3.9
Open Garage <sup>a</sup>	kWh	2.3	1.4	1.2	1.0	0.9	0.7
	kBtu	7.8	4.8	4.2	3.6	3.0	2.3
S-2							
NonRefrigerated Distribution/ Shipping <sup>b</sup>	kWh	8.6	4.1	3.7	3.3	3.0	2.6
	kBtu	29.2	14.0	12.7	11.4	10.1	8.8
R-2 Multi-Family (3+ stories)							
Lobby/Common Area	kWh	29.0	17.5	15.3	13.1	10.9	8.7
	kBtu	99	59.7	52.2	44.7	37.2	29.7
Studio/Micro-unit	kWh	9238	3284	3156	3028	2900	2771
	kBtu	31520	11205	10768	10331	9893	9456
One Bedroom	kWh	18476	6568	6312	6055	5799	5543
	kBtu	63040	22411	21536	20661	19787	18912
Two Bedroom	kWh	27714	9852	9468	9083	8699	8314
	kBtu	94560	33616	32304	30992	29680	28368
Three Bedroom	kWh	36952	13136	12624	12111	11598	11086
	kBtu	126080	44821	43072	41323	39573	37824
Additional Bedroom	kWh	9238	3284	3156	3028	2900	2771
	kBtu	31520	11205	10768	10331	9893	9456
All Occupancies/Use Types		2003	2018	2021	2024	2027	2030
		U-Factor					
Vertical Fenestration							
Nonmetal			0.28	0.27	0.25	0.24	0.23
Metal - Fixed			0.33	0.31	0.28	0.26	0.23
Metal - Operable			0.34	0.32	0.29	0.26	0.23
Roof			0.016	0.015	0.014	0.013	0.012
Wall (above/below grade)			0.031	0.028	0.024	0.021	0.018
Floors			0.024	0.023	0.021	0.020	0.018
		F-Value					
Slab on Grade			0.41	0.39	0.36	0.34	0.32
		CFM75/ft <sup>2</sup>					
Air Leakage			0.25	0.17	0.14	0.11	0.08

#### Zone 5B:

	Site EUI	Base	Current	Future			
Building Occupancy/ Use	ft <sup>2</sup> /year	2003	2018	2021	2024	2027	2030
A-3							
Library	kWh	31.9	15.3	13.9	12.4	11.0	9.6
	kBtu	108.8	52.2	47.3	42.4	37.5	32.6
B							

	Site EUI	Base	Current	Future			
Building Occupancy/ Use	ft <sup>2</sup> /year	2003	2018	2021	2024	2027	2030
Office/Bank	kWh	20.1	9.1	8.3	7.5	6.8	6.0
	kBtu	68.6	30.9	28.3	25.8	23.2	20.6
Medical Office (nondiagnostic)	kWh	15.0	7.2	6.5	5.9	5.2	4.5
	kBtu	51.3	24.6	22.3	20.0	17.7	15.4
E School K-12	kWh	18.3	8.8	8.0	7.1	6.3	5.5
	kBtu	62.4	30.0	27.2	24.3	21.5	18.7
1-2 Hospital (in-patient)	kWh	48.5	23.3	21.1	18.9	16.7	14.6
	kBtu	165.5	79.4	72.0	64.5	57.1	49.7
M Grocery/Food Market	kWh	66.3	31.8	28.8	25.8	22.9	19.9
	kBtu	226.1	108.5	98.4	88.2	78.0	67.8
	kWh	28.4	13.6	12.4	11.1	9.8	8.5
	kBtu	97.0	46.6	42.2	37.8	33.5	29.1
S-1 Parking							
	kWh	3.8	2.3	2.0	1.7	1.4	1.1
	kBtu	13.0	8.0	7.0	5.9	4.9	3.9
	kWh	2.3	1.4	1.2	1.0	0.9	0.7
S-2 Enclosed Garage <sup>a</sup>	kBtu	7.8	4.8	4.2	3.6	3.0	2.3
	kWh	10.5	5.0	4.6	4.1	3.6	3.1
	kBtu	35.8	17.2	15.6	14.0	12.4	10.7
R-2 Multi-Family (3+ stories)							
	kWh	29.0	18.8	16.3	13.8	11.2	8.7
Lobby/Common Area	kBtu	99	64.2	55.6	46.9	38.3	29.7
	kWh	9238	3495	3314	3133	2952	2771
Studio/Micro-unit	kBtu	31520	11925	11308	10691	10073	9456
	kWh	18476	6990	6628	6267	5905	5543
One Bedroom	kBtu	63040	23851	22616	21381	20147	18912
	kWh	27714	10485	9943	9400	8857	8314
Two Bedroom	kBtu	94560	35776	33924	32072	30220	28368
	kWh	36952	13980	13257	12533	11809	11086
Three Bedroom	kBtu	126080	47701	45232	42763	40293	37824
	kWh	9238	3495	3314	3133	2952	2771
Additional Bedroom	kBtu	31520	11925	11308	10691	10073	9456
All Occupancies/Use Types		2003	2018	2021	2024	2027	2030
		U-Factor					
Vertical Fenestration							
Nonmetal			0.25	0.23	0.21	0.18	0.16
Metal - Fixed			0.31	0.27	0.23	0.20	0.16
Metal - Operable			0.32	0.28	0.24	0.20	0.16
Roof			0.016	0.015	0.014	0.013	0.012
Wall (above/below grade)			0.031	0.028	0.024	0.021	0.018

All Occupancies/Use Types	2003	2018	2021	2024	2027	2030
Floors		0.024	0.023	0.021	0.020	0.018
	<b>F-Value</b>					
Slab on Grade		0.41	0.39	0.36	0.34	0.32
	<b>CFM75/ft<sup>2</sup></b>					
Air Leakage		0.25	0.17	0.14	0.11	0.08

<sup>a</sup>Lighting power allowance must still comply with Table C405.4.2(2).

