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DPD 2012 Energy Code ORD
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Version #3

CITY OF SEATTLE

ORDINANCE _____

COUNCIL BILL _____

AN ORDINANCE relating to the Seattle Energy Code, amending Section 22.700.010 of the Seattle Municipal Code; and adopting by reference Chapters 51-11C and 51-11R of the Washington Administrative Code, and amending certain of those chapters; and repealing Sections 2-18 of Ordinance **123430.**

BE IT ORDAINED BY THE CITY OF SEATTLE AS FOLLOWS:

Section 1. Section 22.700.010 of the Seattle Municipal Code is amended as follows:

22.700.010 Seattle Energy Code.

The Seattle Energy Code consists of: 1) The first printing of Chapters 51-11C and 51-11R of the Washington Administrative Code, effective July 1, 2013, which are adopted by reference; and 2) the amendments and additions to Chapters 51-11C and 51-11R of the Washington Administrative Code set out in this ordinance. One copy of the first printing of Chapters 51-11C and 51-11R of the Washington Administrative Code, effective July 1, 2013, is filed with the City Clerk in C.F. 313190.

((~~A. The 2009 Washington State Energy Code (WAC 51-11), which is filed with the City Clerk in C.F. 311044, and the amendments thereto adopted by Council Bill 116967, which are the Seattle Amendments, are hereby adopted and by this reference made a part of this subtitle. The Seattle Amendments include amendments to Reference Standard 29 and add Reference Standards 35 and 36. The 2009 Washington State Energy Code, with all Seattle Amendments, constitutes the Seattle Energy Code for all purposes other than application to residential spaces. B. For purposes of this Section 22.700.010~~

~~1. Prior to the effective date of the 2009 Washington State Energy Code, "residential spaces" are defined as spaces within the definition of "Group R" occupancy in Chapter 3 of the 2006 Seattle Building Code, as adopted by Ordinance 122528, or within the exception in Section 101.2 of that code, and~~

~~2. effective upon the date when the 2009 Washington State Energy Code takes effect, "residential spaces" are defined as set forth in Chapter 2 of the 2009 Washington State Energy Code under "RESIDENTIAL".~~

~~C. Effective upon the date when the 2009 Washington State Energy Code takes effect, the 2009 Washington State Energy Code, with the Seattle Amendments only to Chapter 1 and to Sections 1144 and 1162 of Chapter 11, and the provisions for procedure, administration and enforcement described in Section 1105 of the Seattle Amendments, shall constitute the Seattle Energy Code for residential spaces, to the extent that the provisions thereof apply to residential spaces. Until the effective date of the 2009 Washington State Energy Code, the 2006 Washington State Energy Code, as filed in C.F. 308938, and the amendments thereto adopted by Ordinance 122530, constitute the Seattle Energy Code for residential spaces, except as provided in Section 101.1.2 of the Seattle Amendments regarding procedure, administration and enforcement provisions.~~

~~D. It is the City's intent that the Seattle Energy Code constitute part of a local building code, and that any provisions that would be superseded by federal standards but for the application of 42 USC Section 6316(b)(2)(B) or of any other exception to federal preemption shall be applicable to the full extent authorized by any such exception. Any other provision notwithstanding, any requirement of the Seattle Energy Code shall be applicable at any time only to the maximum extent that its application is not prohibited by United States law as then in effect. If any provision of the Seattle Amendments shall be determined to be invalid or unenforceable for any reason, and if the such invalidity or unenforceability would otherwise result in application of any standard below that required by the Washington State Energy Code as then in effect, then the~~

~~standard of the Washington State Energy Code as then in effect shall apply unless such application is prohibited by applicable federal law.~~))

Section 2. The following sections of Chapter 1 of WAC 51-11C-10000 are amended as follows:

CHAPTER 1 SCOPE AND ADMINISTRATION

SECTION C101

SCOPE AND GENERAL REQUIREMENTS.

C101.1 Title. This code, consisting of Chapter 1 [CE] through Chapter 5 [CE] and Appendices A through D, shall be known as the "Commercial Portions of the *International Energy Conservation Code* of Seattle" (([~~NAME OF JURISDICTION~~])) or the "Seattle Commercial Energy Code"**,** and shall be cited as such. It is referred to herein as "this code."

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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 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.

C101.4.2 ((~~Historic~~)) *Landmark* buildings. The ((~~building official~~)) *code official* may modify the specific requirements of this code for ((~~historic buildings~~)) *landmarks* and require in lieu thereof alternate requirements ~~which~~ that the *code official* determines will not have an adverse

effect on the designated historic features of the building and 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 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(s) of the existing building or building system to comply with this code.~~))

C101.4.3 Additions, alterations, renovations or repairs. Additions, alterations, renovations or repairs 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(s) of the existing building or building system to comply with this code. Additions, alterations, renovations or repairs 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. *Substantial alterations* and repairs shall comply with the provisions of Section C101.4.7.

EXCEPTION: The following need not comply provided the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Glass only replacements in an existing sash and frame.

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. Reroofing for roofs where neither the sheathing nor the insulation is exposed. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.
6. 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.
7. Alterations to lighting systems only that replace less than ((~~60)~~) 20 percent of the luminaires in a space, provided that such alterations do not increase the installed interior lighting power.
8. ((~~Alterations that replace only the bulb and ballast within the existing luminaires in a space provided that the *alteration* does not increase the installed interior lighting power.~~)) **C101.4.3.1 Lighting and motors.** Alterations that add, alter or replace ((~~60)~~) 20 percent or more of the luminaires or of the lamps plus ballasts alone in a space enclosed by walls or ceiling-height partitions, or on the exterior of the building, shall comply with Sections C405.5 and C405.6. Where less than ((~~60)~~) 20 percent of the fixtures in a space enclosed by walls or ceiling-height partitions, or on the exterior of the building, are new or altered, the installed lighting wattage shall be maintained or reduced.

New lighting control devices shall comply with the requirements of Section C405.2. 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, C405.2.2.3, C405.2.3, C405.2.4 ((~~C405.3.4)~~), and as applicable C408.3. In addition,

office areas less than 300 ft^2 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 C405.2.2 and C408.3. 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 requirements in Sections C405.2.2 and C408.3.

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 and C408.3.

Those motors which are altered or replaced shall comply with Section C403.2.13. In no case shall the energy efficiency of the building be decreased.

C101.4.3.2 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.

All new systems in existing buildings, including packaged unitary equipment and packaged split systems, shall comply with Section C403.

Where mechanical cooling is added to a space that was not previously cooled, the mechanical cooling system shall comply with the economizer requirements in Section C403.3.1 or C403.4.1.

EXCEPTION: Alternate designs that are not in full compliance with this code may be approved when the building official determines that existing building or occupancy constraints make full compliance impractical or where full compliance would be economically impractical.

Alterations to existing mechanical cooling systems shall not decrease economizer capacity unless the system complies with Section C403.3.1 or C403.4.1. In addition, for existing mechanical cooling systems that do not comply with Sections C403.3.1 or Section C403.4.1, including both the individual unit size limits and the total building capacity limits on units without economizer, other alterations shall comply with Table ((~~C101.4.3.1~~)) C101.4.3.2.

When space cooling equipment is replaced, controls shall be installed to provide for integrated operation with economizer in accordance with Section C403.3.

Existing equipment currently in use may be relocated within the same floor or same tenant space if removed and reinstalled within the same permit.

C101.4.4 Change in occupancy or use. Spaces undergoing a change in occupancy from an F, S or U occupancy to an occupancy other than F, S or U shall comply with this code. Any space that is converted to a residential dwelling unit or portion thereof, from another use or occupancy shall comply with this code. Where the use in a space changes from one use in Table C405.5.2(1) or (2) to another use in Table C405.5.2(1) or (2), the installed lighting wattage shall comply with Section C405.5.

EXCEPTION: Where the component performance building envelope option in Section C402.1.3 is used to comply with this section, the Proposed UA is allowed to be up to 110 percent of the Target 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 and Section C401.2 (3).

C101.4.5 Change in space conditioning. Any nonconditioned space 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 that is altered to become conditioned

space, or any heated but not cooled space that is altered to become both heated and cooled, shall be required to be brought into full compliance with this code.

EXCEPTION: Where the component performance building envelope option in Section C402.1.3 is used to comply with this section, the Proposed UA is allowed to be up to 110 percent of the Target 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 and Section C401.2 (3).

C101.4.6 Mixed occupancy. Where a building includes both *residential* and *commercial* occupancies, each occupancy shall be separately considered and meet the applicable provisions of IECC-Commercial Provisions or IECC--Residential Provisions.

Table ((~~C101.4.3.1~~)) **C101.4.3.2**
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. (reserved)				
2. Split Systems	Efficiency: min.[1] Economizer: C403.4.1[2]	Efficiency: + 10/5%[5] Economizer: Shall not decrease existing economizer capability	Only for new units < 54,000 Btu/h replacing unit installed prior to 1991 (one of two): Efficiency: + 10/5%[5] Economizer: 50%[6] For units > 54,000 Btu/h or any units installed after 1991: Option A	Efficiency: min.[1] Economizer: C403.4.1[2, 4]
3. Water Source Heat Pump	Efficiency: min.[1] Economizer: C403.4.1[2]	(two of three): Efficiency: + 10/5%[5] Flow control valve[7] Economizer: 50%[6]	(three of three): Efficiency: + 10/5%[5] Flow control valve[7] Economizer: 50%[6] (except for certain pre-1991 systems[8])	Efficiency: min.[1] Economizer: C403.4.1[2, 4] (except for certain pre-1991 systems[8])

4. Hydronic Economizer using Air-Cooled Heat Rejection Equipment (Dry Cooler)	Efficiency: min.[1] Economizer: 1433[2]	Efficiency: + 10/5%[5] Economizer: Shall not decrease existing economizer capacity	Option A	Efficiency: min.[1] Economizer: C403.4.1[2, 4]
5. Air-Handling Unit (including fan coil units) where the system has an air-cooled chiller	Efficiency: min.[1] Economizer: C403.4.1[2]	Economizer: Shall not decrease existing economizer capacity	Option A (except for certain pre-1991 systems[8])	Option A (except for certain pre-1991 systems[8])
6. Air-Handling Unit (including fan coil units) and Water-cooled Process Equipment, where the system has a water-cooled chiller[10]	Efficiency: min.[1] Economizer: C403.4.1[2]	Economizer: Shall not decrease existing economizer capacity	Option A (except for certain pre-1991 systems[8] and certain 1991-2004 systems[9])	Efficiency: min.[1] Economizer: C403.4.1[2, 4] (except for certain pre-1991 systems[8] and certain 1991-2004 systems[9])
7. Cooling Tower Unit Type	Efficiency: min.[1] Economizer: C403.4.1[2] Any alteration with new or replacement equipment	No requirements Replacement unit of the same type with the same or smaller output capacity	Option A Replacement unit of the same type with a larger output capacity	Option A New equipment added to existing system or replacement unit of a different type
8. Air-Cooled Chiller	Efficiency: min.[1] Economizer: C403.4.1[2]	Efficiency: .+ 5%[11] Economizer: Shall not decrease existing economizer capacity	Efficiency (two of two): (1) .+ 10%[12] and (2) multistage Economizer: Shall not decrease existing economizer capacity	Efficiency: min.[1] Economizer: C403.4.1[2, 4]
9. Water- Cooled Chiller	Efficiency: min.[1] Economizer: C403.4.1[2]	Efficiency (one of two): (1) .+ 10%[13] or (2) plate frame heat exchanger[15] Economizer: Shall not decrease existing economizer capacity	Efficiency (two of two): (1) .+ 15%[14] and (2) plate frame heat exchanger[15] Economizer: Shall not decrease existing economizer capacity	Efficiency: min.[1] Economizer: C403.4.1[2, 4]
10. Boiler	Efficiency: min.[1] Economizer: C403.4.1[2]	Efficiency: .+ 8%[16] Economizer: Shall not decrease existing economizer capacity	Efficiency: .+ 8%[16] Economizer: Shall not decrease existing economizer capacity	Efficiency: min.[1] Economizer: C403.4.1[2, 4]

[1] Minimum equipment efficiency shall comply with Section C403.2.3 and Tables C403.2.3(1) through C403.2.3(9).

[2] System and building shall comply with Section C403.4.1 (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 C403.4.1.

[3] All equipment replaced in an existing building shall have air economizer complying with Sections C403.3.1 and C403.4.1 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 1 to Section C403.3.1.

[4] All separate new equipment added to an existing building shall have air economizer complying with Sections C403.3.1 and C403.4.1 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 1 to Section C403.4.1.

[5] Equipment shall have a capacity-weighted average cooling system efficiency:

a. For units with a cooling capacity below 54,000 Btu/h, a minimum of 10% greater than the requirements in Tables C403.2.3(1) and C403.2.3(2) (1.10 x values in Tables C403.2.3(1) and C403.2.3(2)).

b. For units with a cooling capacity of 54,000 Btu/h and greater, a minimum of 5% greater than the requirements in Tables C403.2.3(1) and C403.2.3(2) (1.05 x values in Tables C403.2.3(1) and C403.2.3(2)).

[6] 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 capable of providing this additional outside air and equipped with economizer control.

[7] Have flow control valve to eliminate flow through the heat pumps that are not in operation with variable speed pumping control complying with Section C403.4.3 for that heat pump.

a. 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.

b. As an alternate to this requirement, have a capacity-weighted average cooling system efficiency that is 5% greater than the requirements in note 5 (i.e., a minimum of 15%/10% greater than the requirements in Tables C403.2.3(1) and C403.2.3(2) (1.15/1.10 x values in Tables C403.2.3(1) and C403.2.3(2)).

[8] 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 Btu/h.

[9] Economizer not required for systems installed with water economizer plate and frame heat exchanger complying with previous codes between 1991 and June 2013, provided that the total fan coil load does not exceed the existing or added capacity of the heat exchangers.

[10] 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.

[11] The air-cooled chiller shall have an IPLV efficiency that is a minimum of 5% greater than the IPLV requirements <u>in EER</u> in Table C403.2.3(7) (1.05 x IPLV values <u>in EER</u> in Table C403.2.3(7)).

[12] The air-cooled chiller shall:

a. Have an IPLV efficiency that is a minimum of 10% greater than the IPLV requirements in EER in Table C403.2.3(7) (1.10 x IPLV values in EER in Table C403.2.3(7)); and

b. Be multistage with a minimum of two compressors.

[13] The water-cooled chiller shall have an IPLV efficiency that is a minimum of 10% greater than the IPLV requirements in kW/ton in Table C403.2.3(7) (1.10 x IPLV values in kW/ton in Table C403.2.3(7)). Water cooled centrifugal chillers designed for non-standard conditions shall have an NPLV efficiency that is at least 10 percent greater than the adjusted maximum NPLV rating in kW/ton defined in paragraph C403.2.3.1 (1.10 x NPLV).

[14] The water-cooled chiller shall have an IPLV efficiency that is a minimum of 15% greater than the IPLV requirements in kW/ton in Table C403.2.3(7), (1.15 x IPLV values in kW/ton in Table C403.2.3(7)). Water cooled centrifugal chillers designed for non-standard conditions shall have an NPLV efficiency that is at least 10% greater than the adjusted maximum NPLV rating in kW/ton defined in paragraph C403.2.3.1 (1.10 x NPLV).

[15] 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.

[16] The replacement boiler shall have an efficiency that is a minimum of 8% higher than the value in Table C403.2.3(5) (1.08 x value in Table C403.2.3(5)), except for electric boilers.

C101.4.7 Substantial alterations or repairs. In addition to meeting the applicable requirements of this code, any building or structure to which substantial alterations or repairs are made shall comply with the requirements of this section. A permit application for a voluntary energy upgrade to the building envelope is permitted to be made separately from the permit application for a substantial alterations project, provided that the threshold determination for substantial alterations includes the value of any such building envelope work.

Exceptions:

1. Alterations and repairs to *landmark* buildings shall comply with this section to the extent that the *code official* determines that such compliance does not have an adverse effect on the designated historic features of the building. The energy use allowed by subsections 2, 3 or 4 of Section C101.4.7.3 is permitted to be increased in proportion to the additional energy use required for protection of such designated features.

2. A project that is defined as a substantial alteration primarily due to the seismic retrofitting

of a building's unreinforced masonry walls is exempt from the requirements of this section.

3. A building constructed in compliance with the 2003 or more recent edition of the Seattle Building Code that would be classified as a substantial alteration only due to being reoccupied after being substantially vacant for more than 24 months is exempt from the requirements of this section.

C101.4.7.1 Definition. For the purposes of this section, substantial alterations or repairs means items 1, 2 or 4, or any combination thereof, of the definition of substantial alterations or repairs in Chapter 3 of the Seattle amendments to the IEBC, as determined by the *code official*.

Informative Note: Definitions 1, 2 and 4 of "substantial alterations or repairs" in the Seattle amendments to the IEBC are as follows:
1. Repair of buildings with damage ratios of 60 percent or more.
2. Remodeling or additions that substantially extend the useful physical and/or economic life of the building or a significant portion of the building, other than typical tenant remodeling.
4. Re-occupancy of a building that has been substantially vacant for more than 24 months in occupancies other than Group R-3.

C101.4.7.2 Pre-submittal conference. The applicant shall attend a pre-submittal conference to discuss the selected compliance path. Prior to this conference, the applicant shall meet with each energy utility serving the building to determine whether technical assistance or financial incentives are available for energy efficiency upgrades, and shall submit documentation of these meetings.

C101.4.7.3 Energy Efficiency. Buildings undergoing substantial alterations shall comply with one of the following:

1. Full code compliance. Fully comply with the requirements of this code for new construction.

2. Envelope thermal performance within 20 percent of code. Demonstrate that heat loss through the altered building envelope is no more than 20 percent greater than allowed by the

Seattle Energy Code, using the Component Performance Building Envelope Option in Section C402.1.3, and meet all other prescriptive requirements of the Seattle Energy Code for new construction.

2.1. Default U-values. The values listed in Appendix A and Section C303 shall be used as the default U-values for existing building envelope components. For buildings with permits issued after January 1, 1992, existing building envelope components are deemed to meet the minimum U-values required by the edition of the Seattle Energy Code in effect at the time of permit application, where visual inspection by the *code official* reveals that those components appear to be equal to or better than code-compliant components.

3. Total building performance within 15 percent of code. Demonstrate that the building energy consumption will be less than 105 percent of the standard reference design using the Total Building Performance methodology in Section C407 of the Seattle Energy Code.