<sup>b</sup>Applicable to heated warehouses only.

**FIGURE F101.3.2**  
**Washington State Outcome-based Energy Budget Form**

**WASHINGTON STATE OUTCOME-BASED ENERGY BUDGET FORM**

*(reserved for graphics)*

**Building occupancy/use** \_\_\_\_\_

**Conditioned floor area**  
**SF**

**Code maximum site EUI energy budget**

**Predicted EUI**

Electric

Gas

Propane

Oil

Other (source/  
generation)

**Generation Potential EUI**

Building Integral  (combined must exceed 40%)

On-site

Off-site  (max 40%)

Purchase  (max 40%)

**Percentage better than energy budget**

**Percentage potential EUI above  
predicted EUI**

**PROJECT  
SUMMARY**

Building Name	
Address	
City	
Owner	
Address	
City, State, Zip	

**PROJECT CERTIFICATION**

Name		<i>(seal)</i>
Firm		
Date		

**WAC 51-11C-40215 Section C402.1.5—Component performance alternative.**

**C402.1.5 Component performance alternative.** Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be permitted in lieu of compliance with the *U*-factors and *F*-factors in Table C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1.

For buildings with more than one space conditioning category, component performance compliance shall be demonstrated separately for each space conditioning category. Interior partition ceilings, walls, fenestration and floors that separate space conditioning areas shall be applied to the component performance calculations for the space conditioning category with the highest level of space conditioning.

**Equation 4-2**

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

Where:

A = Sum of the (UA Dif) values for each distinct assembly type of the building thermal envelope, other than slabs on grade

$$\text{UA Dif} = \text{UA Proposed} - \text{UA Table}$$

$$\text{UA Proposed} = \text{Proposed } U\text{-value} \times \text{Proposed Area}$$

$$\text{UA Table} = (U\text{-factor from Table C402.1.4 or C402.4}) \times \text{Area}$$

B = Sum of the (FL Dif) values for each distinct slab on-grade perimeter condition of the building thermal envelope

$$\text{FL Dif} = \text{FL Proposed} - \text{FL Table}$$

$$\text{FL Proposed} = \text{Proposed } F\text{-value} \times \text{Proposed Perimeter length}$$

$$\text{FL Table} = (F\text{-factor specified in Table C402.1.4}) \times \text{Proposed Perimeter length}$$

The maximum allowed prescriptive vertical fenestration area, identified as "Vertical Fenestration Area allowed" in factor C below, is the gross above-grade wall area times either:

1. 30%
2. 40% if the building complies with Section C402.4.1.1 or Section C402.4.1.4; or
3. 40% if the *U*-values used in calculating A for vertical fenestration are taken from Section C402.4.1.3 rather than Table C402.4

Where the proposed vertical fenestration area is less than or equal to the Vertical Fenestration Area allowed, the value of C (Excess Vertical Glazing Value) shall be zero. Otherwise:

$$C = (CA \times UV) - (CA \times U_{\text{Wall}}), \text{ but not less than zero}$$

CA	=	(Proposed Vertical Fenestration Area) — (Vertical Fenestration Area allowed)
UAW	=	Sum of the (UA table) values for each above-grade wall assembly
U <sub>Wall</sub>	=	UAW / (sum of proposed wall area + CA)
UAV	=	Sum of the (UA Table) values for each vertical fenestration assembly
UV	=	UAV / Total Vertical Fenestration Area allowed

Where the proposed skylight area is less than or equal to the skylight area allowed by Section C402.4.1, the value of D (Excess Skylight Value) shall be zero. Otherwise:

$$D = (DA \times US) - (DA \times U_{\text{Roof}}), \text{ but not less than zero}$$

DA	=	(Proposed Skylight Area) — (Allowable Skylight Area from Section C402.4.1)
UAR	=	Sum of the (UA Table) values for each roof assembly
U <sub>Roof</sub>	=	UAR / (sum of proposed roof area + DA)
UAS	=	Sum of the (UA Table) values for each skylight assembly
US	=	UAS / the Allowable Skylight Area from Section C402.4.1

Where required by other sections of the code Proposed Total Envelope UA and Allowed Total Envelope UA shall be calculated as:

Proposed Total Envelope UA	=	Sum of UA Proposed and FL Proposed for each distinct envelope assembly
Allowed Total Envelope UA	=	Sum UA Table — C — D

Where:

Sum UA Table	=	Sum of UA Table and FL Table for each distinct envelope assembly))
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<b>Proposed Total UA</b>	≡	<u>UA-glaz-prop + UA sky-prop + UA-opaque-prop + FL-slab-prop</u>
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<b>Allowable Total UA</b>	≡	<u>UA-glaz-allow + UA-glaz-excess + UA sky-allow + UA-sky-excess + UA-opaque-allow + FL-slab-allow</u>
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<b><u>UA-glaz-prop</u></b>	=	<u>Sum of (proposed <i>U</i>-value x proposed area) for each distinct vertical fenestration type, up to code maximum area</u>
<b><u>UA-sky-prop</u></b>	=	<u>Sum of (proposed <i>U</i>-value x proposed area) for each distinct skylight type, up to the code maximum area</u>
<b><u>UA-opaque-prop</u></b>	=	<u>Sum of (proposed <i>U</i>-value x proposed area) for each distinct opaque thermal envelope type</u>
<b><u>FL-slab-prop</u></b>	=	<u>Sum of (proposed <i>F</i>-value x proposed length) for each distinct slab on grade perimeter assembly</u>
<b><u>UA-glaz-allow</u></b>	=	<u>Sum of (code maximum vertical fenestration <i>U</i>-value from Table C402.4, or Section C402.4.1.3 if applicable, x proposed area) for each distinct vertical fenestration type, not to exceed the code maximum area<sup>1</sup></u>
<b><u>UA-glaz-excess</u></b>	=	<u><i>U</i>-value for the proposed wall type from Table C402.4<sup>2</sup> x vertical fenestration area in excess of the code maximum area</u>
<b><u>UA-sky-allow</u></b>	=	<u>Sum of (code maximum skylight <i>U</i>-value from Table C402.4 x proposed area) for each distinct skylight type proposed, not to exceed the code maximum area</u>
<b><u>UA-sky-excess</u></b>	=	<u><i>U</i>-value for the proposed roof type from Table C402.4<sup>3</sup> x skylight area in excess of the code maximum area</u>
<b><u>UA-opaque-allow</u></b>	=	<u>Code maximum opaque envelope <i>U</i>-value from Table C402.1.4 for each opaque door, wall, roof, and floor assembly x proposed area</u>
<b><u>FL-slab-allow</u></b>	=	<u>Code maximum <i>F</i>-value for each slab-on-grade perimeter assembly x proposed length</u>

**Notes:**

<sup>1</sup> Where multiple vertical fenestration types are proposed and the code maximum area is exceeded, the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed vertical fenestration area of each type.

<sup>2</sup> Where multiple wall types are proposed the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed above grade wall area of each type.

<sup>3</sup> Where multiple roof types are proposed the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed roof area of each type.

**C402.1.5.1 Component *U*-factors.** The *U*-factors for typical construction assemblies are included in Chapter 3 and Appendix A. These values

shall be used for all calculations. Where proposed construction assemblies are not represented in Chapter 3 or Appendix A, values shall be calculated in accordance with the ASHRAE *Handbook—Fundamentals*, using the framing factors listed in Appendix A.

For envelope assemblies containing metal framing, the *U*-factor shall be determined by one of the following methods:

1. Results of laboratory measurements according to acceptable methods of test.

2. ASHRAE *Handbook—Fundamentals* where the metal framing is bonded on one or both sides to a metal skin or covering.

3. The zone method as provided in ASHRAE *Handbook—Fundamentals*.

4. Effective framing/cavity *R*-values as provided in Appendix A.

When return air ceiling plenums are employed, the roof/ceiling assembly shall:

a. For thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and

b. For gross area purposes, be based upon the interior face of the upper plenum surface.

5. Tables in ASHRAE 90.1 Normative Appendix A.

6. Calculation method for steel-framed walls in accordance with Section C402.1.4.1 and Table C402.1.4.1.

**C402.1.5.2 SHGC rate calculations.** Fenestration SHGC values for individual components and/or fenestration are permitted to exceed the SHGC values in Table C402.4 and/or the maximum allowable fenestration areas in Section C402.4.1 where the proposed values result in  $SHGCA_p$  less than  $SHGCA_t$  as determined by Equations 4-3 and 4-4.

**Equation 4-3—( ~~Target  $SHGCA_t$~~**   
**Equation C402-3**  
**~~Target  $SHGCA_t$~~ ) SHGC Rate Calculations**

$$\frac{((SHGCA_t - SHGC_{ogt}(A_{ogt}) + SHGC_{vgt})}{(A_{vgt} + A_{vgmt} + A_{vgmot} + A_{vgdt})}$$

Where:

$SHGCA_t$  = The target combined solar heat gain of the target fenestration area.

$SHGC_{ogt}$  = The solar heat gain coefficient for skylight fenestration found in Table C402.4.

$A_{ogt}$  = The target skylight area.

$SHGC_{vgt}$  = The solar heat gain coefficient for vertical fenestration found in Table C402.4 which corresponds to the proposed total fenestration area as a percentage of gross exterior wall.

$A_{vgt}$  = The target vertical fenestration area with nonmetal framing.

$A_{vgmt}$  = The target vertical fenestration area with fixed metal framing.

$A_{vgmot}$  = The target vertical fenestration area with operable metal framing.

$A_{vgdt}$  = The proposed vertical fenestration area of entrance doors.

NOTE: The vertical fenestration area does not include opaque doors and opaque spandrel panels:))



**Proposed Total SHGCxA ≤ Allowable Total SHGCxA**

Where:

<u>Proposed Total SHGCxA</u>	=	<u>SHGCxA-glaz-prop + SHGCxA-sky-prop</u>
<u>Allowable Total SHGCxA</u>	=	<u>SHGCxA-glaz-allow + SHGCxA-sky-allow</u>
<u>SHGCxA-glaz-prop</u>	=	<u>Sum of (proposed SHGCx proposed area) for each distinct vertical fenestration type</u>
<u>SHGCxA-sky-prop</u>	=	<u>Sum of (proposed SHGCx proposed area) for each distinct skylight type</u>
<u>SHGCxA-glaz-allow</u>	=	<u>Sum of (code maximum vertical fenestration SHGC from Table C402.4, or Section C402.4.1.3 if applicable, x proposed area) for each distinct vertical fenestration type, not to exceed the code maximum area</u>
<u>SHGCxA-sky-allow</u>	=	<u>Sum of (code maximum skylight SHGC from Table C402.4x proposed area) for each distinct skylight type, not to exceed the code maximum area</u>

If the proposed vertical fenestration area does not exceed the Vertical Fenestration Area allowed, the target area for each vertical fenestration type shall equal the proposed area. If the proposed vertical fenestration area exceeds the Vertical Fenestration Area allowed, the target area of each vertical fenestration element shall be reduced in the base envelope design by the same percentage and the net area of each above-grade wall type increased proportionately by the same percentage so that the total vertical fenestration area is exactly equal to the Vertical Fenestration Area allowed.

If the proposed skylight area does not exceed the Allowable Skylight Area from Section C402.4.1, the target area shall equal the proposed area. If the proposed skylight area exceeds the Allowable Skylight Area from Section C402.4.1, the area of each skylight element shall be reduced in the base envelope design by the same percentage and the net area of each roof type increased proportionately by the same percentage so that the total skylight area is exactly equal to the allowed percentage per Section C402.3.1 of the gross roof area.