4. Operating energy alternative. The *code official* may allow a calculated building energy consumption 20 percent greater than the standard reference design calculated in accordance with the Total Building Performance methodology in Section C407, provided that:

a. The applicant demonstrates that constructability, economic, or historic preservation considerations preclude conformance with any of the above options; and

b. The owner agrees to operate the altered building at or below the annual energy use level predicted for that calculated energy performance during a period of 12 consecutive months, concluding no later than three years after issuance of the certificate of occupancy, adjusted as allowed by Sections C402.1.5.6 through C402.1.5.10, and to meet the requirements of Sections C402.1.5.11 through C402.1.5.13, substituting the energy consumption standard in option 4 of this Section C101.4.7.3 for the energy consumption targets set out in Section C402.1.5.2.

4.1. Reporting. The building owner shall report the energy consumption in kBTU/square foot using automated reporting directly from utilities via Energy Star

Portfolio Manager, and shall authorize the *code official* to view the reports directly in Portfolio Manager during the demonstration period.

C101.4.7.4 Impracticality. In cases where full compliance with all the requirements of Section C101.4.7 is impractical, the applicant is permitted to arrange a pre-design conference with the design team and the *code official* to seek modifications. The applicant shall identify specific requirements that are impractical, and shall identify design solutions and modifications that achieve a comparable level of energy efficiency. The *code official* is authorized to waive specific requirements in this code to the extent that the *code official* determines those requirements to be impractical.

C101.5 Compliance. *Residential buildings* shall meet the provisions of IECC--Residential Provisions. *Commercial buildings* shall meet the provisions of IECC--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.

C101.5.2 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 provisions of this code:

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

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

3. Greenhouses isolated from any conditioned space and not intended for occupancy.

C101.5.2.1 Semi-heated spaces. A *semi-heated* space shall meet all of the *building thermal envelope* requirements, except that insulation is not required for opaque wall assemblies. *Fenestration* shall comply with building thermal envelope requirements. Component performance calculations involving semi-heated spaces shall calculate fully

insulated opaque walls for the Target UA calculation, and Total Building Performance calculations involving semi-heated spaces shall calculate fully insulated opaque walls for the Standard Reference Design.

Informative Note: There is no separate "freeze protection" space conditioning category for unoccupied utility buildings. Spaces with no cooling and less than 3.4 BTU/h-ft^2 heating capacity are not required to be insulated. The opaque walls of spaces that meet the definition of "semi-heated" in Chapter 2 are not required to be insulated, but otherwise the thermal envelope of semi-heated spaces must meet all requirements for conditioned space. Spaces with any

C102.1 General. This code does not ((~~is not intended to~~)) prevent the use of any material, method of construction, design or insulating system prohibited by this code or not specifically ((~~prescribed~~)) allowed herein, provided that such construction, design or insulating system has been *approved* by the *code official* ((~~as meeting the intent of this code~~)).

The *code official* may approve an alternate material, method of construction, design or insulating system, provided the *code official* finds that the proposed alternate complies with the provisions of this code, and that the alternate, when considered together with other safety features of the building or other relevant circumstances, will provide at least an equivalent level of strength, effectiveness, fire resistance, durability, safety and sanitation.

The *code official* may require that sufficient evidence or proof be submitted to reasonably substantiate any claims regarding the use or suitability of the alternate. The *code official* may, but is not required to, record the approval of modifications and any relevant information in the files of the *code official* or on the approved permit plans.

C102.2 Modifications. The *code official* may modify the requirements of this code for individual cases provided the *code official* finds: (1) there are practical difficulties involved in carrying out the provisions of this code; (2) the modification is in conformity with the intent and

purpose of this code; (3) the modification will provide a reasonable level of fire protection and structural integrity when considered together with other safety features of the building or other relevant circumstances, and (4) the modification maintains or improves the energy efficiency of the building. The *code official* may, but is not required to, record the approval of modifications and any relevant information in the files of the *code official* or on the approved permit plans.

SECTION C103

APPLICATIONS AND PERMITS ((~~CONSTRUCTION DOCUMENTS.~~))

C103.1 General. A permit for work performed according to this code shall be obtained in accordance with Chapter 1 of the International Building Code, International Mechanical Code or Seattle Electrical Code.

C103.2 Construction documents. Construction documents and other supporting data shall comply with this section and the International Building Code, International Mechanical Code, International Existing Building Code and Seattle Electrical Code. ((~~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 exist, 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.~~))

C103.2.1 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, insulation materials and their *R*-values; *fenestration U*-factors and SHGCs; area-weighted *U*-factor and SHGC calculations; mechanical system design criteria; mechanical and service water heating system and equipment types, sizes and efficiencies; economizer description; equipment and systems controls; fan motor horsepower (hp) and controls; duct sealing, duct and pipe insulation and location; lighting fixture schedule with wattage and control narrative; and air sealing details.

((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.~~))

SECTION C104

INSPECTIONS.

C104.1 General. Construction or work for which a permit is required shall be subject to inspection by the *code official* in accordance with this section and the International Building Code, International Mechanical Code and Seattle Electrical Code.

***

C104.7 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.

((~~C104.8 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.*~~

~~**C104.8.1 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.~~))

***

SECTION C106

REFERENCED STANDARDS.

C106.1 Referenced codes and standards. The codes and standards referenced in this code shall be those listed in Chapter 5, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections C106.1.1 and C106.1.2.

C106.1.1 References to other codes. Whenever an International, National or Uniform Code is referenced in this code, it means the Seattle edition of that code, which includes local amendments. References to the "Building Code", "Residential Code", "Fire Code", "Electrical Code", "Mechanical Code" and "Plumbing Code" mean the Seattle editions of those codes. **((~~Conflicts.~~** ~~Where differences occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.~~))

C106.1.2 Provisions in referenced codes and standards. Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

***

C106.4 Other laws. The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law. ((~~In addition to the requirements of this code, all occupancies shall conform to the provisions included in the State Building Code (chapter 19.27 RCW). In case of conflicts among the codes enumerated in RCW 19.27.031 (1) through (4) and this code, an earlier named code shall govern over those following.~~)) In the case of conflict between the duct sealing and insulation requirements of this code and the duct insulation requirements of Sections 603 and 604 of the *International Mechanical Code*, the duct insulation requirements of this code, or where applicable, a local jurisdiction's energy code shall govern.

SECTION C107

FEES.

C107.1 Fees. A fee for each permit and for other activities related to the enforcement of this code shall be paid as set forth in the Fee Subtitle, Seattle Municipal Code Title 22, Subtitle IX. **((**~~A permit shall not be issued until the fees prescribed in Section C107.2 have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.~~

~~**C107.2 Schedule of permit fees.** A fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.~~

~~**C107.3 Work commencing before permit issuance.** Any person who commences any work before obtaining the necessary permits shall be subject to an additional fee established by the *code official*, which shall be in addition to the required permit fees.~~

~~**C107.4 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.~~

~~**C107.5 Refunds.** The *code official* is authorized to establish a refund policy.~~))

SECTION C108

((~~STOP WORK ORDER.~~)) ENFORCEMENT

C108.1 Authority. The *code official* is authorized to enforce this code in accordance with the International Building Code, International Mechanical Code and Seattle Electrical Code. ((~~Whenever the *code official* finds any work regulated by this code being performed in a manner either contrary to the provisions of this code or dangerous or unsafe, the *code official* is authorized to issue a stop work order.~~

~~**C108.2 Issuance.** The stop-work order shall be in writing and shall be given to the owner of the property involved, or to the owner's agent, or to the person doing the work. Upon issuance of a stop-work order, the cited work shall immediately cease. The stop-work order shall state the reason for the order, and the conditions under which the cited work will be permitted to resume.~~

~~**C108.3 Emergencies.** Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.~~

~~**C108.4 Failure to comply.** Any person who shall continue any work after having been served with a stop-work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be liable to a fine of not less than **[AMOUNT]** dollars or more than **[AMOUNT]** dollars.~~))

SECTION C109

((~~BOARD OF APPEALS.~~)) ADMINISTRATIVE REVIEW

C109.1 Administrative review by the *code official*. Applicants may request administrative review by the *code official* of decisions or actions pertaining to the administration and enforcement of this code. Requests shall be addressed to the *code official*.

C109.2 Administrative review by the Construction Codes Advisory Board. Applicants may request review by the Construction Codes Advisory Board of decisions or actions pertaining to the application and interpretation of this code. The review will be performed by a panel of three or more members of the Construction Codes Advisory Board, chosen by the Board Chair. The Chair shall consider the subject of the review and members' expertise when selecting members to conduct a review. The decision of the review panel is advisory only; the final decision is made by the *code official*.

((~~**General.** In order to hear and decide appeals of orders, decisions or determinations made by the *code official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The *code official* shall be an ex-officio member of said board~~

~~but shall have no vote on any matter before the board. The board of appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *code official*.~~

~~**C109.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. The board shall have no authority to waive requirements of this code.~~

~~**C109.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training and are not employees of the jurisdiction.~~))

SECTION C110

VIOLATIONS.

It shall be unlawful for any person, firm, or corporation to erect or construct any building, or remodel or rehabilitate any existing building or structure in the state, or allow the same to be done, contrary to or in violation of any of the provisions of this code. Violations shall be administered according to the procedures set forth in Section 103 of the International Building Code.

SECTION C111

LIABILITY.

Nothing contained in this code is intended to be nor shall be construed to create or form the basis for any liability on the part of any city or county or its officers, employees or agents for any injury or damage resulting from the failure of a building to conform to the provisions of this code, or by reason or as a consequence of any inspection, notice, order, certificate, permission or approval authorized or issued or done in connection with the implementation or enforcement of

this code, or by reason of any action or inaction on the part of the City related in any manner to the enforcement of this code by its officers, employees or agents.

This code shall not be construed to relieve or lessen the responsibility of any person owning, operating or controlling any building or structure for any damages to persons or property caused by defects, nor shall the Department of Planning and Development or the City of Seattle be held to have assumed any such liability by reason of the inspections authorized by this code or any permits or certificates issued under this code.

Section 3. The following sections of Chapter 2 of WAC 51-11-20000 are amended as follows:

Chapter 2 [CE]--Definitions.

Section C201--General.

C201.1 Scope. Unless stated otherwise, the following words and terms in this code shall have the meanings indicated in this chapter and this code.

***

C201.4 Terms not defined. Terms not defined by this chapter or this code shall have ordinarily accepted meanings such as the context implies.

***

Section C202--General definitions.

AUTOMATIC CONTROL DEVICE. A device capable of automatically turning loads off and on without manual intervention.

***

BUILDING ENTRANCE. Any door, set of doors, doorway, or other form of portal (including elevator doors such as in parking garages) that is used to gain access to the building from the outside by the public. Where buildings have separate one-way doors to enter and leave, this also includes any doors ordinarily used to leave the building.

***

CODE OFFICIAL. The ((~~officer or other designated authority~~)) Director of the Seattle Department of Planning and Development charged with the administration and enforcement of this code, or a duly authorized representative.

***

COMPUTER ROOM. A room whose primary function is to house electronic equipment for the processing and storage of electronic data and that has a design electronic data equipment power density exceeding 20 watts/ft^2 of conditioned floor area (215 watts/m^2).

***

CONDITIONED SPACE. An area or room within a building being heated or cooled, containing uninsulated ducts, or with a fixed opening directly into an adjacent *conditioned space*. Elevator shafts, stair enclosures, enclosed corridors connecting conditioned spaces, and enclosed spaces through which conditioned air is transferred at a rate exceeding three air changes per hour are considered conditioned spaces for the purposes of the *building thermal envelope* requirements.

***

CONTROLLED RECEPTACLE. An electrical receptacle that is controlled by an automatic control device.

***

DAYLIGHT ZONE. (See also Fig. C202.4)

1. **Under skylights.** The area under skylights whose horizontal dimension, in each direction, is equal to the skylight dimension in that direction plus either 70 percent of the floor-to-ceiling height or the dimension to a ceiling height opaque partition, or to a partition that is more than 50 percent opaque, or one-half the distance to adjacent skylights or vertical *fenestration*, whichever is least.

2. **Adjacent to vertical** *fenestration***.** The area adjacent to vertical *fenestration* which receives daylight through the *fenestration*. For purposes of this definition and unless more detailed analysis is provided, the primary daylight *zone* depth is assumed to extend into the space a distance equal to the window head height and the secondary daylighted zone extends from the edge of the primary zone to a distance equal to two times the window head height or to the nearest ceiling height opaque partition, or to a partition that is more than 50 percent opaque, whichever is less. The daylight *zone* width is assumed to be the width of the window plus 2 feet (610 mm) on each side, or the window width plus the distance to an opaque partition, or the window width plus one-half the distance to adjacent skylight or vertical *fenestration*, whichever is least.

3. **In parking garages.** 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 and no exterior obstructions within 20 feet.

4. **Under atrium glazing.** The area at the floor directly beneath the atrium and the top floor under the atrium, whose horizontal dimension, in each direction, is equal to the distance between the floor and ceiling height. Levels below the top floor that are not directly beneath the atrium are unaffected.

***

DPD. The Seattle Department of Planning and Development.

***

IT (INFORMATION TECHNOLOGY) ENERGY. Electrical energy consumed by UPS (Uninterruptible Power Supply) units, servers, and associated electronic data storage and data processing equipment, but not by lighting or HVAC equipment.

***

LANDMARK. A building or structure that is subject to a requirement to obtain a certificate of approval from the City Landmarks Preservation Board before altering or making significant changes to specific features or characteristics, that has been nominated for designation or has been designated for preservation by the City Landmarks Preservation Board, that has been designated for preservation by the State of Washington, has been listed or determined eligible to be listed in the National Register of Historic Places, or is located in a landmark or special review district subject to a requirement to obtain a certificate of approval before making a change to the external appearance of the structure.

***

QUALIFIED COMMISSIONING AUTHORITY. A person qualified by formal training and at least two years' experience commissioning projects of similar scale and complexity, and who is a registered design professional, an ASHRAE Commissioning Process Management Professional,

a Building Commissioning Association (BCA) Certified Commissioning Professional, or an AABC Commissioning Group (ACG) Certified Commissioning Authority.

***

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 heating system output capacity ((~~of~~)) equal to or greater than 3.4 Btu/(h-ft^2) but not greater than 8 Btu/(h-ft^2);

2. Is not a cold storage space or frozen storage space.

***

SOLAR ZONE. A clear area or areas reserved solely for current and future installation of photovoltaic or solar hot water systems.

Section 4. The following sections of Chapter 3 of WAC 51-11-30000 are amended as follows:

CHAPTER 3 [CE]--GENERAL REQUIREMENTS.

Section C301--Climate zones.

C301.1 General. Climate zones from Table C301.1 shall be used in determining the applicable requirements from Chapter 4. Seattle is in Zone 4-C (4-Marine).

***

C302.2 Exterior design conditions. The heating or cooling outdoor design temperatures shall be ~~selected from Appendix C~~ 24°F for heating and 82°F dry bulb and 66°F wet bulb for cooling.

***

Section 5. The following sections of Chapter 4 of WAC 51-11-40000 are amended as follows:

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

1. The requirements of Sections C402, C403, C404, C405, C408, ((~~and~~)) C409 and C410.

2. The requirements of Sections C407, C408, C409, C410, C402.4, 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 93 percent of the standard reference design building.

3. The requirements of C402.1.5.

C402.1.1 Insulation and *fenestration* criteria. The *building thermal envelope* shall meet the requirements of Tables C402.2 and C402.3 based on the climate zone specified in Chapter 3. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *R*-values from the "Group R" column of Table C402.2. 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 C402.2.

Informative Note: For the application of the building envelope requirements to elevator

***

C402.1.2 *U*-factor alternative. An assembly with a *U*-factor, *C*-factor, or *F*-factor equal or less than that specified in Table C402.1.2 shall be permitted as an alternative to the *R*-value in Table C402.2. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *U*-factor, *C*-factor, or *F*-factor from the "Group R" column of Table C402.1.2. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *U*-factor, *C*-factor or *F*-factor from the "All other" column of Table C402.1.2. 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. The U-values and R-values of foam insulation products used for the purpose of

compliance with this code shall be based on the aged Long-Term Thermal Resistance (LTTR) values of the insulation.

***

Table C402.1.2
Opaque Thermal Envelope Assembly Requirements[a]

CLIMATE ZONE	5 AND MARINE 4		6	
	All Other	Group R	All Other	Group R
Roofs				
Insulation entirely above deck	~~((U-0.034))~~ U-0.026	~~((U-0.031))~~ U-0.026	U-0.032	U-0.031
Metal buildings	~~((U-0.031~~ U-0.027	~~((U-0.031))~~ U-0.027	U-0.029	U-0.031
Attic and other	U-0.021	U-0.021	U-0.021	U-0.021
Walls, Above Grade				
Mass	~~((U-0.078[d])~~ U-0.057	~~((U-0.078))~~ U-0.057	U-0.078	U-0.071
Metal building	U-0.052	U-0.052	U-0.052	U-0.044
Steel framed	U-0.055	U-0.055	U-0.049	U-0.044
Wood framed and other	~~((U-0.054))~~ U-0.051	~~((U-0.054))~~ U-0.051	U-0.051	U-0.044
Walls, Below Grade				
Below-grade wall[b]	~~((Same as above grade))~~ U-0.070	~~((Same as above grade))~~ U-0.070	Same as above grade	Same as above grade
Floors				
Mass	~~((U-0.031))~~ U-0.029	~~((U-0.031))~~ U-0.029	U-0.031	U-0.031
Joist/framing	~~((U-0.029))~~ U-0.029 steel joist U-0.025 wood joist	~~((U-0.033))~~ U-0.029 steel joist U-0.025 wood joist	U-0.029	U-0.029

Slab-on-Grade Floors				
Unheated slabs	~~((F-0.528))~~ F-0.520	~~((F-0.510))~~ F-0.520	F-0.54	F-0.52
Heated slabs[c]	~~((F-0.55))~~ F-0.360	~~((F-0.55))~~ F-0.360	F-0.55	F-0.55

a Use of opaque assembly U-factors, C-factors, and F-factors from Appendix A is required unless otherwise allowed by Section C402.1.2.

b Where heated slabs are below grade, below-grade walls 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 U-factor from Table C402.1.2.))~~

C402.1.3 Component performance building envelope option.

C402.1.3.1 General. Buildings or structures whose design heat loss rate (UA_p) and solar heat gain coefficient rate (SHGC * A_p) are less than or equal to the target heat loss rate (UA_t) and solar heat gain coefficient rate (SHGC * A_t) shall be considered in compliance with this section. The stated *U*-factor, *F*-factor, or allowable area of any component assembly listed in Table C402.1.2 and Table C402.3, such as roof/ceiling, opaque wall, opaque door, *fenestration*, floor over conditioned space, slab-on-grade floor, radiant floor or opaque floor may be increased and the *U*-factor or *F*-factor for other components decreased, provided that the total heat gain or loss for the entire building envelope does not exceed the total resulting from compliance to the *U*-factors, *F*-factors or allowable areas specified in this section. Compliance shall be calculated in total for the building envelope for nonresidential spaces and for residential spaces.

EXCEPTION. A design heat loss rate in compliance with Equation C402-5 is permitted in lieu of a calculation in compliance with Equations C402.1 and C402.2

C402.1.3.2 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 90.1-2010 Normative Appendix A.

C402.1.3.3 UA calculations. The target UA_t and the proposed UA_p shall be calculated using Equations C402-1 and C402-2 and the corresponding areas and *U*-factors from Table C402.1.2 and Table C402.3. For the target UA_t calculation, the skylights shall be located in roof/ceiling area up to the maximum skylight area per Section C402.3.1, and the remainder of the *fenestration* allowed per Section C402.3.1 shall be located in the wall area.

C402.1.3.4 SHGC rate calculations. Solar heat gain coefficient shall comply with Table C402.3. The target $SHGCA_t$ and the proposed $SHGCA_p$ shall be calculated using Equations C402-3 and C402-4 and the corresponding areas and SHGCs from Table C402.3.

***

Equation C402-1

Target UA_t

$$UA_t = U_{radt}A_{radt}.+ U_{mrt}A_{mrt}.+ U_{rat}A_{rat}.+ U_{mwt}(A_{mwt}. +A_{mwbgt})+ U_{mbwt}(A_{mbwt}+A._{mbwbgt}).+ U_{sfwt}(A_{sfwt}+A_{sfwbgt})..+ U_{wfwt}(A_{wfwt}.+A_{wfwbgt}).+ U_{fmt}A_{fmt}.+ U_{fjt}A_{fjt}.+ F_{st}P_{st}.+F_{srt}P_{srt}.+ U_{dst}A_{dst}.+ U_{drt}A_{drt}.+ U_{vgt}A_{vgt}.+ U_{vgmt}A_{vgmt}.+ U_{vgmot}A_{vgmot}.+ U_{vgdt}A_{vgdt}.+ U_{ogt}A_{ogt}$$

U_{at} = The target combined specific heat transfer of the gross roof/ceiling assembly, exterior wall and floor area.

Where:

U_{radt} = The thermal transmittance value for roofs with the insulation entirely above deck found in Table C402.1.2.

U_{mrt} = The thermal transmittance value for metal building roofs found in Table C402.1.2.

U_{rat} = The thermal transmittance value for attic and other roofs found in Table C402.1.2.

U_{mwt} = The thermal transmittance value for opaque mass walls found in Table C402.1.2.

U_{mbwt} = The thermal transmittance value for opaque metal building walls found in Table C402.1.2.

U_{sfwt} = The thermal transmittance value for opaque steel-framed walls found in Table C402.1.2.

U_{wfwt} = The thermal transmittance value for opaque wood framed and other walls found in Table C402.1.2.

U_{fmt} = The thermal transmittance value for mass floors over unconditioned space found in Table C402.1.2.

U_{fjt} = The thermal transmittance value for joist floors over unconditioned space found in Table C402.1.2.

F_{st} = The F-factor for slab-on-grade floors found in Table C402.1.2.

F_{srt} = The F-factor for radiant slab floors found in Table C402.1.2.

U_{dst} = The thermal transmittance value for opaque swinging doors found in Table C402.2.

U_{drt} = The thermal transmittance value for opaque roll-up or sliding doors found in Table C402.2.

U_{vgt} = The thermal transmittance value for vertical fenestration with nonmetal framing found in Table C402.3 which corresponds to the proposed vertical fenestration area as a percent of gross exterior wall area. * Buildings utilizing Section C402.3.1.3 shall use the thermal transmittance value specified there.

U_{vgmt} = The thermal transmittance value for vertical fenestration with fixed metal framing found in Table C402.3 which corresponds to the proposed vertical fenestration area as a percent of gross exterior wall area. * Buildings utilizing Section C402.3.1.3 shall use the thermal transmittance value specified there.

U_{vgmot} = The thermal transmittance value for vertical fenestration with operable metal framing found in Table C402.3 which corresponds to the proposed vertical fenestration area as a percent of gross exterior wall area. * Buildings utilizing Section C402.3.1.3 shall use the thermal transmittance value specified there.

U_{vgdt} = The thermal transmittance value for entrance doors found in Table C402.3 which corresponds to the proposed vertical fenestration area as a percent of gross exterior wall area. * Buildings utilizing Section C402.3.1.3 shall use the thermal transmittance value specified there.

U_{ogt} = The thermal transmittance for skylights found in Table C402.3 which corresponds to the proposed skylight area as a percent of gross exterior roof area.

A_{fmt} = The proposed mass floor over unconditioned space area, A_{fm}.

A_{fjt} = The proposed joist floor over unconditioned space area, A_{fj}.

P_{st} = The proposed linear feet of slab-on-grade floor perimeter, P_s.

P_{srt} = The proposed linear feet of radiant slab floor perimeter, P_{rs}.

A_{dst} = The proposed opaque swinging door area, A_{ds}.

A_{drt} = The proposed opaque roll-up or sliding door area, A_{dr}.

and

If the vertical fenestration area as a percent of gross above-grade exterior wall area does not exceed the maximum allowed in Section C402.3.1.3:

A_{mwt} = The proposed opaque mass above-grade wall area, A_{mw}.

A_{mwbgt} = The proposed opaque below-grade mass wall area, A_{mwbg}.

A_{mbwt} = The proposed opaque above-grade metal building wall area, A_{mbw}.

A_{sfwbgt} = The proposed opaque below-grade steel framed wall area, A_{sfwbg}.

A_{sfwt} = The proposed opaque above-grade steel framed wall area, A_{sfw}.

A_{sfwbgt} = The proposed opaque below-grade steel framed wall area, A_{sfwbg}.

A_{wfwt} = The proposed opaque above-grade wall wood framed and other area, A_{wfw}.

A_{wfwbgt} = The proposed opaque below-grade wall wood framed and other area, A_{wfwbg}.

A_{vgt} = The proposed vertical fenestration area with nonmetal framing, A_{vg}.

A_{vgmt} = The proposed vertical fenestration area with fixed metal framing, A_{vgm}.

A_{vgmot} = The proposed vertical fenestration area with operable metal framing, A_{vgmo}.

A_{vgdt} = The proposed entrance door area, A_{vgd}.

or

For buildings utilizing C402.3.1.2, vertical fenestration area as a percent of gross exterior above-grade wall may not exceed the amounted allowed by that section. For all other buildings, if the vertical fenestration area as a percent of gross exterior above-grade wall area exceeds the maximum allowed in Section C402.3.1, the 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 allowed percentage per Section C402.3.1 of the gross above-grade wall area. The target wall area of a given wall type shall be the sum of the proposed below grade area and the increased above-grade area.

and

If the skylight area as a percent of gross exterior roof area does not exceed the maximum allowed in Section C402.3.1:

A_{radt} = The proposed roof area with insulation entirely above the deck, A_{rad}.

A_{mrt} = The proposed roof area for metal buildings, A_{mr}.

A_{rat} = The proposed attic and other roof area, A_{or}.

A_{ogat} = The proposed skylight area, A_{ogor}.

or

If the skylight area as a percent of gross exterior roof area exceeds the maximum allowed in Section C402.3.1, 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.

*NOTE: The vertical fenestration area does not include opaque doors and opaque spandrel panels.

EQUATION C402-3

TARGET $SHGCA_t$

$SHGCA_t = SHGC_{ogt}A_{ogort} + SHGC_{vgt}(A_{vgt} + A_{vgmt} + A_{vgmot} + A_{vgdt})$

Where:

$SHGCA_t$ = The target combined ((~~specific~~)) solar heat gain of the target fenestration area.

SHGCog = The solar heat gain coefficient for skylight fenestration found in Table C402.3 and Aogt as defined in Equation C402-1.

$SHGC_{vgt}$ = The solar heat gain coefficient for vertical fenestration found in Table C402.3 which corresponds to the proposed total fenestration area as a percent of gross exterior wall area, and ((~~A_{ogort}~~)), A_{vgt}, A_{vgmt}, A_{vgmot} and A_{vgdt} are defined under Equation C402-1. Buildings utilizing Section C402.3.1.3 shall use the SHGC value specified there. The SHGC may be adjusted for projection factors per the requirements of C402.3.3.

$SHGC_{ogt}$ = The solar heat gain coefficient for skylight fenestration found in Table C402.3, and A_{ogort} as defined under Equation C402-1.

EQUATION C402-4

PROPOSED $SHGCA_p$

$SHGCA_p = SHGC_{og}A_{og} + SHGC_{vg}A_{vg}$

Where:

$SHGCA_p$ = The combined proposed ((~~specific~~)) 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.

Equation C402-5
Component Performance UxA

(UA Sum) + (FL Sum) + (CA Sum) + (XVG) + (XSky) < Zero. **(Equation 402-5)**

Where:

UA Sum = Sum of the (UA Dif) values for each assembly that comprises a portion of the building thermal envelope, other than assemblies included in FL Sum and CA Sum

UA Dif = (UA Proposed) – (UA Table)

UA Table = (Maximum allowable U-factor specified in Table C402.1.2 or Table C402.3) x (Area)[a]

UA Proposed = (Proposed U-value) x (Area)

FL Sum = Sum of the (FL Dif) values for each slab on grade assembly that comprises a portion of the building thermal envelope

FL Dif = (FL Proposed) – (FL Table)

FL Table = (Maximum allowable F-factor specified in Table C402.1.2) x (Perimeter length)

FL Proposed = (Proposed F-value) x (Perimeter length)

CA Sum = Sum of the (CA Dif) values for each below-grade wall assembly that comprises a portion of the building thermal envelope

CA Dif = (CA Proposed) – (CA Table)

CA Table = (Maximum allowable C-factor specified in Table C402.1.2) x (area)

CA Proposed = (Proposed C-value) x (area)

XVG (Excess Vertical Glazing Value) = (XVGArea x UVG) – (XVGArea x UWall), but not less than zero.

XVGArea (Excess Vertical Glazing Area) = (Proposed Vertical Glazing Area) – (Allowable Vertical Glazing Area determined in accordance with Section C402.3.1)

UA Wall = Sum of the (UA Proposed) values for each opaque assembly comprising a portion of the above-grade exterior wall

UWall = UA Wall / total above-grade opaque exterior wall area

UA VG = Sum of the (UA Proposed) values for each vertical glazing assembly

UVG = UA VG / total vertical glazing area

XSky (Excess Skylight Value) = (XSArea X USky) – (XSArea x U Roof), but not less than zero.

XSArea (Excess Skylight Area) = (Proposed Skylight Area) – (Allowable Skylight Area determined in accordance with Section C402.3.1)

UA Roof = Sum of the (UA Proposed) values for each opaque assembly comprising a portion of a roof

URoof = UA Roof / total opaque roof area

UA Sky = Sum of the (UA Proposed) values for each skylight assembly

USky = UA Sky / total skylight area

Footnote
a: Fenestration U-factors in Table C402.3 may be modified by the exceptions to Sections C402.3, C402.3.1 and C402.3.1.2.

C402.1.4 Semi-heated spaces. All spaces shall comply with the requirements in Section C402 unless they meet the definition for semi-heated spaces. For semi-heated spaces, the building envelope shall comply with the same requirements as that for conditioned spaces in Section C402; however, for semi-heated spaces heated by other than electric resistance heating equipment, wall insulation is not required for those walls that separate semi-heated spaces from the exterior provided that the space meets all the requirements of semi-heated space. Semi-heated spaces shall be calculated separately from other conditioned spaces for compliance purposes. Building envelope assemblies separating conditioned space from semi-heated space shall comply with exterior envelope insulation requirements. When choosing the uninsulated wall option, the wall shall not be included in Component Performance Building Envelope Option calculation.

C402.1.5 Target Performance Path.

C402.1.5.1 Scope. Buildings of the following occupancy types are permitted to conform to the Target Performance Path and are not required to comply with Seattle Energy Code requirements other than the mandatory measures listed in Section C402.1.5.3 below.

1. B-occupancy office

2. B-occupancy medical office

3. R-2 occupancy multi-family over three stories

4. S-1 & S-2 occupancy warehouse (non-refrigerated)

5. E-occupancy school

6. M-occupancy retail

7. I-2 occupancy hospital

8. Other occupancy type, where specific permission is granted by the *code official*. Any such permission, if granted, shall be made either on the basis of an energy use target approved by the *code official* for that occupancy based on the best-performing local examples of that occupancy, or by provision of a metering system that segregates and separately reports the energy loads for the additional occupancy from those of the occupancies listed in 1 – 7 above.

9. Mixed use: A mixed use building is any building containing more than one of the occupancies listed in 1 – 8 above.

C402.1.5.2 Energy use targets. Buildings, including their initial tenant improvements, using the Target Performance Path shall be designed to use less energy than the weighted sum of the following energy use targets, as demonstrated by approved energy modeling. Energy use targets are expressed in terms of thousand BTU per square foot of conditioned floor area per year (kBTU/ft^2/yr).

1. B-occupancy office: 40 kBTU/ ft^2/yr

2. B-occupancy medical office: 50 kBTU/ ft^2/yr

3. R-2 occupancy multi-family: 35 kBTU/ ft^2/yr

4. S-1 & S-2 occupancy warehouse: 25 kBTU/ ft^2/yr

5. E-occupancy school: 45 kBTU/ ft^2/yr

6. M-occupancy retail: 60 kBTU/ ft^2/yr

7. I-2 occupancy hospital: 150 kBTU/ ft^2/yr

8. Parking garages, including unconditioned and conditioned spaces, within the above occupancies shall be calculated separately at: 10 kBTU/ ft^2/yr for enclosed garages and 6 kBTU/ ft^2/yr for open garages.

C402.1.5.2.1 Data Center Energy. Anticipated total data center energy use is permitted to be added to the overall building energy usage target in accordance with this section. The anticipated *IT energy* usage shall be multiplied by a factor of 1.45 to determine the anticipated total data center energy use. The *IT energy* usage shall be separately sub-metered in a secure manner approved by the *code official* and automatically exported to *DPD* showing daily, monthly and annual totals during the operational energy use demonstration period set forth in Section C402.1.5.6. Actual *IT energy* shall be adjusted in accordance with Section C402.1.5.7.

C402.1.5.3 Mandatory Measures. Buildings using the Target Performance Path shall:

1.Meet their assigned building energy use targets;

2. Have an area-weighted average U-value for all *fenestration* less than 0.40; and

3. Comply with the following portions of the Seattle Energy Code. Each of the code chapters and sections listed below includes all of its sub-sections.

3.1. Chapters 1, 2 and 3 (Scope and Administration, Definitions, and General Requirements) of the Seattle Energy Code, commercial section

3.2. C402.4 Air Leakage

3.3. C403.2.4 Thermostatic Controls

3.4. C404.9 Domestic hot water meters

3.5. C408 System Commissioning

3.6. C409 Energy Metering and Energy Consumption Management

C402.1.5.4 Energy Modeling Methodology. Energy use shall be modeled according to the following procedures from Section C407, Total Building Performance:

1. C407.1 Scope

2.C407.4 Documentation (requirements for "Standard Reference Design" are not applicable)

3. C407.5.2 Thermal Blocks

4. C407.6 Calculation Software Tools

Schedules, internal loads and other assumptions related to the operation of the building are permitted to be developed at the discretion of the design team and the energy modeler. For occupancy types listed in Appendix B of this code, where any of the following operating loads or schedules of operating hours used in modeling calculations is less than 80 percent of that listed in Appendix B, or where the occupant density in square feet per occupant is more than 120 percent of that listed in Appendix B, such deviations shall be clearly documented in the final analysis report and shall be subject to approval by the *code official*.

1. Occupant density and schedule

2. Lighting operation schedule

3. Receptacle loads and schedule

4. Elevator and escalator schedule

5. Water heating quantity and schedule

In addition to documenting modeling assumptions, the compliance report required by Section C407.4.1 shall include the following:

1. Summary of principal building characteristics that are above or below prescriptive energy code requirements.

2. Sensitivity analysis of principal internal load and other building operational assumptions that demonstrate a range of expected energy performance in the context of typical meteorological year (TMY) conditions. The following sensitivity analyses shall be reported, in tabular format:

2.1. Occupant density +/- 20 percent (except residential occupancies)

2.2. Lighting Power Density +/- 20 percent

2.3. Miscellaneous Load Power Density +/- 20 percent

2.4. Infiltration Rates +/- 20 percent

2.5. Temperature Setpoints +/- 2 degrees F

Table C402.1.5.4 Example of Sensitivity Analysis Report Format

Allowable EUI: 45 kBTU/ft^2		
Predicted EUI: 40 kBTU/ft^2		
Input	EUI (Low Range)	EUI (High Range)
Occupant Density	35	42
Lighting Power Density	38	41
Misc. Load Power Density	35	45
Infiltration	38	44
Temperature Setpoints	36	48

Informative Note: Energy models completed for the sensitivity analysis are not required to meet the target EUI. The sensitivity analysis is intended to test the robustness of the results in the presence of uncertainty.

The annual modeled building site energy use, under nominal conditions, shall be lower than the building's assigned energy performance target.

C402.1.5.5 Energy Modeler Qualifications. Energy models shall be created only by persons qualified by education and training to perform such work and who have at least two years' experience modeling buildings of similar scale and complexity. The modeling documentation submitted shall be signed either by a licensed professional engineer who is qualified by training and experience to perform energy modeling or by an individual with an active certification from ASHRAE as a Building Energy Modeling Professional (BEMP).

C402.1.5.6 Demonstration of Operating Energy Use. Metered energy data shall be supplied directly via automated reporting from utilities to DPD using Portfolio Manager, and adjusted for the percentage of floor area occupied. While at least 75 percent

occupied, the building shall operate at or below its assigned energy use target established in Section C402.1.5.2 or item 8 of Section 402.1.5.1 for any recording period of 12 consecutive months that is completed within three years of the date of the Certificate of Occupancy, as adjusted under this Section C402.1.5. The owner shall notify the *code official* when this 12-month period has been successfully completed.