**( (Equation 4-4**  
**Proposed SHGCA<sub>p</sub>**

$$SHGCA_p = SHGC_{og}A_{og} + SHGC_{vg}A_{vg}$$

Where:

$SHGCA_t$	=	The combined proposed solar heat gain of the proposed fenestration area.
$SHGC_{og}$	=	The solar heat gain coefficient of the skylights.
$A_{og}$	=	The skylight area.
$SHGC_{vg}$	=	The solar heat gain coefficient of the vertical fenestration.

$A_{vg}$  = The vertical fenestration area.  
NOTE: The vertical fenestration area does not include opaque doors and opaque spandrel panels.))

AMENDATORY SECTION (Amending WSR 19-02-089, filed 1/2/19, effective 7/1/19)

**WAC 51-11C-40406 Section C404.6—Pipe insulation.**

**C404.6 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 ((C403.2.9)) C403.10.3. 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 ((C403.2.9)) C403.10.3 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, including through hangers and supports, such that thermal bridging is prevented, 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.
8. Hot water piping that is part of the final pipe run to the plumbing fixture and is not part of the heated-water circulation system.

circulation path is not required to meet the minimum insulation requirements of C404.6.

AMENDATORY SECTION (Amending WSR 19-02-089, filed 1/2/19, effective 7/1/19)

**WAC 51-11C-50300 Section C503—Alterations.**

**C503.1 General.** Alterations to any building or structure shall comply with the requirements of Section C503 and the code for new construction. Alterations to an existing building, building system or portion thereof shall conform to the provisions of this code as they relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this code. Alterations shall be such that the existing building or structure is no less conforming with 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 they 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.))~~

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

1. Storm windows installed over existing fenestration.
2. Surface applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided the code does not require the glazing fenestration to be replaced.
3. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are insulated to full depth with insulation having a minimum nominal value of R-3.0 per inch installed per Section C402.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. *Roof recover.*
6. *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations, renovations or repairs* to the remainder of the building envelope.
7. Replacement of existing doors that separate conditioned space from the exterior shall not require the installation of a vestibule or revolving door, provided however that an existing vestibule that separates a conditioned space from the exterior shall not be removed.

**C503.2 Change in space conditioning.** Any ~~((nonconditioned))~~ low energy space in accordance with Section C402.1.1.1 that is altered to become *conditioned space* or *semi-heated space* shall be ~~((required to be))~~ brought into full compliance with this code. Any semi-heated space in accordance with Section C402.1.1.2 that is altered to become conditioned space shall be required to be brought into full compliance with this code.

For buildings with more than one space conditioning category, the interior partition walls, ceilings, floors and fenestration that separate space conditioning areas shall comply with the thermal envelope requirements per the area with the highest level of space conditioning.

A change in space conditioning project shall be deemed to comply with this code if the project area alone complies or if the existing building and the project area combined comply with this code as a whole building.

EXCEPTIONS:

1. Where the component performance building ~~((envelope option))~~ alternative in Section C402.1.5 is used to ((empty)) demonstrate compliance with this Section, the Proposed Total ((Envelope)) UA is allowed to be up to 110 percent of the ((Allowed)) Allowable Total Envelope UA. ((Where the total building performance option in Section C407 is used to comply with this section, the annual energy consumption of the proposed design is allowed to be 110 percent of the annual energy consumption otherwise allowed by Section C407.3.))
2. Where total building performance in Section C407 is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.
3. Buildings or spaces that were permitted prior to the 2009 Washington state energy code, or were originally permitted as unconditioned, may comply with this section as follows:
  - 3.1. Where the component performance alternative in Section C402.1.5 is used, the Proposed Total UA is allowed to be up to 110 percent of the Allowable Total UA.
  - 3.2. Where total building performance in Section C407 is used, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3.

**C503.3 Building envelope.** New building envelope assemblies that are part of the alteration shall comply with Sections C402.1 through C402.5 as applicable.

EXCEPTION: Air leakage testing is not required for alterations and repairs, unless the project includes a change in space conditioning according to Section C503.2 or a change of occupancy or use according to Section C505.1.

**C503.3.1 Roof replacement.** *Roof replacements* shall comply with Table C402.1.3 or C402.1.4 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck.

**C503.3.2 Vertical fenestration.** The addition of *vertical fenestration* that results in a total building vertical fenestration area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.4. Alterations that result in a total building vertical fenestration area greater than specified in Section C402.4.1 shall comply with one of the following:

1. Vertical fenestration alternate ~~((per))~~ in accordance with Section C402.1.3 for the new vertical fenestration added.

2. Vertical fenestration alternate (~~(per)~~) in accordance with Section C402.4.1.1 for the area adjacent to the new vertical fenestration added.

3. Existing building and alteration area are combined to demonstrate compliance with the component performance (~~(option)~~) alternate with target area adjustment (~~(per)~~) in accordance with Section C402.1.5 (~~(or the)~~) for the whole building.

4. Total building performance (~~(option)~~) alternative in Section C407 for the whole building.

**EXCEPTIONS:**

1. Additional envelope upgrades are included in the project so the addition of vertical fenestration does not cause a reduction in overall building energy efficiency, as approved by the *code official*.
2. Where the component performance alternative for the whole building is used to demonstrate compliance with this section, the Proposed Total UA is allowed to be up to 110 percent of the Allowed Total UA.
3. Where total building performance for the whole building is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed in Section C407.3.

**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.

**C503.3.3 Skylight area.** The addition of *skylights* that results in a total building skylight area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.4. (~~(Alterations)~~) The addition of *skylights* that results in a total building skylight area greater than that specified in Section C402.4.1 shall comply with one of the following:

1. Existing building and alteration area are combined to demonstrate compliance with the component performance (~~(option)~~) alternative with target area adjustment (~~(per)~~) in accordance with Section C402.1.5 (~~(or the)~~) for the whole building.

2. Total building performance (~~(option)~~) in accordance with Section C407 for the whole building.

**EXCEPTIONS:**

1. Additional envelope upgrades are included in the project so the addition of skylights does not cause a reduction in overall building energy efficiency, as approved by the *code official*.
2. Where the component performance alternative for the whole building is used to demonstrate compliance with this section, the Proposed Total UA is allowed to be up to 110 percent of the Allowed Total UA.
3. Where total building performance for the whole building is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be up to 110 percent of the annual carbon emissions from energy consumption allowed in Section C407.3.

**C503.4 Mechanical systems.** Those parts of systems which are altered or replaced shall comply with Section C403. Additions or alterations shall not be made to an existing mechanical system that will cause the existing mechanical system to become out of compliance.

**EXCEPTIONS:**

1. Existing mechanical systems which are altered or where parts of the systems are replaced are not required to be modified to comply with Section (~~(C403.6)~~) C403.3.5 as long as mechanical cooling capacity is not added to (~~(the)~~) a system that did not have cooling capacity prior to the alteration.
2. Alternate mechanical system designs that are not in full compliance with this code may be approved when the code official determines that existing building constraints including, but not limited to, available mechanical space, limitations of the existing structure, or proximity to adjacent air intakes or exhausts makes full compliance impractical. Alternate designs shall include additional energy saving strategies not prescriptively required by this code for the scope of the project including, but not limited to, demand control ventilation, energy recovery, or increased mechanical cooling or heating equipment efficiency above that required by Tables C403.3.2(1) through C403.3.2(12).
3. Only those components of existing HVAC systems that are altered or replaced shall be required to meet the requirements of Section C403.8.1. Allowable fan motor horsepower. Components replaced or altered shall not exceed the fan power limitation pressure drop adjustment values in Table C403.8.1(2) at design conditions. Section C403.8.1 does not require the removal and replacement of existing system ductwork.

**C503.4.1 New mechanical systems.** All new mechanical systems in existing buildings, including packaged unitary equipment and packaged split systems, shall comply with Section C403.

**C503.4.2 Addition of cooling capacity.** Where mechanical cooling is added to a space that was not previously cooled, the mechanical system shall comply with either Section ~~((C403.6 or C403.3))~~ C403.3.5 or C403.5.

EXCEPTIONS:

1. ~~((Alternate designs that are not in full compliance with this code may be approved when the code official determines that existing building constraints including, but not limited to, available mechanical space, limitations of the existing structure, or proximity to adjacent air intakes/exhausts make full compliance impractical. Alternate designs shall provide alternate energy savings strategies including, but not limited to, Demand Control Ventilation or increased mechanical cooling or heating efficiency above that required by Tables C403.2.3(1) through C403.2.3(10).~~
- 2.) Qualifying small equipment: ~~((This exception shall not be used for unitary cooling equipment installed outdoors or in a mechanical room adjacent to the outdoors. This exception is allowed to be used for other))~~ Economizers are not required for cooling units and split systems serving one zone with a total cooling capacity rated in accordance with Section ~~((C403.2.3))~~ C403.3.2 of less than 33,000 Btu/h (hereafter referred to as qualifying small systems) provided that these are high-efficiency cooling equipment with SEER and EER values more than 15 percent higher than minimum efficiencies listed in Tables ~~((C403.2.3))~~ C403.3.2 (1) through (3), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify for this exception. The total capacity of all qualifying small equipment without economizers shall not exceed 72,000 Btu/h per building, or 5 percent of ~~((its))~~ the building total air economizer capacity, whichever is greater. ~~((That))~~

Notes and exclusions for Exception 1:

1.1. The portion of the equipment serving Group R occupancies is not included in determining the total capacity of all units without economizers in a building.

1.2. Redundant units are not counted in the capacity limitations.

1.3. This exception shall not be used for the initial tenant improvement of a shell-and-core ~~((permit))~~ building or space, or for ~~((the initial tenant improvement or for))~~ Total Building Performance in accordance with Section C407.

~~((3.))~~ 1.4. This exception shall not be used for unitary cooling equipment installed outdoors or in a mechanical room adjacent to the outdoors.

2. Chilled water terminal units connected to systems with chilled water generation equipment with IPLV values more than 25 percent higher than minimum part load equipment efficiencies listed in Table ~~((C403.2.3))~~ C403.3.2(7), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify for this exception. The total capacity of all systems without economizers shall not exceed 480,000 Btu/h per building, or 20 percent of ~~((its))~~ the building total air economizer capacity, whichever is greater. ~~((That))~~

Notes and exclusions for Exception 2:

2.1. The portion of the equipment serving Group R occupancy is not included in determining the total capacity of all units without economizers in a building.

2.2. This exception shall not be used for the initial ~~((permit (this includes any initial permit for the space including, but not limited to, the shell-and-core permit, built-to-suit permit, and tenant improvement permit) or for Total Building Performance Method))~~ tenant improvement of a shell-and-core building or space, or for total building performance in accordance with Section C407.

**C503.4.3 Alterations or replacement of existing cooling systems.** Alterations to, or replacement of, existing mechanical cooling systems shall not decrease the building total economizer capacity unless the system complies with either Section ~~((C403.2.6 or C403.3. In addition, for existing mechanical cooling systems that do not comply with either Section C403.2.6 or C403.3, including both the individual unit))~~ C403.3.5 or C403.5. System alterations or replacement shall comply with Table C503.4 when the individual cooling size limit~~((s))~~ and the ~~((total))~~ building total capacity limit~~((s on units))~~ of all cooling equipment without economizer~~((; other alterations shall comply with Table C503.4))~~ do not comply with Section C403.3.5 or C403.5.