C402.1.5.6.1 Extension of Demonstration Period. For good cause, including conditions where less than 75 percent of the building is occupied, the *code official* may extend the three-year period for one additional year, but in no case for more than three additional one-year periods. If the building is not at least 75 percent occupied after three additional one-year periods, the *code official* shall evaluate compliance with Section C402.1.5.6 based on the most recent one-year period and adjusted for the actual occupancy rate during that period.

C402.1.5.7 Adjustment for Data Center Energy Usage. Where data center *IT energy* use during the demonstration period, multiplied by a factor of 1.45, is higher than the total data center energy use as calculated according to Section C402.1.5.2.1, that additional energy shall be added to the total allowable energy use. Where data center *IT energy* use, multiplied by a factor of 1.45, is lower than the total data center energy use as calculated according to Section C402.1.5.2.1, that shortfall shall be subtracted from the total allowable energy use.

C402.1.5.8 Adjustment for Change in Occupancy. When the occupancy of the building or a portion of the building changes from that assumed in the permit submittal, the assigned energy performance target shall be adjusted to reflect the new occupancy. If the new occupancy is not listed in Section C402.1.5.2, either the *code official* shall assign it an energy use target based on the best-performing local examples of that occupancy type, or a metering system shall be provided that excludes the energy loads for the additional occupancy.

C402.1.5.9 Adjustment for Unusually Cold Years. If the heating degree days (HDD) recorded by the national weather service for the Seattle-Tacoma International Airport exceeds 4885 HDD for the 12-month demonstration period (4 percent above the average 4697 HDD at 65° F base), the assigned energy performance target is permitted to be increased by 1 percent for that period.

C402.1.5.10 Adjustment for Retail Operating Hours. If the annual number of hours that a retail occupancy is open to the public during the 12-month recording period exceeds the hours assumed in the energy model by more than 4 percent, the annual energy use target for the retail space use only is permitted to be increased by 1 percent for each 4 percent increase in such hours. This claim shall be documented by publicly-available published hours of operation.

C402.1.5.11 Financial Security. The applicant shall provide a financial security to be used as a penalty for failing to achieve an operating energy use lower than the building's energy use target according to Section C402.1.5.6. The penalty shall be administered as provided in Section C110, except that the amount of the penalty shall be determined using Table C402.1.5.11 and not the amounts in Building Code Section C103. The financial security shall be submitted to and approved by the *code official* prior to issuance of the building's Certificate of Occupancy. The financial security requirement shall be fulfilled by one of the following methods:

1. An irrevocable letter of credit from a financial institution authorized to do business in Seattle, in an amount equal to $4.00 per square foot of gross floor area.
2. A bond secured by the applicant to ensure compliance with this section, in an amount equal to $4.00 per square foot of gross floor area.
3. A binding pledge that within 3 years of receipt of the Certificate of Occupancy, adjusted as allowed under Section C402.1.5, the applicant will comply with the requirements of

this section.

A binding pledge pursuant to item 3 of this subsection shall be recorded as a covenant in the land records of King County between the applicant and the City of Seattle in a form that is satisfactory to the Seattle City Attorney. The covenant shall bind the applicant and any successors in title to pay any fines levied pursuant to this section. A lien will be placed on the property in cases of non-payment.

If the owner provides evidence that the building has operated at or below its target energy performance level as provided in Section C402.1.5.6, the financial security provided by the applicant shall be returned to the applicant, or the pledge and covenant shall be released, and the applicant will have no further obligations under this section.

C402.1.5.12 Procedure for non-compliance. If the owner fails to provide evidence that the building has operated as required under Section C402.1.5.6, the *code official* shall, as applicable, either:

1. Draw down on a financial security provided in the form of an irrevocable letter of credit or a bond, in whole, or in part, or
2. Levy a fine against an applicant that provided a financial security in the form of a binding pledge as set forth in Section C402.1.5.11(3). The fine shall be in the amount shown in Table C402.1.5.12 and shall be issued as a civil penalty.

The amount of the fine levied or the amount drawn down from a financial security shall be determined per Table C402.1.5.12.

Table C402.1.5.12 Financial Security and Energy Efficiency Reimbursements

Energy use exceeding target	Amount of fine or draw-down from financial security, per square foot	Maximum reimbursement per square foot for work approved under Section C402.1.5.12
Less than 10%	$1.00	$0.50
10% to less than 20%	$2.00	$1.00
20% to less than 30%	$3.00	$1.50
30% or greater	$4.00	$2.00

C402.1.5.13 Reimbursements. Where a financial security has been drawn down pursuant to item 1 in Section C402.4.12, or a fine has been levied pursuant to item 2 in Section C402.5.12, the *code official* shall reimburse the owner for documented expenses incurred to lower the operating energy use of the building, including commissioning, repairs or improvements to the existing energy-consuming systems, or provision of additional energy efficiency measures, up to the maximum reimbursement amounts listed in Table C402.1.5.12. Such expenditures shall be approved in advance by the *code official*, and the work shall be fully completed within one year of the date when a financial security has been drawn down pursuant to item 1 in Section C402.5.12, or a fine has been levied pursuant to item 2 in Section C402.5.12.

C402.2 Specific insulation requirements (Prescriptive). Opaque assemblies shall comply with Table C402.2. 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.

Table C402.2
Opaque Thermal Envelope Requirements[a, f]

CLIMATE ZONE	5 AND MARINE 4 (SEATTLE)		6	
	All Other	Group R	All Other	Group R
Roofs				
Insulation entirely above deck	~~((R-30ci))~~ R-38ci	R-38ci	R-30ci	R-38ci

Metal buildings (with R-3.5 thermal blocks)[a, b]	~~((25 + R-11 LS))~~ 25 + R-22 LS	~~((25 + R-11 LS))~~ 25 + R-22 LS	R-25 .+ R-11 LS	R-30 .+ R-11 LS
Attic and other	R-49	R-49	R-49	R-49
Walls, Above Grade				
Mass	~~((R-9.5))~~ Exterior: R-16 c.i. Interior: R-13 + R-6 ci wood stud, or R-13 + R-10 ci metal stud	~~((R-13.3ci))~~ Exterior: R-16 c.i. Interior: R-13 + R-6 ci wood stud, or R-13 + R-10 ci metal stud	R-11.4ci	R-15.2ci
Metal building	R-13 .+ R-13ci	R-13 .+ R-13ci	R-13 .+ R-13ci	R-19 .+ R-16ci
Steel framed	R-13 .+ R-10ci	R-19 .+ R-8.5ci	R-13 .+ R-12.5ci	R-19 .+ R-14ci
Wood framed and other	~~((R-21 int))~~ R-13 + R-7.5 ci	R-21 int	R-13 .+ R-7.5ci or R-20 .+ R-3.8ci	R-21 .+ R-5ci
Walls, Below Grade				
Below-grade wall[d]	~~((Same as above grade))~~ Exterior R-10 ci Interior: R-19 wood stud, or R-13 + R-6 ci metal stud	~~((Same as above grade))~~ Exterior R-10 ci Interior: R-19 wood stud, or R-13 + R-6 ci metal stud	Same as above grade	Same as above grade
Floors				
Mass	R-30ci	R-30ci	R-30ci	R-30ci
Joist/framing	~~((R-30[e]))~~ Steel frame: R-38 +R-4 ci Wood frame: R-38	~~((R-30[e]))~~ Steel frame: R-38 +R-4 ci Wood frame: R-38	R-38[e]	R-38[e]
Slab-on-Grade Floors				
Unheated slabs	R-10 for 24" below	R-10 for 24" below	R-10 for 48" below	R-15 for 48" below

Heated slabs[d]	R-10 perimeter & under entire slab	R-10 perimeter & under entire slab	R-10 perimeter & under entire slab	R-10 perimeter & under entire slab
Opaque Doors				
Swinging	U-0.37	U-0.37	U-0.37	U-0.37
Roll-up or sliding	~~((R-4.75))~~ U-0.390	~~((R-4.75))~~ U-0.390	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 shall be provided, otherwise use the U-factor compliance method in Table C402.1.2.
c. Reserved. ((~~**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 C402.2 or U-factor from Table C402.1.2.~~))
d Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
e Steel floor joist systems shall be insulated to R-38 .+ R-10ci.
f For roof, wall or floor assemblies where the proposed assembly would not be continuous insulation, ((~~two~~)) an alternate nominal R-value compliance option((~~s~~)) for assemblies with isolated metal penetrations of otherwise continuous insulation ((~~are~~)) is shown in the right-hand column of the table below:

Assemblies with continuous insulation (see definition)	**Alternate option for assemblies with metal penetrations, greater than 0.04% but less than 0.08%**

R-11.4ci	R-14.3 ci
R-13.3ci	R-16.6 ci
R-15.2ci	R-19.0 ci
R-30ci	R-38 ci
R-38ci	R-48 ci
R-13 .+ R-7.5ci	R-13 .+ R-9.4 ci
R-13 .+ R-10ci	R-13 .+ R-12.5 ci
R-13 .+ R-12.5ci	R-13 .+ R-15.6 ci
R-13 .+ R-13ci	R-13 .+ R-16.3 ci
R-19 .+ R-8.5ci	R-19 .+ R-10.6 ci
R-19 .+ R-14ci	R-19 .+ R-17.5 ci
R-19 .+ R-16ci	R-19 .+ R-20 ci
R-20 .+ R-3.8ci	R-20 .+ R-4.8 ci
R-21 .+ R-5ci	R-21 .+ R-6.3 ci

These alternate nominal R-value compliance options are 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 0.0008 (0.08%).

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 C402.1.2 for determination of U-factors for assemblies that include metal other than screws and nails.

C402.2.1 Roof assembly. The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.2, 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 C402.2.
2. Unit skylight curbs included as a component of an NFRC 100 rated assembly 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.

Informative Note: The section below regarding roof solar reflectance does not apply to

C402.2.1.1 Roof solar reflectance and thermal emittance. Low-sloped roofs with a slope less than 2 units vertical in 12 horizontal, directly above cooled conditioned spaces in Climate Zones 1, 2, and 3 shall comply with one or more of the options in Table

C402.2.1.1.

EXCEPTIONS: The following roofs and portions of roofs are exempt from the requirements in Table C402.2.1.1:

1. Portions of roofs that include or are covered by:

1.1. Photovoltaic systems or components.

1.2. Solar air or water heating systems or components.

1.3. Roof gardens or landscaped roofs.

1.4. Above-roof decks or walkways.

1.5. Skylights.

1.6. HVAC systems, components, and other opaque objects mounted above the roof.

2. Portions of roofs shaded during the peak sun angle on the summer solstice by permanent features of the building, or by permanent features of adjacent buildings.

3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (psf) (74 kg/m^2) or 23 psf (117 kg/m^2) pavers.

4. Roofs where a minimum of 75 percent of the roof area meets a minimum of one of the exceptions above.

Table C402.2.1.1
Reflectance and Emittance Options[a]

Three-year aged solar reflectance[b] of 0.55 and three-year aged thermal emittance[c] of 0.75
Initial solar reflectance[b] of 0.70 and initial thermal emittance[c] of 0.75
Three-year-aged solar reflectance index[d] of 64 initial solar reflectance index[d] of 82

a The use of area-weighted averages to meet these requirements shall be permitted. Materials lacking initial tested values for either solar reflectance or thermal emittance, shall be assigned both an initial solar reflectance of 0.10 and an initial thermal emittance of 0.90. Materials lacking three-year aged tested values for either solar reflectance or thermal emittance shall be assigned both a three-year aged solar reflectance of 0.10 and a three-year aged thermal emittance of 0.90.

b Solar reflectance tested in accordance with ASTM C 1549, ASTM E 903 or ASTM E 1918.

c Thermal emittance tested in accordance with ASTM C 1371 or ASTM E 408.

d Solar reflectance index (SRI) shall be determined in accordance with ASTM E 1980 using a convection coefficient of 2.1 Btu/h x ft^2 x °F (12W/m2 x K). Calculation of aged SRI shall be based on aged tested values of solar reflectance and thermal emittance. Calculation of initial SRI shall be based on initial tested values of solar reflectance and thermal emittance.

C402.2.2 Classification of walls. Walls associated with the building envelope shall be classified in accordance with Section C202.

C402.2.3 Thermal resistance of above-grade walls. The minimum thermal resistance (*R*-value) of the insulating materials installed in the wall cavity between the framing members

and continuously on the walls shall be as specified in Table C402.2, 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 C402.2.

"Mass walls" shall include walls weighing not less than:

1. 35 psf (170 kg/m^2) of wall surface area; or

2. 25 psf (120 kg/m^2) of wall surface area if the material weight is not more than 120 pounds per cubic foot (pcf) (1,900 kg/m^3).

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 Table C402.2.

C402.2.5 Floors over outdoor air or unconditioned space. The minimum thermal resistance (*R*-value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in Table C402.2, based on construction materials used in the floor assembly.

"Mass floors" shall include floors weighing not less than:

1. 35 psf (170 kg/m^2) of floor surface area; or

2. 25 psf (120 kg/m^2) of floor surface area if the material weight is not more than 120 pcf (1,900 kg/m^3).

C402.2.6 Slabs on grade. Where the slab on grade is in contact with the ground, the minimum thermal resistance (R-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors and under the entire slab of heated slab-on-grade floors shall be as specified in Table C402.2. The insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the

interior or exterior for the total distance shown in the table. Insulation extending away from the building shall be protected by pavement or by a minimum of 10 inches (254 mm) of soil.

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

C402.2.7 Opaque doors. Opaque doors (doors having less than 50 percent glass area) shall meet the applicable requirements for doors as specified in Table C402.2 and be considered as part of the gross area of above-grade walls that are part of the building envelope.

C402.2.8 Insulation of radiant heating systems. Radiant panels, and associated U-bends and headers, designed for sensible heating of an indoor space through heat transfer from the thermally effective panel surfaces to the occupants or indoor space by thermal radiation and natural convection and the bottom surfaces of floor structures incorporating radiant heating shall be insulated with a minimum of R-3.5 (0.62 $m^2/K \times W$). Adjacent envelope insulation counts towards this requirement.

C402.3 *Fenestration* (Prescriptive). *Fenestration* shall comply with Table C402.3. Automatic daylighting controls specified by this section shall comply with Section C405.2.2.3.2.

EXCEPTION. Single glazing is permitted for security purposes and for revolving doors, provided that the total area of single glazing does not exceed 1 percent of the gross exterior wall area, and such glazing is included in the percentage of the total glazing area, U-factor and SHGC requirements in Section C402.3.

Table C402.3
Building Envelope Requirements--*Fenestration*

CLIMATE ZONE	**5 AND MARINE 4**	**6**
Vertical *Fenestration*		
***U*-factor**		
Nonmetal framing (all)[a]	0.30	0.30
Metal framing (fixed)[b]	0.38	0.36
Metal framing (operable)[c]	0.40	0.40
Metal framing (entrance doors)[d]	0.60	0.60
SHGC		
SHGC	((~~0.40~~)) 0.35	0.40
Skylights		
***U*-factor**	((~~0.50~~)) 0.45	0.50
SHGC	((~~0.35~~)) 0.32	0.35

NR .= No requirement.

a "Nonmetal framing" includes framing materials other than metal, with or without metal reinforcing or cladding.

b "Metal framing" includes metal framing, with or without thermal break. "Fixed" includes curtain wall, storefront, picture windows, and other fixed windows.

c "Metal framing" includes metal framing, with or without thermal break. "Operable" includes openable *fenestration* products other than "entrance doors."

d "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."

C402.3.1 Maximum area. The vertical *fenestration* area (not including opaque doors and opaque spandrel panels) shall not exceed 30 percent of the gross above-grade wall area. The skylight area shall not exceed ((~~3~~)) 5 percent of the gross roof area.

EXCEPTION: For vertical *fenestration* at street level retail or for other occupancies where the Seattle Land Use Code requires street-level transparency, the *fenestration* area shall not exceed 75 percent of the area of the street-level wall that faces the street or that adjoins other pedestrian areas used for retail access. For the purposes of this exception, the street-level wall shall be measured from the street-level floor to the interior ceiling level or to 20 feet above floor level, whichever is lowest. When this exception is utilized, separate calculations shall be performed for these sections of the building envelope, and these values shall not be averaged with any others for compliance purposes. On the street level the 75 percent *fenestration* area is permitted to be exceeded, if the additional *fenestration* area is deducted from *fenestration* allowances for other areas of the building.

C402.3.1.1 Increased vertical *fenestration* area with daylighting controls. In Climate Zones 1 through 6, a maximum of 40 percent of the gross above-grade wall area shall be permitted to be vertical *fenestration*, provided:

1. No less than 50 percent of the conditioned floor area is within a daylight zone;
2. Automatic daylighting controls are installed in daylight zones; and
3. Visible transmittance (VT) of vertical *fenestration* is greater than or equal to 1.1 times solar heat gain coefficient (SHGC).

EXCEPTION: *Fenestration* that is outside the scope of NFRC 200 is not required to comply with Item 3.

Informative Note: NFRC 200 covers almost all commonly-used glazing products. *Fenestration* products *not* within NFRC 200's scope include glass block, translucent fiberglass, curved glass, corrugated or patterned glazing, double-pane glass with

C402.3.1.2 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% but shall not exceed 40% of the gross above grade wall area, for the purpose of prescriptive compliance with Section C402.1.2 or for the Target UA calculation in Equations C402-1 or C402-5, provided that each of the following conditions are met:

1. The vertical *fenestration* shall have the following maximum U-factors:

a. Non-metal framing (all) = 0.28

b. Metal framing (fixed) = 0.34

c. Metal framing (operable) = 0.39

d. Metal framing (entrance doors) = 0.60

An area-weighted average shall be permitted to satisfy the U-factor requirements for each fenestration product category listed above. Individual fenestration products from different fenestration product categories shall not be combined in calculating the area-weighted average U-factor.

2. The SHGC of the vertical fenestration shall be less than or equal to 0.35, adjusted for projection factor in compliance with Section C402.3.3.1.

The compliance path described in this Section C402.3.1.2 is not permitted to be used for the Total Building Performance compliance path as set out in Section C407.

((~~C402.3.1. Increased skylight area with daylighting controls.~~ ~~The skylight area shall be~~

~~permitted to be a maximum of 5 percent of the roof area provided automatic daylighting controls are installed in daylight zones under skylights~~.))