**C503.4.4 Controls for cooling equipment replacement.** When space cooling equipment is replaced, controls shall comply with all requirements under Section ~~((C403.6))~~ C403.3.5 and related subsections ~~((or provide for integrated operation with economizer in accordance with Section C403.3.1))~~, and Section C403.5.1 for integrated economizer control.

**C503.4.5 Cooling equipment relocation.** Existing equipment currently in use may be relocated within the same floor or same tenant space if removed and reinstalled within the same permit.

**Table C503.4**  
**Economizer Compliance Options for Mechanical Alterations**

	Option A	Option B (alternate to A)	Option C (alternate to A)	Option D (alternate to A)
Unit Type	Any alteration with new or replacement equipment	Replacement unit of the same type with the same or smaller output capacity	Replacement unit of the same type with a larger output capacity	New equipment added to existing system or replacement unit of a different type
1. Packaged Units	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,3</sup> )) <u>C403.5<sup>b</sup></u>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,3</sup> )) <u>C403.5<sup>b</sup></u>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,4</sup> )) <u>C403.5<sup>b</sup></u>
2. Split Systems	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	For units ≤ 60,000 Btuh: Efficiency: + ((+/-5% <sup>5</sup> )) 10% <sup>c</sup> Economizer: shall not decrease existing economizer capability	(( <del>Only for new</del> )) For units ((<54,000)) ≤ 60,000 Btuh replacing unit installed prior to 1991 (one of two): Efficiency: + ((+/-5% <sup>5</sup> )) 10% <sup>c</sup> Economizer: 50%(( <sup>6</sup> )) <sup>f</sup>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,4</sup> )) <u>C403.5<sup>b</sup></u>
		Otherwise: Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup>	((For units > 54,000 Btuh or any units installed after 1991: Option A)) Otherwise: Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup>	
3. Water Source Heat Pump	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	(two of three): Efficiency: + ((+/-5% <sup>5</sup> )) 10% <sup>c</sup> For units ≤ 72,000 Btuh Flow control valve(( <sup>7</sup> )) <sup>g</sup> Economizer: 50%(( <sup>6</sup> )) <sup>f</sup>  Otherwise: Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup>	(three of three): Efficiency: + ((+/-5% <sup>5</sup> )) 10% <sup>c</sup> For units ≤ 72,000 Btuh Flow control valve(( <sup>7</sup> )) <sup>g</sup> Economizer: 50%(( <sup>6</sup> )) <sup>f</sup> (except for certain pre-1991 systems(( <sup>8</sup> )) <sup>h</sup> )  Otherwise: Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,4</sup> )) <u>C403.5<sup>b</sup></u> (except for certain pre-1991 systems(( <sup>8</sup> )) <sup>h</sup> )
4. (( <del>Hydronic</del> )) Water Economizer using Air-Cooled Heat Rejection Equipment (Dry Cooler)	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>1433</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	Efficiency: + ((+/-5% <sup>5</sup> )) 5% <sup>d</sup> Economizer: shall not decrease existing economizer capacity	((Option A)) Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,4</sup> )) <u>C403.5<sup>b</sup></u>
5. Air-Handling Unit (including fan coil units) where the system has an air-cooled chiller	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	Economizer: shall not decrease existing economizer capacity	((Option A)) Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup> (except for certain pre-1991 systems(( <sup>8</sup> )) <sup>h</sup> ) <sup>i</sup>	((Option A)) Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup> (except for certain pre-1991 systems(( <sup>8</sup> )) <sup>h</sup> ) <sup>i</sup>
6. Air-Handling Unit (including fan coil units) and Water-cooled Process Equipment, where the system has a water-cooled chiller <sup>10</sup>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	Economizer: shall not decrease existing economizer capacity	((Option A)) Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup> (except for certain pre-1991 systems(( <sup>8</sup> )) <sup>h</sup> ) <sup>i</sup> and certain ((1991-2004)) 1991-2016 systems(( <sup>2</sup> )) <sup>j</sup>	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,4</sup> )) <u>C403.5<sup>b</sup></u> (except for certain pre-1991 systems(( <sup>8</sup> )) <sup>h</sup> ) <sup>i</sup> and certain ((1991-2015)) 1991-2016 systems(( <sup>2</sup> )) <sup>j</sup>
7. Cooling Tower	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	No requirements	((Option A)) Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup>	((Option A)) Efficiency: min. <sup>a</sup> Economizer: C403.5 <sup>b</sup>
8. Air-Cooled Chiller	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	Efficiency: + ((5% <sup>11</sup> )) 10% <sup>k</sup> Economizer: shall not decrease existing economizer capacity	Efficiency (two of two): (1) + 10%(( <sup>12</sup> )) <sup>k,1</sup> and (2) multistage Economizer: shall not decrease existing economizer capacity	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,4</sup> )) <u>C403.5<sup>b</sup></u>
9. Water-Cooled Chiller	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2</sup> )) <u>C403.5<sup>b</sup></u>	Efficiency (one of two): (1) part load IPLV + ((+10% <sup>13</sup> )) 15% <sup>n</sup> or (2) plate frame heat exchanger(( <sup>15</sup> )) <sup>o</sup> Economizer: shall not decrease existing economizer capacity	Efficiency (two of two): (1) part load IPLV + 15%(( <sup>14</sup> )) <sup>n</sup> and (2) plate-frame heat exchanger(( <sup>15</sup> )) <sup>o</sup> Economizer: shall not decrease existing economizer capacity	Efficiency: min.(( <sup>1</sup> )) <sup>a</sup> Economizer: (( <del>€403.3</del> <sup>2,4</sup> )) <u>C403.5<sup>b</sup></u>

	Option A	Option B (alternate to A)	Option C (alternate to A)	Option D (alternate to A)
Unit Type	Any alteration with new or replacement equipment	Replacement unit of the same type with the same or smaller output capacity	Replacement unit of the same type with a larger output capacity	New equipment added to existing system or replacement unit of a different type
((10.-Boiler	Efficiency: min. <sup>1</sup> Economizer: C403.3 <sup>2</sup>	Efficiency: + 8% <sup>16</sup> Economizer: shall not decrease existing economizer capacity	Efficiency: + 8% <sup>16</sup> Economizer: shall not decrease existing economizer capacity	Efficiency: min. <sup>1</sup> Economizer: C403.3 <sup>2,4</sup> )

- (<sup>1</sup>)  
a. Minimum equipment efficiency shall comply with Section ((C403.2.3)) C403.3.2 and Tables ((C403.2.3)) C403.3.2(1) through ((C403.2.3(10))) C403.3.3.2(12).
- (<sup>2</sup>)  
b. ~~((System and building shall comply))~~ All separate new equipment and replacement equipment shall have air economizer complying with Section ((C403.3)) C403.5 (including both the individual unit size limits and the total building capacity limits on units without economizer). It is acceptable to comply using one of the exceptions to Section ((C403.3 or C504.3.4)) C403.5.
- (<sup>3</sup>)  
a. All equipment replaced in an existing building shall have air economizer complying with Section C403.3 unless both the individual unit size and the total capacity of units without air economizer in the building is less than that allowed in Exception 2 to Section C503.4.  
4. All separate new equipment added to an existing building shall have air economizer complying with Section C403.3 unless both the individual unit size and the total capacity of units without air economizer in the building is less than that allowed in Exception 3 to Section C503.4.))  
c. Reserved.  
d. Equipment shall have a capacity-weighted average cooling system efficiency that is 5% better than the requirements in Tables C403.3.2(1) and C403.3.2(2) (1.05 x values in Tables C403.3.1(1) and C403.3.2(2)).
- (<sup>5</sup>)  
e. Equipment shall have a capacity-weighted average cooling system efficiency(;) that is 10% better than the requirements in Tables C403.3.2(1)A and C403.3.2(2) (1.10 x values in Tables C403.3.1(1)A and C403.3.2(2)).
- ((a.  
b. For units with a cooling capacity below 54,000 Btuh, a minimum of 10% greater than the requirements in Tables C403.2.3(1) and C403.2.3(2).  
b. For units with a cooling capacity of 54,000 Btuh and greater, a minimum of 5% greater than the requirements in Tables C403.2.3(1) and C403.2.3(2).))
- (<sup>6</sup>)  
f. Minimum of 50% air economizer that is ducted in a fully enclosed path directly to every heat pump unit in each zone, except that ducts may terminate within 12 inches of the intake to an HVAC unit provided that they are physically fastened so that the outside air duct is directed into the unit intake. If this is an increase in the amount of outside air supplied to this unit, the outside air supply system shall be configured to provide this additional outside air and equipped with economizer control.
- (<sup>7</sup>)  
g. Water-source heat pump systems shall have a flow control valve to eliminate flow through the heat pumps that are not in operation ((with)) and variable speed pumping control complying with Section C403.4.2 for that heat pump.  
- When the total capacity of all units with flow control valves exceeds 15% of the total system capacity, a variable frequency drive shall be installed on the main loop pump.  
- As an alternate to this requirement, ((have a)) the capacity-weighted average cooling system efficiency ((that is 5% greater)) shall be 5% better than the requirements in ((note 5)) footnote c for water-source heat pumps (i.e., a minimum of ((15%/10%)) 15% greater than the requirements in Table((s C403.2.3(1) and C403.2.3(2))) C403.3.2(2)).
- ((<sup>8</sup>  
h. Systems installed prior to 1991 without fully utilized capacity are allowed to comply with Option B, provided that the individual unit cooling capacity does not exceed 90,000 Btuh.))  
h. Water economizer equipment shall have a capacity-weighted average cooling system efficiency that is 10% better than the requirements in Tables C403.3.2(8) and C403.3.2(9) (1.10 x values in Tables C403.3.2(8) and C403.3.2(9)).
- (<sup>9</sup>)  
i. Air economizer is not required for systems installed with water economizer plate and frame heat exchanger complying with previous codes between 1991 and June 2016, provided that the total fan coil load does not exceed the existing or added capacity of the heat exchangers.
- (<sup>10</sup>)  
j. For water-cooled process equipment where the manufacturers specifications require colder temperatures than available with waterside economizer, that portion of the load is exempt from the economizer requirements.
- (<sup>11</sup>)  
k. The air-cooled chiller shall have an IPLV efficiency that is a minimum of ((5%)) 10% greater than the IPLV requirements in EER in Table ((C403.2.3(7))) C403.3.2(7) (1.10 x IPLV values in EER in Table C403.3.2(7)).
- (<sup>12</sup>)  
l. The air-cooled chiller shall(;) be multistage with a minimum of two compressors.  
((a.  
b. Have an IPLV efficiency that is a minimum of 10% greater than the IPLV requirements in Table C403.2.3(7); and  
b. Be multistage with a minimum of two compressors.
- <sup>13</sup>)  
m. The water-cooled chiller shall have ((an)) full load and part load IPLV efficiency that is a minimum of ((10%)) 5% greater than the IPLV requirements in Table C403.2.3(7).
- (<sup>14</sup>)  
n. The water-cooled chiller shall have an IPLV ((efficiency)) value that is a minimum of 15% ((greater)) lower than the IPLV requirements in Table C403.2.3(7) (1.15 x IPLV values in Table C403.3.2(7)). Water-cooled centrifugal chillers designed for nonstandard conditions shall have an NPLV value that is at least 15% lower than the adjusted maximum NPLV rating in kW per ton defined in Section C403.3.2.1 (1.15 x NPLV).
- (<sup>15</sup>)  
o. Economizer cooling shall be provided by adding a plate-frame heat exchanger on the waterside with a capacity that is a minimum of 20% of the chiller capacity at standard AHRI rating conditions.
- (<sup>16</sup>  
p. The replacement boiler shall have an efficiency that is a minimum of 8% higher than the value in Table C403.2.3(5), except for electric boilers.))  
p. Reserved.  
q. Systems installed prior to 1991 without fully utilized capacity are allowed to comply with Option B, provided that the individual unit cooling capacity does not exceed 90,000 Btuh.