C402.3.2 Minimum skylight *fenestration* area. For single story buildings only, in an enclosed space greater than 10,000 square feet (929 m^2), directly under a roof with ceiling heights greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, gymnasium/exercise center, convention center, automotive service, manufacturing, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation, or workshop, the total daylight zone under skylights shall be not less than half the floor area and shall provide a minimum skylight area to daylight zone under skylights of either:

1. Not less than 3 percent with a skylight VT of at least 0.40; or

2. Provide a minimum skylight effective aperture of at least 1 percent determined in accordance with Equation C4-1.

Skylight Effective Aperture = (085 x Skylight Area x Skylight VT x WF)/Daylight zone under skylight

(Equation C4-1)

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.

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

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

1. Buildings in Climate Zones 6 through 8.

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

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

C402.3.2.1 Lighting controls in daylight zones under skylights. All lighting in the daylight zone shall be controlled by automatic daylighting controls that comply with Section C405.2.2.3.2.

~~**((EXCEPTION**: Skylights above daylight zones of enclosed spaces are not required in:~~

~~1. Buildings in Climate Zones 6 through 8.~~

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

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

C402.3.2.2 Haze factor. Skylights in office, storage, automotive service, manufacturing,

nonrefrigerated warehouse, retail store, and distribution/sorting area spaces shall have a glazing material or diffuser with a measured haze factor greater than 90 percent when tested in accordance with ASTM D 1003.

EXCEPTION: Skylights designed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles, or the geometry of skylight and light well need not comply with Section C402.3.2.2.

C402.3.3 Maximum *U*-factor and SHGC. For vertical *fenestration*, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in Table C402.3, based on the window projection factor. For skylights, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in Table C402.3.

The window projection factor shall be determined in accordance with Equation C4-2.

$PF = A/B$ **(Equation C4-2)**

where:

PF	=	Projection factor (decimal).
A	=	Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.
B	=	Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

Where different windows or glass doors have different *PF* values, they shall each be evaluated separately.

C402.3.3.1 SHGC adjustment. Where the *fenestration* projection factor for a specific vertical *fenestration* product is greater than or equal to 0.2, the required maximum SHGC from Table C402.3 shall be adjusted by multiplying the required maximum SHGC by the multiplier specified in Table C402.3.3.1 corresponding with the orientation of the

fenestration product and the projection factor.

Table C402.3.3.1
SHGC Adjustment Multipliers

PROJECTION FACTOR	ORIENTED WITHIN 45 DEGREES OF TRUE NORTH	ALL OTHER ORIENTATION
$0.2 \leq PF < 0.5$	1.1	1.2
$PF \geq 0.5$	1.2	1.6

C402.3.3.2 Increased vertical *fenestration* SHGC. In Climate Zones 1, 2 and 3, vertical *fenestration* entirely located not less than 6 feet (1729 mm) above the finished floor shall be permitted a maximum SHGC of 0.40.

C402.3.3.3 Reserved.

C402.3.3.4 Reserved.

C402.3.3.5 Dynamic glazing. For compliance with Section C402.3.3, the SHGC for dynamic glazing shall be determined using the manufacturer's lowest-rated SHGC, and the VT/SHGC ratio shall be determined using the maximum VT and maximum SHGC. Dynamic glazing shall be considered separately from other *fenestration*, and area-weighted averaging with other *fenestration* that is not dynamic glazing shall not be permitted.

C402.3.4 Area-weighted *U*-factor. An area-weighted average shall be permitted to satisfy the *U*-factor requirements for each *fenestration* product category listed in Table C402.3. Individual *fenestration* products from different *fenestration* product categories listed in Table C402.3 shall not be combined in calculating area-weighted average *U*-factor.

C402.4 Air leakage (Mandatory). The thermal envelope of buildings shall comply with Sections C402.4.1 through C402.4.8.

C402.4.1 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 C402.4.1.1 and C402.4.1.2.

EXCEPTION: Air barriers are not required in buildings located in Climate Zones 1, 2 and 3.

C402.4.1.1 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. Air barrier penetrations shall be sealed in accordance with Section C402.4.2. 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. Recessed lighting fixtures shall comply with Section C404.2.8. Where similar objects are installed which penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

4. 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.

EXCEPTION: Buildings that comply with Section C402.4.1.2.3 are not required to comply with Items 1 and 3.

Informative Note: The continuous air barrier is intended to control the air leakage into and out of the conditioned space. The definition of conditioned space includes semiheated spaces, so these spaces are included when detailing the continuous air barrier and when determining the pressure boundary for conducting the air leakage

C402.4.1.2 Air barrier compliance options. A continuous air barrier for the opaque building envelope shall comply with Section C402.4.1.2.3.

C402.4.1.2.1 Materials. Materials with an air permeability no greater than 0.004 cfm/ft^2 (0.02 L/s · m^2) under a pressure differential of 0.3 inches water gauge (w.g.) (75 Pa) when tested in accordance with ASTM E 2178 shall comply with this section. Materials in Items 1 through 15 shall be deemed to comply with this section provided joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than 3/8 inch (10 mm).

2. Oriented strand board having a thickness of not less than 3/8 inch (10 mm).

3. Extruded polystyrene insulation board having a thickness of not less than 1/2 inch (12 mm).

4. Foil-back polyisocyanurate insulation board having a thickness of not less than 1/2 inch (12 mm).

5. Closed cell spray foam a minimum density of 1.5 pcf (2.4 kg/m^3) having a thickness of not less than 1 1/2 inches (36 mm).

6. Open cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).

7. Exterior or interior gypsum board having a thickness of not less than 1/2 inch (12 mm).

8. Cement board having a thickness of not less than 1/2 inch (12 mm).

9. Built up roofing membrane.

10. Modified bituminous roof membrane.

11. Fully adhered single-ply roof membrane.

12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 5/8 inch (16 mm).

13. Cast-in-place and precast concrete.

14. Fully grouted concrete block masonry.

15. Sheet steel or aluminum.

C402.4.1.2.2 Assemblies. Assemblies of materials and components with an average air leakage not to exceed 0.04 cfm/ft^2 (0.2 L/s · m^2) under a pressure differential of 0.3 inches of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E 2357, ASTM E 1677 or ASTM E 283 shall comply with this section. Assemblies listed in Items 1 and 2 shall be deemed to comply provided joints are sealed and requirements of Section C402.4.1.1 are met.

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

2. A Portland cement/sand parge, stucco or plaster minimum 1/2 inch (12 mm) in thickness.

C402.4.1.2.3 Building test. The completed building shall be tested and the air leakage rate of the *building envelope* shall not exceed 0.40 cfm/ft^2 at a pressure differential of 0.3 inches water gauge (2.0 L/s · m^2 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*. The following modifications shall be made to ASTM E 779:

1. Tests shall be accomplished using either (1) both pressurization and depressurization or (2) pressurization alone, but not depressurization alone. If both pressurization and depressurization are not tested, the air leakage shall be plotted against the corrected P for pressurization in accordance with Section 9.4.

2. The test pressure range shall be from 25 Pa to 80 Pa per Section 8.10, 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, the test shall be rerun with additional readings over a longer time interval.

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.

C402.4.2 Air barrier penetrations. Penetrations of the air barrier and paths of air leakage shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Joints and seals shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials shall be appropriate to the construction materials being sealed. 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.

C402.4.3 Air leakage of *fenestration*. The air leakage of *fenestration* assemblies shall meet the provisions of Table C402.4.3. Testing shall be in accordance with the applicable reference test standard in Table C402.4.3 by an accredited, independent testing laboratory

and *labeled* by the manufacturer.

EXCEPTIONS:

1. Field-fabricated *fenestration* assemblies that are sealed in accordance with Section C402.4.1. A field-fabricated *fenestration* product is a *fenestration* product (including glazed exterior doors) 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 curtain walls.

2. *Fenestration* in buildings that comply with Section C402.4.1.2.3 are not required to meet the air leakage requirements in Table C402.4.3.

3. Custom exterior windows and doors manufactured by a *small business* provided they meet the applicable provisions of Chapter 24 of the *International Building Code*. Once visual inspection has confirmed the presence of a gasket, operable windows and doors manufactured by *small business* shall be permitted to be sealed off at the frame prior to the test.

Table C402.4.3
Maximum Air Infiltration Rate
for *Fenestration* Assemblies

***FENESTRATION* ASSEMBLY**	**MAXIMUM RATE (CFM/FT^2)**	**TEST PROCEDURE**
Windows	0.20[a]	AAMA/ WDMA/ CSA101/I.S.2 /A440 or NFRC 400
Sliding doors	0.20[a]	
Swinging doors	0.20[a]	
Skylights - With condensation weepage openings	0.30	
Skylights - All other	0.20[a]	

Curtain walls	0.06	NFRC 400 or ASTM E 283 at 1.57 psf (75 Pa)
Storefront glazing	0.06	
Commercial glazed swinging entrance doors	1.00	
Revolving doors	1.00	
Garage doors	0.40	ANSI/DASMA 105, NFRC 400, or ASTM E 283 at 1.57 psf (75 Pa)
Rolling doors	1.00	

For SI:
1 cubic foot per minute = 0.47 L/s
1 square foot = 0.093 m^2.
a The maximum rate for windows, sliding and swinging doors, and skylights is permitted to be 0.3 cfm per square foot of *fenestration* or door area when tested in accordance with AAMA/WDMA/CSA101/I.S.2/A440 at 6.24 psf (300 Pa).

C402.4.4 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 either meet the requirements of Section C402.4.3 or shall be gasketed, weatherstripped or sealed.

EXCEPTION: Door openings required to comply with Section 715 or 715.4 of the *International Building Code*; or doors and door openings required by the *International Building Code* to comply with UL 1784 shall not be required to comply with Section C402.4.4.

C402.4.5 Air intakes, exhaust openings, stairways and shafts. Stairway enclosures and elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be provided with dampers in accordance with Sections C402.4.5.1 and C402.4.5.2.

C402.4.5.1 Stairway and shaft vents. Stairway and shaft vents shall be provided with Class I motorized dampers with a maximum leakage rate of 4 cfm/ft^2 (20.3 L/s · m^2) at

1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D.

Stairway and shaft vent dampers shall be installed with controls so that they are capable of automatically opening upon:

1. The activation of any fire alarm initiating device of the building's fire alarm system; or

2. The interruption of power to the damper.

C402.4.5.2 Outdoor air intakes and exhausts. *Outdoor air* supply, exhaust openings and relief outlets shall be provided with Class IA motorized dampers which close automatically when the system is off. Return air dampers shall be equipped with motorized dampers. Dampers shall have a maximum leakage rate of 4 cfm/ft^2 (20.3 L/s · m^2) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D. Gravity (nonmotorized) dampers for ventilation air intakes shall be protected from direct exposure to wind.

EXCEPTIONS: 1. Gravity (nonmotorized) dampers having a maximum leakage rate of 20 cfm/ft^2 (101.6 L/s · m^2) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D are permitted to be used for relief, outside air and exhaust openings in buildings ((~~less than three stories in height above grade~~)) if equipment has less than ((~~5,000~~)) 300 cfm total supply flow.

2. ((~~Gravity (nonmotorized) dampers for ventilation air intakes shall be protected from direct exposure to wind.~~)) (Reserved)

3. Gravity dampers smaller than 24 inches (610 mm) in either dimension shall be permitted to have a leakage of 40 cfm/ft^2 (203.2 L/s · m^2) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D.

4. Gravity (nonmotorized) dampers in Group R occupancies where the design outdoor air intake, relief or exhaust capacity does not exceed ((~~400~~)) 300 cfm (189 L/s).

5. Systems serving areas which require continuous operation.

6. Combustion air intakes.

7. Type I kitchen exhaust hoods.

C402.4.6 Loading dock weatherseals. Cargo doors and loading dock doors shall be equipped with weatherseals to restrict infiltration when vehicles are parked in the doorway.

C402.4.7 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.

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.

EXCEPTIONS:

1. Buildings in Climate Zones 1 and 2.

2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.

3. Doors opening directly from a *sleeping unit* or dwelling unit.

4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area and are separate from the building entrance.

5. Revolving doors.

6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

7. Building entrances in buildings that are less than four stories above grade and less than

10,000 ft^2 in area.

8. Elevator doors in parking garages provided that the elevators have an enclosed lobby at each level of the garage.

9. Entrances to semi-heated spaces.

Informative Note: Building entrances are defined as the means ordinarily used to gain access to the building. Doors other than for building entrances, such as those leading to service areas, mechanical rooms, electrical equipment rooms, or exits from fire stairways, are not covered by this requirement. (There is less traffic through these doors, and the vestibule may limit access for large equipment.) Note that enclosed lobbies lobbies in parking garages also serve to reduce the flow of vehicle exhaust into the building.

C402.4.8 Recessed lighting. Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate of not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

C402.5 Walk-in coolers and walk-in freezers. Walk-in coolers and walk-in freezers shall comply with all of the following:

1. Shall be equipped with automatic door closers that firmly close walk-in doors that have been closed to within 1 inch of full closure.

EXCEPTION: Doors wider than 3 feet 9 inches or taller than 7 feet.

2. Doorways shall have strip doors (curtains), spring-hinged doors, or other method of minimizing infiltration when doors are open.

3. *Walk-in coolers* shall contain wall, ceiling, and door insulation of at least R-25 and *walk-in freezers* at least R-32.

EXCEPTION: Glazed portions of doors or structural members.

4. *Walk-in freezers* shall contain floor insulation of at least R-28.

5. Transparent reach-in doors for *walk-in freezers* and windows in *walk-in freezer* doors shall be of triple-pane glass, either filled with inert gas or with heat-reflective treated glass.

6. Transparent reach-in doors for *walk-in coolers* and windows in *walk-in cooler* doors shall be double-pane glass with heat-reflective treated glass and gas filled; or triple-pane glass, either filled with inert gas or with heat-reflective treated glass.

C402.6 Refrigerated warehouse coolers and refrigerated warehouse freezers. Refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with all of the following:

1. Shall be equipped with automatic door closers that firmly close walk-in doors that have been closed to within 1 inch of full closure.

EXCEPTION: Doors wider than 3 feet 9 inches or taller than 7 feet.

2. Doorways shall have strip doors (curtains), spring-hinged doors, or other method of minimizing infiltration when doors are open.

3. *Refrigerated warehouse coolers* shall contain wall, ceiling, and door insulation of at least R-((~~25~~)) 38 and *refrigerated warehouse freezers* at least R-((~~32~~)) 38.

EXCEPTION: Glazed portions of doors or structural members.

4. *Refrigerated warehouse* freezers shall contain floor insulation of at least R-((~~28~~)) 38.

5. Transparent reach-in doors for *refrigerated warehouse freezers* and windows in *refrigerated warehouse freezer* doors shall be of triple-pane glass, either filled with inert gas or with heat-reflective treated glass.

6. Transparent reach-in doors for *refrigerated warehouse coolers* and windows in *refrigerated warehouse cooler* doors shall be double-pane glass with heat-reflective treated glass and gas filled; or triple-pane glass, either filled with inert gas or with heat-reflective

treated glass.

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C403.2 Provisions applicable to all mechanical systems (Mandatory). Mechanical systems and equipment serving the building heating, cooling or ventilating needs shall comply with Sections C403.2.1 through C403.2.11.

C403.2.1 Calculation of heating and cooling loads. Design loads shall be determined in accordance with the procedures described in ANSI/ASHRAE/ACCA Standard 183. The design loads shall account for the building envelope, lighting, ventilation and occupancy loads based on the project design. 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*. Alternatively, design loads shall be determined by an *approved* equivalent computation procedure, using the design parameters specified in Chapter 3.

C403.2.2 Equipment and system sizing. The output capacity of heating and cooling equipment and systems shall not exceed 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 have the capability to sequence the operation of each unit based on load.

3. The output capacity of heating and cooling equipment and systems may exceed the loads

calculated in accordance with Section C403.2.1, provided that the smallest-capacity equipment available from a selected manufacturer that is capable of serving the heating and cooling loads is utilized and that the equipment capacity does not exceed 150 percent of the calculated loads.

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) and C403.2.3(8) 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(9). 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.

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 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 I/s · kW) condenser water flow shall have maximum full-load kW/ton and *NPLV* ratings adjusted using Equations C4-3 and C4-4.

Adjusted minimum full-load COP ratings = (Full-load COP from Table 6.8.1C of AHRI Standard 550/590) × K_{adj}

Adjusted minimum NPLV rating = (IPLV from Table 6.8.1C of AHRI Standard 550/590) × *Kadj*

Where:

K_{adj} = A × B

A = $0.0000015318 \times (\text{LIFT})^4 - 0.000202076 \times (\text{LIFT})^3 .+ 0.0101800 \times (\text{LIFT})^2 - 0.264958 \times \text{LIFT} .+ 3.930196$

B = $0.0027 \times L_{vg}^{Evap}$ (°C) .+ 0.982

LIFT = $L_{vg}^{Cond} - L_{vg}^{Evap}$

L_{vg}^{Cond} = Full-load condenser leaving water temperature (°C)

L_{vg}^{Evap} = Full-load leaving evaporator temperature (°C)

SI units shall be used in the K_{adj} equation.

The adjusted full-load and *NPLV* values shall only be applicable for centrifugal chillers meeting all of the following full-load design ranges:

1. The leaving evaporator fluid temperature is not less than 36°F (2.2°C).
2. The leaving condenser fluid temperature is not greater than 115°F (46.1°C).
3. LIFT is not less than 20°F (11.1°C) and not greater than 80°F (44.4°C).

EXCEPTION: Centrifugal chillers designed to operate outside of these ranges need not

comply with this code.

C403.2.3.2 Positive displacement (air- and water-cooled) chilling packages. Equipment with a leaving fluid temperature higher than 32°F (0°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 and Split System electric heating and cooling equipment. Packaged and split system electric equipment providing both heating and cooling, and cooling only equipment with electric heat in the main supply duct before VAV boxes, in each case with a total cooling capacity greater than 20,000 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 where WAC 246-320-525 allows only 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.

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C403.2.4 HVAC system controls. Each heating and cooling system shall be provided with

thermostatic controls as specified in Section C403.2.4.1, C403.2.4.2, C403.2.4.3, C403.2.4.4, C403.4.1, C403.4.2, C403.4.3, C403.4.4, C403.4.5, C403.4.6, C403.4.7, C403.4.8, C403.4.9, or C403.4.10.

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*. 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 or C403.4.1 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.

EXCEPTION: 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. 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); and

2. The perimeter system heating and cooling supply is controlled by a thermostat located within the *zones* served by the system.

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°F. <u>At final inspection, the lock out</u>

control shall be set to 32° F (0°C) or less.

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.

C403.2.4.2 Setpoint overlap restriction. Where used to control both heating and cooling, *zone* thermostatic controls shall 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 capable of being shut off or reduced to a minimum.

EXCEPTION: Thermostats requiring manual changeover between heating and cooling modes.

C403.2.4.3 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.

C403.2.4.3.1 Thermostatic setback capabilities. Thermostatic setback controls shall have the capability 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).

C403.2.4.3.2 Automatic setback and shutdown capabilities. 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 capable of being adjusted to operate the system for

up to 2 hours; or an occupancy sensor.

C403.2.4.3.3 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.

C403.2.4.4 Shutoff damper controls. ((~~Both o~~)) Outdoor air supply, relief and exhaust ducts shall be equipped with motorized dampers complying with Section C402.4.5.2 that will automatically shut when the systems or spaces served are not in use or during building warm-up, cooldown, and setback.

EXCEPTIONS:

1. Gravity relief dampers complying with exception 1 to Section C402.4.5.2 serving systems with a design outdoor air intake, relief or exhaust capacity of less than ((~~5,000)~~) 300 cfm total supply shall be permitted ((~~in buildings less than three stories in height)~~).

2. Gravity dampers shall be permitted for buildings of any height located in Climate Zones 1, 2 and 3.

3. Gravity (nonmotorized) dampers in Group R occupancies where the design outdoor air intake or exhaust capacity does not exceed ((~~400~~)) 300 cfm (189 L/s).

4. Systems serving areas which require continuous operation.

5. Combustion air intakes.

6. Operation of dampers shall be allowed during ventilation prepurge one hour before expected occupancy and for unoccupied period precooling during the cooling season.

7. Dampers are not required in systems where specifically prohibited by the *International Mechanical Code*.

C403.2.4.5 Snow melt system controls. Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting 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 will allow shutoff 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 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.

C403.2.4.7 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) ~~or hotel and motel guest rooms, a minimum of~~ 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.

C403.2.4.8 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 capable of shutting 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 capable of operating 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 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.

C403.2.4.9 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 capable of shutting 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 capable of operating 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 as follows: When used to control heating only: 55°F to 75°F; when used to control cooling only: 70°F to 85°F.

C403.2.4.10 Direct digital control system capabilities. All complex systems equipped with direct digital control (DDC) systems and all buildings with total cooling capacity exceeding 780,000 Btu/h (2,662 kW) shall have the following capability:

1. Trending: All control system input and output points shall be accessible and programmed for trending, and a graphic trending package shall be provided with the control system.

2. Demand Response Setpoint Adjustment: Control logic shall increase the cooling zone set points by at least 2°F (1°C) and reduce the heating zone set points by at least 2°F (1°C) when activated by a demand response signal. The demand response signal shall be a binary input to the control system or other interface approved by the serving electric utility.

C403.2.5 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 provide the capability to reduce the outdoor air supply to the minimum required by Chapter 4 of the *International Mechanical Code*.

C403.2.5.1 Demand controlled ventilation. Demand control ventilation (DCV) shall be provided for spaces larger than 500 square feet (50 m^2) and with an occupant load greater than 25 people per 1000 square feet (93 m^2) of floor area (as established in Table 403.3 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 (1400 L/s).

EXCEPTION: Demand control ventilation is not required for systems and spaces as follows:

1. Systems with energy recovery complying with Section C403.2.6.

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 1,000 cfm (472 L/s).

4. Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1,200 cfm (600 L/s).

5. Ventilation provided for process loads only.

C403.2.5.2 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.

C403.2.5.3 Enclosed loading dock, motor vehicle repair garage and parking garage exhaust ventilation system control. Mechanical ventilation systems for enclosed loading docks, motor vehicle repair garages 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 upon detection of vehicle operation or the presence of occupants by approved automatic detection devices. Each of the following types of controllers shall be capable of shutting off fans or modulating fan speed. Control devices shall not reduce airflow rates below the minimum requirement in accordance with the *International Mechanical Code* during scheduled periods of occupied operation.

1. 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, repair garages and enclosed 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.

2. Occupant detection sensors used to activate the system shall detect entry ((~~into the parking garage~~)) along both the vehicle and pedestrian pathways.

C403.2.5.3.1 System activation devices for enclosed loading docks. Ventilation systems for enclosed loading docks shall operate continuously during unoccupied hours at the minimum ventilation rate required by Section 404.2 of the International Mechanical Code and shall be activated to the full required ventilation rate 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.

C403.2.5.3.2 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 to activate the full required ventilation rate.

C403.2.5.4 Exhaust systems.

C403.2.5.4.1 Kitchen hoods. Each kitchen area with total exhaust capacity larger

than 2,000 cfm shall be provided with make-up air sized so that at least 50% of exhaust air volume be (a) unheated or heated to no more than 60°F and (b) uncooled or cooled without the use of mechanical cooling.

EXCEPTIONS:

1. Where hoods are used to exhaust ventilation air which would otherwise exfiltrate or be exhausted by other fan systems. A detailed accounting of exhaust airflows shall be provided on the plans that accounts for the impact of any required demand controlled ventilation.
2. Certified grease extractor hoods that require a face velocity no greater than 60 fpm.

C403.2.5.4.2 Laboratory exhaust systems. Buildings with laboratory exhaust systems having a total exhaust rate greater than 5,000 cfm (2,360 L/s) shall include heat recovery systems to precondition~~ed~~ 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) in Climate Zones 4C/5B and 35°F (19.4°C) in Climate Zone 6B. A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section C403.4.

EXCEPTIONS:

1. Variable air volume laboratory exhaust and room supply systems capable of reducing exhaust and make-up air volume to 50% or less of design values; or
2. Direct make-up (auxiliary) air supply equal to at least 75% 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 capable of reducing 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% 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} = Energy recovery at 60% 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

C403.2.6 Energy recovery.

C403.2.6.1 Energy recovery ventilation systems. Any system with minimum outside air requirements at design conditions greater than 5,000 CFM or any system required by

Table C403.2.6 shall include an energy recovery system. 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 C403.4. 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).

Informative Note: In Seattle, the outdoor design air temperature is 24°F as specified in Appendix C. The difference between 24°F and 65°F is 41 degrees. One-half of 41 degrees is 20.5 degrees. Therefore, to provide 50 percent heat recovery effectiveness in Seattle, the heat recovery system shall raise the outside supply air temperature to a minimum of 44.5°F (24°F + 20.5°F) at the outdoor design conditions.

EXCEPTION: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code*.

2. Laboratory fume hood systems that include at least one of the following features, and also comply with Section 403.2.5.4.2:

2.1. Variable-air-volume hood exhaust and room supply systems capable of reducing 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 heating energy is provided from site-recovered or site solar energy.

5. Heating energy recovery in Climate Zones 1 and 2.

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. Multi-zone systems with cold deck supply air and zone reheat where the minimum outdoor air is less than 70 percent of total supply air.

9. Systems serving residential multifamily spaces 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.

10. Type I kitchen exhaust hoods

C403.2.6.2 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 recovery.

C403.2.6.3 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^2 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. The required heat recovery system shall have the capacity to provide the smaller of:

1. 60 percent of the peak heat rejection load at design conditions; or

2. 50 percent of the sum of the service water heating load plus space heating load.

Table C403.2.6
Energy Recovery Requirement

Climate Zone	Percent (%) Outdoor Air at Full Design Airflow Rate					
	≥ 30% and < 40%	≥ 40% and < 50%	≥ 50% and < 60%	≥ 60% and < 70%	≥ 70% and < 80%	≥ 80%
	Design Supply Fan Airflow Rate (cfm)					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥ 5000	≥ 5000
1B, 2B, 5C	NR	NR	≥ 26000	≥ 12000	≥ 5000	≥ 4000
6B	≥ 11000	≥ 5500	≥ 4500	≥ 3500	≥ 2500	≥ 1500
1A, 2A, 3A, 4A, 5A, 6A	≥ 5500	≥ 4500	≥ 3500	≥ 2000	≥ 1000	> 0
7, 8	≥ 2500	≥ 1000	> 0	> 0	> 0	> 0

NR .= Not required.

Informative Note: For Climate Zone 4C (Seattle), Table C403.2.6 requires energy recovery for HVAC systems that have a design supply fan airflow rate greater than 5000 CFM and have a minimum requirement for 70% or more outside air. Thus a system with a 5000 CFM fan and an 80% outside air requirement for ventilation, providing just 4000 CFM of outside air, would require energy recovery.

In addition, the first sentence of Section C403.2.6.1 states that any system requiring more than 5000 CFM of outside air, no matter what percentage of the total supply air that represents, also requires energy recovery. Thus a 12,000 CFM fan with a 50% outside air requirement would require energy recovery.

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C403.2.7 Duct and plenum insulation and sealing.

C403.2.7.1 Ducts, shafts and plenums conveying outside 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, such duct surfaces shall meet the requirements for metal framed walls per Table C402.1.2. Duct surfaces included as part of the building envelope shall not be used in the calculation of maximum glazing area as described in Section 402.3.1.

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.

C403.2.7.2 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 a minimum of R-8 insulation where located outside the building. 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 C402.2.3.

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).

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 where located within conditioned space.

All ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply with Section 603.9 of the *International Mechanical Code*.

C403.2.7.3 Duct construction. Ductwork shall be constructed and erected in accordance with the *International Mechanical Code*. For the purposes of this section, longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow. Duct wall penetrations are openings made by any screw, fastener, pipe, rod or wire. All other connections are considered transverse joints, including but not limited to spin-ins, taps and other branch connections, access door frames and jambs, and duct connections to equipment.

C403.2.7.3.1 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.

C403.2.7.3.2 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*.

C403.2.7.3.3 High-pressure and exterior duct systems. Ducts designed to operate at static pressures in excess of 3 inches water gauge (w.g.) (750 Pa) and all ductwork located outside the building envelope shall be insulated and sealed in accordance with Section C403.2.7. In addition, ducts and plenums shall be leak-tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual* with the rate of air leakage (*CL*) less than or equal to 6.0 as determined in accordance with Equation C4-5.

(Equation C4-5)

$$CL = F/P0.65$$

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.

C403.2.8 Piping insulation. All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.2.8.

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).

C403.2.8.1 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.

Table C403.2.8
Minimum Pipe Insulation Thickness (thickness in inches)[a]

Fluid Operating Temperature Range and Usage (°F)	Insulation Conductivity	Nominal Pipe or Tube Size (inches)

	Conductivity Btu · in. /(h · ft^2 · °F)^b	**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

[a] 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 (Btu × in/h × ft^2 × °F) and

k = The upper value of the conductivity range listed in the table for the applicable fluid temperature.

c For direct-buried heating and hot water system piping, reduction of these thicknesses by 1-1/2 inches (38 mm) shall be permitted (before thickness adjustment required in footnote b but not to thicknesses less than 1 inch (25 mm).

C403.2.9 Mechanical systems commissioning and completion requirements. Mechanical systems shall be commissioned and completed in accordance with Section C408.2.

C403.2.10 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 meet the provisions of Sections C403.2.10.1 through C403.2.10.((~~2~~))5. All motors less than 1 horsepower shall meet the provisions of Sections C403.2.10.3.

C403.2.10.1 Allowable fan floor 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 C403.2.10.1(1). This includes supply 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.

EXCEPTION: The following fan systems are exempt from allowable fan floor horsepower requirement.

1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust and/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.

C403.2.10.2 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.

C403.2.10.3 Fractional hp fan motors. Motors for fans that are 1/12 hp or greater and less than 1 hp 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 in the airstream within fan-coils and terminal units that operate only when providing heating to the space served.

2. Motors installed in space conditioning equipment certified under Section C403.2.3.

Table C403.2.10.1(1)
Fan Power Limitation

	Limit	**Constant Volume**	**Variable Volume**
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	hp ≤ $CFM_S \times 0.0011$	hp ≤ $CFM_S \times 0.0015$

Option 2: Fan system bhp	Allowable fan system bhp	bhp ≤ $CFM_S \times 0.00094 + A$	bhp ≤ $CFM_S \times 0.0013 + A$

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 [$PD \times CFM_D/4131$]

For SI: 1 cfm .= 0.471 L/s.

Where:

PD = Each applicable pressure drop adjustment from Table C403.2.10.1(2) in. w.c.

CFM_D = The design airflow through each applicable device from Table C403.2.10.1(2) in cubic feet per minute.

For SI: 1 bhp .= 735.5 W, 1 hp .= 745.5 W.

Table C403.2.10.1(2)
Fan Power Limitation Pressure Drop Adjustment

Device	Adjustment
Credits	
Fully ducted return and/or exhaust air systems	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
Energy recovery device, other than coil runaround loop	(2.2 × energy recovery effectiveness) – 0.5 inch w.c. for each airstream
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	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

w.c. .= water column
For SI: 1 inch w.c..= 249 Pa, 1 inch.= 25.4 mm

C403.2.10.4. Multiple-zone Variable Air Volume (VAV) System Ventilation

Optimization Control. Multiple-zone VAV systems with direct digital control (DDC) of individual zone boxes reporting to a central control panel shall include means to automatically reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency as set out in ASHRAE 62.1, Appendix A.

Exceptions. The following systems are exempt from this section:

1. VAV Systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air
2. Dual-duct dual-fan VAV systems
3. VAV systems with fan-powered terminal units
4. Systems where total design exhaust airflow is more than 70 percent of the total design outdoor air intake flow requirements

C403.2.10.5 Multiple-zone VAV System Outdoor Airflow Control. Multiple-zone VAV systems with a minimum outside air requirement of 5,000 CFM 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 zonal systems as required by Sections C403.2.10.4 and C403.2.5.1.

Exceptions.

1. Systems that meet all of the following are exempt from this section:

1.1 No spaces served by the system require demand control ventilation per Section C403.2.5.1.

1.2 The system meets the one of the exceptions to Section C403.2.10.4.

1.3 The system complies with Section 403.6 of the International Mechanical Code.

2. Systems where total design exhaust airflow is more than 70 percent of the total design outdoor air intake flow requirements are exempt from this section.

C403.2.11 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.

C403.2.12 System criteria. For fan and pump motors ((~~7.5~~)) 5 hp and greater including motors in or serving custom and packaged air handlers serving variable air volume fan systems, constant volume fans, parking garage ventilation 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.).

See Seattle Building Code, Section 3016.15 for energy efficiency requirements for ventilation fan systems in elevators.

C403.2.12.1 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.

Cooling towers serving chilled water systems shall be selected to maintain a return condenser water temperature to the tower of 86° F (30° C) or less at peak design conditions.

EXCEPTION. In existing buildings where physical constraints preclude a change from the original design, replacement cooling towers of the same or smaller capacity are exempt from this requirement.

Hydronic heat pump and other cooling and refrigeration equipment, including but not

limited to icemakers and walk-in coolers, shall not use domestic water only one time before dumping it to waste (no single pass water cooling systems are allowed).

EXCEPTIONS.

1. Replacement of existing icemakers is exempt from this requirement.

2. Use of single pass cooling for medical and dental equipment during power outages and other emergencies is exempt from this requirement.

C403.2.12.1.1 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.

C403.2.12.1.2 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~~)) and require external static pressure capability or open circuit cooling towers that have external sound attenuation.

C403.2.12.2 Large volume fan systems. Single or multiple fan systems serving a zone or adjacent zones without separating walls with total air flow over 10,000 cfm (3,540 L/s) are required to reduce airflow based on space thermostat heating and cooling demand. A variable speed drive shall reduce airflow to a maximum 75 percent of peak airflow or minimum ventilation air requirement as required by Section 403 of the *International Mechanical Code*, whichever is greater.

EXCEPTIONS:

1. Systems where the function of the supply air is for purposes other than temperature control, such as maintaining specific humidity levels or supplying an exhaust system.

2. Dedicated outdoor air supply unit(s) with heat recovery where airflow is equal to the minimum ventilation requirements and other fans cycle off unless heating or cooling is required.

3. An area served by multiple units where designated ventilation units have 50 percent or less of total area airflow and nonventilation unit fans cycle off when heating or cooling is not required.

All air-conditioning equipment and air-handling units with direct expansion cooling and a cooling capacity at AHRI conditions greater than or equal to 110,000 Btu/h that serve single zones shall have their supply fans controlled by two-speed motors or variable speed drives. At cooling demands less than or equal to 50 percent, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:

1. Two-thirds of the full fan speed; or

2. The volume of outdoor air required to meet the ventilation requirements of Section 403 of the *International Mechanical Code*.

C403.2.13 Electric motor efficiency. Design A and B squirrel-cage, T-frame induction permanently wired polyphase motors of 1 hp or more having synchronous speeds of 3,600, 1,800 and 1,200 rpm shall have a nominal full-load motor efficiency no less than the corresponding values for energy efficient motors provided in NEMA Standard MG-1.

EXCEPTIONS:

1. Motors used in systems designed to use more than one speed of a multi-speed motor.

2. Motors used as a component of the equipment meeting the minimum equipment efficiency requirements of Section C403.2.3 and Tables C403.2.3(1) through C403.2.3(9) provided that the motor input is included when determining the equipment efficiency.

3. Motors that are an integral part of specialized process equipment.

4. Where the motor is integral to a listed piece of equipment for which no complying motor has been approved.

Fan motors less than 1 hp in series terminal units and in fan-coil units shall be electronically commutated motors, or shall have a minimum motor efficiency of ((~~65~~)) 70 percent when rated in accordance with NEMA Standard MG-1 at full load rating conditions.

C403.3 Simple HVAC systems and equipment (Prescriptive). This section applies to unitary or packaged HVAC systems listed in Tables C403.2.3(1) through C403.2.3(8), each serving one *zone* and controlled by a single thermostat in the *zone* served. It also applies to two-pipe heating systems serving one or more *zones*, where no cooling system is installed.

To qualify as a simple system, systems shall have no active humidification or simultaneous heating and cooling and shall be one of the following:

1. Air cooled, constant volume packaged equipment, which provide heating, cooling or both, and require only external connection to duct work and energy services with cooling capacity of 135,000 Btu/h or less.

2. Air cooled, constant volume split systems, which provide heating, cooling or both, with cooling capacity of 84,000 Btu/h or less.

3. Heating only systems which have a capacity of less than 1,000 cfm or which have a minimum outside air supply of less than 30 percent of the total air circulation.

The combined airflow rate of all simple systems serving single rooms must be less than 10,000 cfm or they do not qualify as simple systems.

C403.3.1 Economizers. Each cooling system that has a fan shall include an air economizer meeting the requirements of Sections C403.3.1.1 through C403.3.1.1.4.