**C503.5 Service hot water systems.** New service hot water systems that are part of the alteration shall comply with Section C404.

**C503.6 Lighting, controlled receptacles and motors.** Alterations or the addition of lighting, controlled receptacles and motors shall comply with Sections C503.6.1 through C503.6.6.

**C503.6.1 Luminaire additions and alterations.** Alterations that add or replace 50 percent or more of the luminaires in a space enclosed by walls or ceiling-height partitions, replace 50 percent or more of parking garage luminaires, or replace 50 percent or more of the total installed wattage of exterior luminaires shall comply with Sections C405.4 and C405.5. Where less than 50 percent of the fixtures in an interior space enclosed by walls or ceiling-height partitions or in a parking garage are ~~((new))~~ added or replaced, or less than 50 percent of the installed exterior wattage is ~~((altered))~~ replaced, the installed lighting wattage shall be maintained or reduced.

**C503.6.2 Rewiring and recircuiting.** Where new wiring is being installed to serve added fixtures and/or fixtures are being relocated to a new circuit, controls shall comply with Sections C405.2.1, C405.2.3, C405.2.4, C405.2.5, C405.2.7(~~(, C405.3)~~), and as applicable C408.3. ~~((In addition, office areas less than 300 ft<sup>2</sup> enclosed by walls or ceiling-height partitions, and all meeting and conference rooms, and all school classrooms, shall be equipped with occupancy sensors that comply with Section C405.2.1 and C408.3.))~~ New lighting control devices shall comply with the requirements of Section C405.2.

**C503.6.3 New or moved lighting panel.** Where a new lighting panel (or a moved lighting panel) with all new raceway and conductor wiring from the panel to the fixtures is being installed, controls shall also comply with ~~((the other))~~, in addition to the requirements of Section C503.6.2, all remaining requirements in Sections C405.2 and C408.3.

**C503.6.4 Newly-created rooms.** Where new walls or ceiling-height partitions are added to an existing space and create a new enclosed space, but the lighting fixtures are not being changed, other than being relocated, the new enclosed space shall have controls that comply with Sections C405.2.1, C405.2.2, C405.2.3, C405.2.4, C405.2.5 and C408.3.

**C503.6.5 Motors.** Those motors which are altered or replaced shall comply with Section C405.8.

**C503.6.6 Controlled receptacles.** Where electric receptacles are added or replaced, controlled receptacles shall be provided in accordance with Section C405.10.

**EXCEPTIONS:**

1. Where an alteration project impacts an area smaller than 5,000 square feet, controlled receptacles are not required.
2. Where existing systems furniture or partial-height relocatable office cubical partitions are reconfigured or relocated within the same area, controlled receptacles are not required in the existing systems furniture or office cubicle partitions.
3. Where new or altered receptacles meet the exception to Section C405.10, they are not required to be controlled receptacles or be located within 12 inches of noncontrolled receptacles.

**C503.7 Refrigeration systems.** Those parts of systems which are altered or replaced shall comply with Section C410. Additions or alterations shall not be made to an existing refrigerated space or system that will cause the existing mechanical system to become out of compliance. All new refrigerated spaces or systems in existing buildings, including refrigerated display cases, shall comply with Section C410.



**WAC 51-11C-50500 Section C505—Change of occupancy or use.**

**C505.1 General.** Spaces undergoing a change in occupancy shall be brought up to full compliance with this code in the following cases:

1. Any space that is converted from an F, S or U occupancy to an occupancy other than F, S or U.

2. Any space that is converted to a Group R dwelling unit or portion thereof, from another use or occupancy.

3. Any Group R dwelling unit or portion thereof permitted prior to July 1, 2002, that is converted to a commercial use or occupancy.

~~((Where the use in a space changes from one use in Table C405.4.2 (1) or (2) to another use in Table C405.4.2 (1) or (2), the installed lighting wattage shall comply with Section C405.4.~~

EXCEPTION: Where the component performance alternative in Section C402.1.5 is used to comply with this section, the Proposed Total Envelope UA is allowed to be up to 110 percent of the Allowed Total Envelope UA. Where the total building performance option in Section C407 is used to comply with this section, the annual energy consumption of the proposed design is allowed to be 110 percent of the annual energy consumption otherwise allowed by Section C407.3.))

A change in occupancy project shall be deemed to comply with this code if the project area alone complies or if the existing building and the project area combined comply with this code as a whole building.

EXCEPTIONS:

1. Where the component performance alternative in Section C402.1.5 is used to demonstrate compliance with this section, the Proposed Total UA is allowed to be up to 110 percent of the Allowable Total UA. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.
2. Where total building performance for the whole building is used to demonstrate compliance with this section, the annual carbon emissions from energy consumption of the proposed design is allowed to be 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3. This exception may be applied to the project area alone, or to the existing building and project area combined as a whole building.
3. Buildings or spaces that were permitted prior to the 2009 WSEC, or were originally permitted as unconditioned, may comply with this section as follows:
  - 3.1. Where the component performance alternative in Section C402.1.5 is used, the Proposed Total UA is allowed to be up to 110 percent of the Allowable Total UA.
  - 3.2. Where total building performance in Section C407 is used, the annual carbon emissions from energy consumption of the proposed design is allowed to be 110 percent of the annual carbon emissions from energy consumption allowed by Section C407.3.

Where the use in a space changes from one use in Table C405.4.2 (1) or (2) to another use in Table C405.4.2 (1) or (2), the installed lighting wattage shall comply with Section C405.4.