EXCEPTION: Economizers are not required for the systems listed below:

1. 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 cooling units and split systems with a total cooling capacity rated in accordance with Section C403.2.3 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 (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 air economizer capacity, whichever is greater. That portion of the equipment serving residential occupancies is not included in determining the total capacity of all units without economizers in a building. Redundant units are not counted in the capacity limitations. This exception shall not be used for the shell-and-core permit or for the initial tenant improvement or for Total Building Performance.

2. Systems 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. For residential 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 (10), 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 and VRF systems, compliance is based on the cooling capacity of individual fan coil units.

4. Where the cooling *efficiency* meets or exceeds the *efficiency* requirements in Table C403.3.1(2).

Table C403.3.1(2)
Equipment Efficiency Performance
Exception for Economizers

Climate Zones	Cooling Equipment Performance Improvement (EER OR IPLV)
2B	10% Efficiency Improvement
3B	15% Efficiency Improvement
4B	20% Efficiency Improvement
4C	64% Efficiency Improvement

C403.3.1.1 Air economizers. Air economizers shall comply with Sections C403.3.1.1.1 through C403.3.1.1.4.

C403.3.1.1.1 Design capacity. Air economizer systems shall be capable of modulating *outdoor air* and return air dampers to provide up to 100 percent of the design supply air quantity as *outdoor air* for cooling.

C403.3.1.1.2 Control signal. Economizer dampers shall be capable of being sequenced 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 capable of providing 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.

C403.3.1.1.3 High-limit shutoff. Air economizers shall be capable of automatically reducing *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 C403.3.1.1.3(1). High-limit shutoff control settings for these control types shall be those specified in Table

C403.3.1.1.3(2).

C403.3.1.1.4 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.

C403.3.2 Hydronic system controls. Hydronic systems of at least 300,000 Btu/h (87,930 W) design output capacity supplying heated ~~and chilled water~~ to comfort conditioning systems shall include controls that meet the requirements of Section C403.4.3.

C403.3.3 Single Zone Variable-Air-Volume Controls. HVAC systems shall have variable airflow controls as follows:

1. Supply fans for air handling and fan coil units with chilled-water cooling coils and supply fans with motors greater than or equal to 5 hp shall be controlled by variable-speed drives or electronically-commutated motors. At cooling demands less than or equal to 50 percent, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:

    1.1. One half of the full fan speed; or

    1.2. The volume of outdoor air required to meet the ventilation requirements of the *International Mechanical Code*.

2. Supply fans for air conditioning equipment and air handling units with direct expansion cooling and a cooling capacity greater than or equal to 110,000 Btu/h that serve single zones shall be controlled by variable-speed drives or electronically-commutated motors. Cooling capacity shall be determined at the rating conditions in the AHRI standard appropriate to the equipment, At cooling demands less than or equal to 50 percent, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:

    2.1. Two-thirds of the full fan speed; or

    2.2. The volume of outdoor air required to meet the ventilation requirements of the *International Mechanical Code*.

C403.4 Complex HVAC systems and equipment (prescriptive). This section applies to HVAC equipment and systems not covered in Section C403.3.

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.

C403.4.1 Economizers. 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 C403.4.1.1 through C403.4.1.4.

EXCEPTIONS:

1. 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 Sections C403.4.1.1 through C403.4.1.4. Water economizer capacity per building shall not exceed 500 tons. This exception shall not be used for Total Building Performance.

2. Systems complying with all of the following criteria:

2.1. Consist of multiple water source heat pumps connected to a common water loop;

2.2. Have a minimum of 60 percent air economizer;

2.3. 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;

2.4. Where provided with a dedicated boiler or furnace for that building, have a central boiler or furnace efficiency of 90 percent minimum for units up to 199,000 Btu/h; and

2.5. Provide heat recovery with a minimum 50 percent heat recovery effectiveness as defined in Section C403.2.6 to preheat the outside air supply.

3. Chilled water terminal units connected to systems with chilled water generation equipment

with IPLV values more than 25 percent higher than 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 for this exception. The total capacity of all systems without economizers shall not exceed ((~~480,000~~)) 72,000 Btu/h per building, or ((~~20~~)) 5 percent of its air economizer capacity, whichever is greater. That portion of the equipment serving Group R Occupancy is not included in determining the total capacity of all units without economizers in a building. 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.

4. 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 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. PTAC and PTHP units with capacities no greater than 8,300 Btu/h are permitted for the purposes of this exception if they have EER values a minimum of 4 percent higher the minimum efficiencies listed in Table C403.2.3(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.

5. Equipment used to cool any dedicated server room, electronic equipment room or telecom switch room provided that they completely comply with Option a, b, ((~~or~~)) c, d or e in the table below. The total capacity of all qualifying 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)[a]	.+15%[b]	Required over 85,000 Btu/h[c]	None Required
Option b	Tables C403.2.3(1) and C403.2.3(2)[a]	.+5%[d]	Required over 85,000 Btu/h[c]	Waterside Economizer
Option c	ASHRAE Standard 127[f]	.+0%[g]	Required over 85,000 Btu/h[c]	Waterside Economizer
Option d	Table C403.2.3(7) [h]	+ 25% [i]	Required for all chillers [j]	None Required
Option e	Table C403.2.3(7) [h]	+ 10/15% [k]	Required over 85,000 Btu/h [c]	Dedicated waterside economizer

Notes for Exception 5:

a 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).

b The cooling equipment shall have an SEER/EER value and an IEER/IPLV value that each is a minimum of 15 percent greater than the value listed in Tables C403.2.3(1) and C403.2.3(2) (1.15 x values in Tables C403.2.3(1) and C403.2.3(2)).

c 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).

d The cooling equipment shall have an SEER/EER value and an IEER/IPLV value that each is a minimum of 5 percent greater than the value listed in Tables C403.2.3(1) and C403.2.3(2) (1.05 x values in Tables C403.2.3(1) and C403.2.3(2)).

e The system shall include a water economizer in lieu of air economizer. Water economizers shall meet the requirements of Sections C403.4.1.2 through C403.4.1.4 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.

f For a system where all cooling equipment is subject to ASHRAE Standard 127.

g The cooling equipment subject to the ASHRAE Standard 127 shall have ~~EER value and an IPLV~~ SCOP value that is ((~~equal or~~)) a minimum of 10 percent greater than the value listed in Tables C403.2.3(1) and C403.2.3(2) (1.10 x values in these tables) 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.

h For a system with chillers subject to the AHRI standards listed in Table C403.2.3(7) (e.g. a chilled water system with fan coil units).

i The cooling equipment shall have an full-load EER value and an IPLV value that is a minimum of 25 percent greater than the value listed in Table C403.2.3(7) (1.25 x value in Table C403.2.3(7) or a full-load and IPLV kW/ton that is at least 25 percent lower than the value listed in Table C403.2.3(7) (0.75 x value in Table C403.2.3(7)).

j For all chillers, 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 and that result 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, or dual tandem scrolls, but hot gas bypass is not a qualifying compressor unloading system).

k For air-cooled chillers, the cooling equipment shall have an IPLV EER value that is a minimum of 10 percent greater than the IPLV EER value listed in Table C403.2.3(7) (1.10 x values in Table C403.2.3(7). For water-cooled chillers, the cooling equipment shall have an IPLV kW/ton that is at least 15 percent lower than the IPLV kW/ton value listed in Table C403.2.3(7) (0.85 x values in Table C403.2.3(7)).

6. 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 in all rooms with VRF units 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 C403.2.6 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 and shall not exceed 20 percent of the floor area served by the VRF system. This exception shall be limited to buildings of 60,000 square feet and less.

7. Medical and laboratory equipment that is directly water-cooled and is not dependent upon space air temperature.

C403.4.1.1 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 in which a water economizer is used and 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) shall satisfy 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).

C403.4.1.2 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.

C403.4.1.3 Integrated economizer control. Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even where additional mechanical cooling is required to meet the remainder of the cooling load.

EXCEPTIONS:

1. Direct expansion systems that include controls that reduce the quantity of *outdoor air*

required to prevent coil frosting at the lowest step of compressor unloading, provided this lowest step is no greater than 25 percent of the total system capacity.

2. Individual direct expansion units that have a rated cooling capacity less than 54,000 Btu/h (15,827 W) and use nonintegrated economizer controls that preclude simultaneous operation of the economizer and mechanical cooling.

C403.4.1.4 Economizer heating system impact. HVAC system design and economizer controls shall be such that economizer operation does not increase the 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.

C403.4.2 Variable air volume (VAV) fan control. Individual VAV fans with motors of 7.5 horsepower (5.6 kW) or greater shall be:

1. Driven by a mechanical or electrical variable speed drive;

2. Driven by a vane-axial fan with variable-pitch blades; or

3. The fan shall have controls or devices that will result in fan motor demand of no more than 30 percent of their design wattage at 50 percent of design airflow when static pressure set point equals one-third of the total design static pressure, based on manufacturer's certified fan data.

C403.4.2.1 Static pressure sensor location. Static pressure sensors used to control VAV fans shall be placed in a position such that the controller setpoint is no greater than one-third the total design fan static pressure, except for systems with *zone* reset control complying with Section C403.4.2.2. For sensors installed downstream of major duct splits, at least one sensor shall be located on each major branch to ensure that static pressure can be maintained in each branch.

C403.4.2.2 Set points for direct digital control. For systems with direct digital control of individual *zone* boxes reporting to the central control panel, the static pressure setpoint

shall be reset based on the *zone* requiring the most pressure, i.e., the setpoint is reset lower until one *zone* damper is nearly wide open.

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 C403.4.3.1 through 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 capable of sequencing 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.

C403.4.3.1 Three-pipe system. Hydronic systems that use a common return system for both hot water and chilled water are prohibited.

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.

C403.4.3.3 Hydronic (water loop) heat pump systems. Hydronic heat pump systems shall comply with Sections C403.4.3.3.1 through C403.4.3.3.3.

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 capable of providing 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.

C403.4.3.3.2 Heat rejection. Heat rejection equipment shall comply with Sections C403.4.3.3.2.1 and C403.4.3.3.2.2.

EXCEPTION: Where it can be demonstrated that a heat pump system will be required to reject heat throughout the year.

C403.4.3.3.2.1 Climate Zones 3 and 4. For Climate Zones 3 and 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.

C403.4.3.3.2.2 Climate Zones 5 through 8. For Climate Zones 5 through 8, 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.

C403.4.3.3.3 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 C403.4.3.6.

C403.4.3.4 Part load controls. Hydronic systems greater than or equal to 300,000 Btu/h (87,930 W) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that have the capability to:

1. Automatically reset the supply-water temperatures using zone-return water temperature, building-return water temperature, or outside air temperature as an indicator of building heating or cooling demand. The temperature shall be capable of being reset by at least 25 percent of the design supply-to-return water temperature difference; and

2. Reduce system pump flow by at least 50 percent of design flow rate utilizing adjustable speed drive(s) on pump(s), or multiple-staged pumps where at least one-half of the total pump horsepower is capable of being automatically turned off or control valves designed to modulate or step down, and close, as a function of load, or other *approved* means.

Hydronic systems serving hydronic heat pumps are exempt from item 1, and only those hydronic systems with a total pump system power greater than 3 hp (2.2 kw) shall have controls meeting the requirements of item 2, above.

C403.4.3.5 Pump isolation. Chilled water plants including more than one chiller shall have the capability 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 have the capability to reduce flow automatically through the boiler plant when a boiler is shut down and automatically shut off flow to boilers ~~chillers~~ that are shut down.

C403.4.3.6 Variable flow controls. Individual pumps requiring variable speed control per Section C403.4.9 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.

Table C403.3.1.1.3(1)
High-limit Shutoff Control Options for Air Economizers

Climate Zones	Allowed Control Types	Prohibited Control Types
1B, 2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	Fixed dry-bulb Differential dry-bulb Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	Fixed enthalpy
1A, 2A, 3A, 4A	Fixed dry-bulb Fixed enthalpy Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	Differential dry-bulb
All other climates	Fixed dry-bulb Differential dry-bulb Fixed enthalpy Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	--

[a]Electronic enthalpy controllers are devices that use a combination of humidity and dry-bulb temperature in their switching algorithm.

Table C403.3.1.1.3(2)
High-limit Shutoff Control Setting for Air Economizers

Device Type	Climate Zone	Required High Limit (Economizer off When): Equation	Description

Fixed dry-bulb	1B, 2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	T_{OA} > 75°F	Outdoor air temperature exceeds 75°F
	5A, 6A, 7A	T_{OA} > 70°F	Outdoor air temperature exceeds 70°F
	All other zones	T_{OA} > 65°F	Outdoor air temperature exceeds 65°F
Differential dry-bulb	1B, 2B, 3B, 3C, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy	All	h_{OA} > 28 Btu/lb[a]	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[a]
Electronic enthalpy	All	$(T_{OA}, RH_{OA}) > A$	Outdoor air temperature/RH exceeds the "A" setpoint curve[b]
Differential enthalpy	All	$h_{OA} > H_{ra}$	Outdoor air enthalpy exceeds return air enthalpy
Dew-point and dry-bulb temperatures	All	DP_{OA} > 55°F or T_{OA} > 75°F	Outdoor air dry-bulb exceeds 75°F or outside dew-point exceeds 55°F (65 gr/lb)

For SI: °C = (°F - 32) × 5/9, 1 Btu/lb = 2.33 kJ/kg.

a At altitudes substantially different than sea level, the fixed enthalpy limit shall be set to the enthalpy value at 75°F and 50 percent relative humidity. As an example, at approximately 6,000 feet elevation the fixed enthalpy limit is approximately 30.7 Btu/lb.

b Setpoint "A" corresponds to a curve on the psychometric chart that goes through a point at approximately 75°F and 40 percent relative humidity and is nearly parallel to dry-bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

C403.4.4 Heat rejection equipment fan speed control. 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.

C403.4.5 Requirements for complex mechanical systems serving multiple zones. Sections C403.4.5.1 through C403.4.5.4 shall apply to complex mechanical systems serving multiple zones. Supply air systems serving multiple zones shall be VAV systems which, during periods of occupancy, are designed and capable of being controlled 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. Minimum flow rates required by applicable codes or standards for occupant health and safety.

EXCEPTION: The following define where individual *zones* or where entire air distribution systems are exempted from the requirement for VAV control:

1. Reserved.

2. *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.

3. *Zones* where special humidity levels are required to satisfy process needs.

4. *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.

5. *Zones* where the volume of air to be reheated, recooled or mixed is no greater than the volume of outside air required to meet the minimum ventilation requirements of Chapter 4 of the *International Mechanical Code*.

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 capable of preventing 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.

C403.4.5.1 Single duct variable air volume (VAV) systems, terminal devices. Single duct VAV systems shall use terminal devices capable of reducing the supply of primary supply air before reheating or recooling takes place.

C403.4.5.2 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 reducing the flow from one duct to a minimum before mixing of air from the other duct takes place.

C403.4.5.3 Reserved.

C403.4.5.4 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.

C403.4.6 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.

C403.4.7 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 C403.4.7.

EXCEPTION: Unitary packaged systems with cooling capacities not greater than 90,000 Btu/h (26,379 W).

Table C403.4.7
Maximum Hot Gas Bypass Capacity

Rated Capacity	Maximum Hot Gas Bypass Capacity (% of total capacity)
≤ 240,000 Btu/h	50
> 240,000 Btu/h	25

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

C403.4.8 Hydronic System Design: All chilled water and condenser water piping shall be designed such that the design flow rate in each pipe segment shall not exceed the values listed in Table C403.4.8 for the appropriate total annual hours of operation. Pipe size selections for systems that operate under variable flow conditions (e.g. modulating 2- way control valves at coils) and that contain variable speed pump motors are allowed to be made from the "Variable Flow/ Variable Speed" columns. All others shall be made from the "Other" columns.

EXCEPTION: Design flow rates exceeding the values in Table C403.4.8 are allowed in specific sections of pipe if the pipe is not in the critical circuit at design conditions and is not predicted to be in the critical circuit during more than 30 percent of operating hours.

Informative Note: The flow rates listed here do not consider noise or erosion. (Lower flow rates are often recommended for noise sensitive locations.)

TABLE C403.4.8

PIPING SYSTEM DESIGN MAXIMUM FLOW RATE IN GPM[1]

	<=2000 hours/yr		>2000 and <=4400 hours/year		> 4400 hours/year	
Pipe Size (in)	Other	Variable Flow/ Variable Speed	Other	Variable Flow/ Variable Speed	Other	Variable Flow/ Variable Speed
2 ½	120	180	85	130	68	110
3	180	270	140	210	110	170
4	350	530	260	400	210	320
5	410	620	310	470	250	370
6	740	1100	570	860	440	680
8	1200	1800	900	1400	700	1100
10	1800	2700	1300	2000	1000	1600
12	2500	3800	1900	2900	1500	2300

1 There are no requirements for pipe sizes smaller than the minimum shown in the table or larger than the maximum shown in the table.

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C403.6 Refrigerated warehouse coolers and refrigerated warehouse freezers. Refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with all of the following:

1. Evaporator fan motors that are less than 1 horsepower and less than 460 volts shall use electronically commutated motors (brushless direct current motors) or 3-phase motors.

2. Condenser fan motors that are less than 1 horsepower shall use electronically commutated

motors, permanent split capacitor-type motors or 3-phase motors.

3. Evaporator fans shall be variable speed, and the speed shall be controlled in response to space conditions.

EXCEPTION. Evaporators served by a single compressor without unloading capability.

4.Compressor systems utilized in refrigerated warehouses shall conform to the following:

4.1. Compressors shall be designed to operate at a minimum condensing temperature of 70°F or less.

4.2. The compressor speed of a screw compressor greater than 50 hp shall be controllable in response to the refrigeration load or the input power to the compressor shall be controlled to be less than or equal to 60 percent of full load input power when operated at 50 percent of full refrigeration capacity.

EXCEPTION. Refrigeration plants with more than one dedicated compressor per suction group.

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C403.7 Compressed air and vacuum air. Compressed air and vacuum air systems shall comply with all of the following:

EXCEPTION: Compressed air and vacuum air systems used for medical purposes are exempt from this section.

1. Air Compressors (50-150 PSI), General**:** Air compressors operating at 50-150 PSI shall comply with the following:

a. All water drains shall be "no loss" drains.

b. Timed unheated desiccant air driers shall not be allowed.

2. Rotary Screw Air Compressors over 10 hp (50-150 PSI)**:** Rotary screw air compressors over 10 hp operating at 50-150 PSI shall not rely on modulation control and shall have one of the following:

a. Receiver capacity greater than three gallons per cfm to allow efficient load/unload control;

b. Variable speed drive controlled air compressor; or

c. Multiple air compressors using a smaller trim-air compressor to trim. The trim compressor shall use variable speed drive control, or shall use load/unload control with greater than three gallon receiver capacity per cfm for the trim air compressor.

C403.8 Commercial food service.

The following types of equipment within the scope of the applicable Energy Star program shall comply with the energy-efficiency and water-efficiency criteria required to achieve the Energy Star label:

a. Commercial fryers: Energy Star Program Requirements for Commercial Fryers.

b. Commercial hot food holding cabinets: Energy Star Program Requirements for Hot Food Holding Cabinets.

c. Commercial steam cookers: Energy Star Program Requirements for Commercial Steam Cookers.

d. Commercial dishwashers: Energy Star Program Requirements for Commercial Dishwashers.

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C404.10 Pools and in-ground permanently installed spas (mandatory). Pools and in-ground permanently installed spas shall comply with Sections C404.10.1 through C404.10.4.

C404.10.1 Heaters. Pool water heaters using electric resistance heating as the primary source of heat are prohibited for pools over 2,000 gallons. Heat pump pool heaters shall have a minimum COP of 4.0 at 50°F db, 44.2°F wb outdoor air and 80°F entering water,

determined in accordance with ((~~ASHRAE Standard 146, Method of Testing for Rating Pool Heaters~~)) AHRI Standard 1160, Performance Rating of Heat Pump Pool Heaters. Other pool heating equipment shall comply with the applicable efficiencies in Section C404.2.3. All heaters shall be equipped with a readily *accessible* on-off switch that is mounted outside of the heater to allow shutting off the heater without adjusting the thermostat setting. Gas-fired heaters shall not be equipped with constant burning pilot lights.

C404.10.2 Time switches. Time switches or other control method that can automatically turn off and on heaters and pumps according to a preset schedule shall be installed on all heaters and pumps. Heaters, pumps and motors that have built in timers shall be deemed in compliance with this requirement.

EXCEPTIONS:

1. Where public health standards require 24-hour pump operation.
2. Where pumps are required to operate solar- and waste-heat-recovery pool heating systems.

C404.10.3 Covers. Heated pools and in-ground permanently installed 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.

C404.10.4 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 capable of decreasing the exhaust air temperature at design heating conditions (80°F indoor) by 36°F (10°C) in Climate Zones 4C and 5B and 48°F (26.7°C) in Climate Zone 6B.

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;

2. Dehumidification heat recovery;

3. Waste heat recovery; or

4. A combination of these system sources capable of providing at least 70 percent of the heating energy required over an operating season.

C404.11 Conservation of water pumping energy. Pumps for domestic water systems shall comply with Section C403.2.12. Water pressure booster systems shall comply with the following:

1. One or more pressure sensors shall be used to vary pump speed or to start and stop pumps, or for both purposes. Either the sensor(s) shall be located near the critical fixtures(s) that determine the pressure required, or logic shall be employed that adjusts the setpoint to simulate operation of remote sensors(s).

2. No device 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. No booster system pumps shall operate when there is no service water flow.

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C405.1 General (mandatory). This section covers lighting system controls, the connection of ballasts, the maximum lighting power for interior applications, electrical energy consumption, minimum acceptable lighting equipment for exterior applications, and minimum efficiencies for motors and transformers.

EXCEPTION: Dwelling units within commercial buildings shall not be required to comply with Sections C405.2 through C405.5 provided that a minimum of 75 percent of the lamps in permanently installed light fixtures shall be high efficacy lamps.

Walk-in coolers and walk-in freezers shall comply with C405.10. Refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with C405.11.

Escalators and moving walks shall comply with Section C405.12. Lighting systems shall be commissioned according to Section C405.13. Receptacles shall be controlled according to Section C405.14.

C405.2 Lighting controls (mandatory). Lighting systems shall be provided with controls as specified in Sections C405.2.1, C405.2.2, C405.2.3, C405.2.4 and C405.2.5.

EXCEPTION: Industrial or manufacturing process areas, as may be required for production and safety.

C405.2.1 Manual lighting controls. All buildings shall include manual lighting controls that meet the requirements of Sections C405.2.1.1 and C405.2.1.2.

C405.2.1.1 Interior lighting controls. Each area enclosed by walls or floor-to-ceiling partitions shall have at least one manual control for the lighting serving that area. The required controls shall be located within the area served by the controls or be a remote switch that identifies the lights served and indicates their status.

EXCEPTIONS: 1. Areas designated as security or emergency areas that need to be continuously lighted.

2. Lighting in stairways or corridors that are elements of the means of egress.

3. Stairwells and parking garages are not permitted to have a wall-mounted manual switch.

C405.2.1.2 Light reduction controls. Each area that is required to have a manual control shall also allow the occupant to reduce the connected lighting load in a reasonably uniform illumination pattern by at least 50 percent. Lighting reduction shall be achieved by one of the following or other *approved* method:

1. Controlling all lamps or luminaires;

2. Dual switching of alternate rows of luminaires, alternate luminaires or alternate lamps;

3. Switching the middle lamp in 3-lamp luminaires independently of the outer lamps; or

4. Switching each luminaire or each lamp.

EXCEPTION: Light reduction controls need not be provided in the following areas and spaces:

1. Areas that have only one luminaire, with rated power less than 100 watts.

2. Areas that are controlled by an occupant-sensing device.

3. Corridors, equipment rooms, storerooms, restrooms, public lobbies, electrical or mechanical rooms.

4. *Sleeping unit* (see Section C405.2.3).

5. Spaces that use less than 0.6 watts per square foot (6.5 W/m^2).

6. Daylight spaces complying with Section C405.2.2.3.2.

C405.2.2 Additional lighting controls. Each area that is required to have a manual control shall also have controls that meet the requirements of Sections C405.2.2.1, C405.2.2.2 and C405.2.2.3.

EXCEPTION: Additional lighting controls need not be provided in the following spaces:

1. *Sleeping units*.

2. Spaces where patient care is directly provided.

3. Spaces where an automatic shutoff would endanger occupant safety or security.

4. Lighting intended for continuous operation.

C405.2.2.1 Automatic time switch control devices. Automatic time switch controls shall be installed to control lighting in all areas of the building. Automatic time switches shall have a minimum 7 day clock and be capable of being set for 7 different day types per week and incorporate an automatic holiday "shut-off" feature, which turns off all loads for at least 24 hours and then resumes normally scheduled operations. Automatic time switches shall also have program back-up capabilities, which prevent the loss of program and time settings for at least 10 hours, if power is interrupted.

EXCEPTIONS:

1. Emergency egress lighting does not need to be controlled by an automatic time switch, except as required by item 7 of Section C405.2.3.

2. Lighting in spaces controlled by occupancy sensors does not need to be controlled by automatic time switch controls.

The automatic time switch control device shall include an override switching device that complies with the following:

1. The override switch shall be in a readily accessible location;

2. The override switch shall be located where the lights controlled by the switch are visible; or the switch shall provide a mechanism which announces the area controlled by the switch;

3. The override switch shall permit manual operation;

4. The override switch, when initiated, shall permit the controlled lighting to remain on for a maximum of 2 hours; and

5. Any individual override switch shall control the lighting for a maximum area of 2,500 ~~5,000~~ square feet (465 m^2).

EXCEPTION: Within malls, arcades, auditoriums, single tenant retail spaces, industrial facilities, pools, gymnasiums, skating rinks and arenas:

1. The time limit shall be permitted to exceed 2 hours provided the override switch is a captive key device; and

2. The area controlled by the override switch is permitted to exceed 5,000 square feet (465 m^2), but shall not exceed 20,000 square feet (1860 m^2).

C405.2.2.2 Occupancy sensors. Occupancy sensors shall be installed in all classrooms, conference/meeting rooms, employee lunch and break rooms, private offices, restrooms, warehouse spaces, storage rooms and janitorial closets, and other spaces 300 square feet (28 m^2) or less enclosed by floor-to-ceiling height partitions. These automatic control devices shall be installed to automatically turn off lights within 30 minutes of all

occupants leaving the space, and shall either be manual on or shall be controlled to automatically turn the lighting on to not more than 50 percent power. At initial installation, occupancy sensor controls shall be set to turn lights off after 15 minutes unless other thresholds required for safety, security or operational considerations are specifically set out in the approved permit.

EXCEPTION: Full automatic-on controls shall be permitted to control lighting in public corridors, stairways, restrooms, primary building entrance areas and lobbies, parking garages, and areas where manual-on operation would endanger the safety or security of the room or building occupants.

C405.2.2.3 Daylight zone control. Daylight zones shall be designed such that lights in the daylight zone are controlled independently of general area lighting and are controlled in accordance with Section C405.2.2.3.2. Each daylight control zone shall not exceed 2,500 square feet (232 m^2). Contiguous daylight zones adjacent to vertical *fenestration* are allowed to be controlled by a single controlling device serving no more than 60 lineal feet of façade, provided that they do not include zones facing more than two adjacent cardinal orientations (i.e., north, east, south, west). The primary daylight zone shall be controlled separately from the secondary daylight zone. Daylight zones under skylights more than 15 feet (4572 mm) from the perimeter shall be controlled separately from daylight zones adjacent to vertical *fenestration*. Controls shall:

1. Control only luminaires within the daylit area.

2. Incorporate time-delay circuits to prevent cycling of light level changes of less than three minutes.

3. Be set initially at 30 footcandles (323 lux) or not more than 110 percent of the illuminance level specified on the construction documents.

EXCEPTION: Daylight zones enclosed by walls or ceiling height partitions and containing two or fewer light fixtures are not required to have a separate switch for general

area lighting.

C405.2.2.3.1 Reserved.

C405.2.2.3.2 Automatic daylighting controls. Setpoint and other controls for calibrating the lighting control device shall be readily accessible.

Daylighting controls device shall be capable of automatically reducing the lighting power in response to available daylight by either one of the following methods:

1. Continuous dimming using dimming ballasts and daylight-sensing automatic controls that are capable of reducing the power of general lighting in the daylit zone continuously to less than 20 percent of rated power at maximum light output.

2. Stepped dimming using multi-level switching and daylight-sensing controls that are capable of reducing lighting power automatically. The system shall provide a minimum of two control channels per zone and be installed in a manner such that at least one control step is between 50 percent and 70 percent of design lighting power and another control step is no greater than 35 percent of design power, and the system is capable of automatically turning the system off.

Exception. In restaurant dining areas and retail sales areas, light fixtures located less than 10 feet horizontally from vertical *fenestration* are not required to be controlled by daylight sensors where the *fenestration* adjoins a sidewalk or other outdoor pedestrian area, provided that the light fixtures are controlled separately from the general area lighting.

C405.2.2.3.3 Reserved.

C405.2.3 Specific application controls. Specific application controls shall be provided for the following:

1. Display and accent light shall be controlled by a dedicated control which 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 which is independent of the controls for other lighting within the room or space.

3. Hotel and motel sleeping units and guest suites shall have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles. Where a hotel/motel includes more than 50 rooms, controls shall be automatic to ensure all power to the lights and switched outlets are turned off when the occupant is not in the room.

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 the control device is readily accessible.

5. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.

6. Lighting equipment that is for sale or for demonstrations in lighting education shall be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.

7. 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 0.05 watts per square foot of building area is exempt from this requirement.

8. Each stairway shall have one or more control devices 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 30 minutes, and restore lighting to full power when occupants enter the stairway. All portions of stairways shall remain illuminated to at least 1 footcandle (11 lux) at the walking surface when the lighting power is reduced.

9. Lighting in parking garages shall have one or more control devices to automatically reduce lighting power in any one controlled zone by not less than 50 percent when no occupants have been detected in that zone for a period not exceeding 30 minutes, and restore lighting to full power when occupants enter or approach the zone. Each lighting zone controlled by occupancy sensors shall be no larger than 7,200 square feet. Pedestrian occupancy sensors controlling any lighting zone are permitted to be configured to detect pedestrians no more than 30 feet outside of that zone. Vehicle occupancy sensors controlling any lighting zone are permitted to be configured to detect vehicles no more than 60 feet outside of that zone.

C405.2.4 Exterior lighting controls. Lighting not designated for dusk-to-dawn operation shall be controlled by either a combination of a photosensor and a time switch, or an astronomical time switch. Lighting designated for dusk-to-dawn operation shall be controlled by an astronomical time switch or photosensor. All time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least 10 hours.

Building façade lighting shall be automatically shut off between midnight or business/facility closing, whichever is later, and 6 AM or business/facility opening, whichever is earlier.

Other lighting, including advertising signage, shall be controlled by a device that automatically reduces the connected lighting power, on a system-wide basis, by at least 30 percent for at least one of the following conditions:

1. from midnight or business/facility closing, whichever is later, and 6 AM or business/facility opening, whichever is earlier; or

2. during any period when no activity has been detected on the site for a time of no longer than 15 minutes.

Exception: Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.

C405.2.5 Area controls. The maximum lighting power that may be controlled from a single switch or automatic control 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^2.

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C405.5 Interior lighting power requirements (prescriptive). A building complies with this section if its total connected lighting power calculated under Section C405.5.1 is no greater than the interior lighting power calculated under Section C405.5.2.

C405.5.1 Total connected interior lighting power. The total connected interior lighting power (watts) shall be the sum of the watts of all interior lighting equipment as determined in accordance with Sections C405.5.1.1 through C405.5.1.4. As an option, in areas of the building where all interior lighting equipment is fed from dedicated lighting branch circuits, the total connected interior lighting power is permitted to be calculated as the sum of the capacities of the lighting branch circuits serving those areas. For the purposes of this section, the connected interior lighting power of a 20-ampere circuit is considered to be 16 amperes, and that of a 15-ampere circuit is 12 amperes. Use of this alternative and the limits of the applicable areas shall be clearly documented on the electrical construction documents.

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.

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.

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.

C405.5.1.1 Screw lamp holders. The wattage shall be the maximum *labeled* wattage of the luminaire.

C405.5.1.2 Low-voltage lighting. The wattage shall be the specified wattage of the transformer supplying the system.

C405.5.1.3 Other luminaires. The wattage of all other lighting equipment shall be the wattage of the lighting equipment verified through data furnished by the manufacturer or other *approved* sources.

C405.5.1.4 Line-voltage lighting track and plug-in busway. The wattage shall be:

1. The specified wattage of the luminaires included in the system with a minimum of 50 W/lin ft. (162 W/lin. m);

2. The wattage limit of the system's circuit breaker; or

3. The wattage limit of other permanent current limiting device(s) on the system.

C405.5.2 Interior lighting power. The total interior lighting power allowance (watts) is determined according to Table C405.5.2(1) using the Building Area Method, or Table C405.5.2(2) using the Space-by-Space Method, for all areas of the building covered in this permit. For the Building Area Method, the interior lighting power allowance is the floor area for each building area type listed in Table C405.5.2(1) times the value from Table C405.5.2(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 C405.5.2(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. 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

C405.5.2(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, except that tradeoffs with covered parking areas are not permitted. See the Seattle Building Code, Section 3016.15, for energy efficiency requirements for lighting in elevators.

C405.6 Exterior lighting (mandatory). Where the power for exterior lighting is supplied through the energy service to the building, all exterior lighting shall comply with Sections C405.6.1 and C405.6.2.

EXCEPTION: Where *approved* because of historical, safety, signage or emergency considerations.

C405.6.1 Exterior building grounds lighting. All exterior building grounds luminaires that operate at greater than 100 watts shall contain lamps having a minimum efficacy of 60 lumens per watt unless the luminaire is controlled by a motion sensor or qualifies for one of the exceptions under Section C405.6.2.

C405.6.2 Exterior building lighting power. The total exterior 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 C405.6.2(2) for the applicable lighting zone. Tradeoffs are allowed only among exterior lighting applications listed in Table C405.6.2(2), Tradable Surfaces section. Parking garage lighting cannot be traded with exterior lighting or with other interior lighting. The lighting zone for the building exterior is determined from Table C405.6.2(1) unless otherwise specified by the local jurisdiction. Exterior lighting for all applications (except those included in the exceptions to Section C405.6.2) shall comply with the requirements of Section C405.6.1.

EXCEPTION: Lighting used for the following exterior applications is exempt where equipped with a control device independent of the control of the nonexempt lighting:

1. Specialized signal, directional and marker lighting associated with transportation;
2. Advertising signage or directional signage;

3. Integral to equipment or instrumentation and is installed by its manufacturer;

4. Theatrical purposes, including performance, stage, film production and video production;

5. Athletic playing areas;

6. Temporary lighting;

7. Industrial production, material handling, transportation sites and associated storage areas;

8. Theme elements in theme/amusement parks; and

9. Used to highlight features of public monuments and registered historic landmark structures or buildings.

Table C405.6.2(1)
Exterior Lighting Zones

Lighting Zone	Description
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas
~~4~~ (not used)	~~High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority~~

C405.6.3 Full cutoff luminaires. For open parking and outdoor areas and roadways, luminaires mounted more than 15 feet above the ground shall be full cutoff luminaires. Full cutoff means a luminaire light distribution where zero candela intensity occurs at an angle of 90 degrees above nadir, and all greater angles from nadir.

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C405.14 *Controlled receptacles*. At least 50 percent of all 125 volt 15- and 20-ampere receptacles installed in private offices, open offices, or classrooms, including those installed in modular partitions and modular office workstation systems, shall be *controlled receptacles*. In rooms larger than 200 square feet (19 M^2), 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 30 minutes, or

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 capable of providing an independent schedule for each portion of the building not to exceed 25,000 square feet (2,323 M^2) and not to exceed one full floor. The device shall be capable of being overridden for periods of up to two hours by a timer accessible to occupants. Any individual override switch shall control the *controlled receptacles* for a maximum area of 5,000 square feet (465 M^2). 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*.

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C407.2 Mandatory requirements. Compliance with this section requires that the criteria of Sections C402.4, C403.2, C404, ((~~and~~)) C405, C408, C409 and C410 be met.

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.

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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 is less than or equal to <u>93 percent of</u> the annual energy consumption of the *standard reference design*.

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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 <u>information listed in Appendix D</u> ((~~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).))~~

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(excerpt from)

Table C407.5.1(1)
Specifications for the Standard Reference and Proposed Designs

Skylights	Area	As proposed

	1. The proposed skylight area; where the proposed skylight area is less than ((~~3~~)) 5 percent of gross area of roof assembly. 2. ((~~3~~)) 5 percent of gross area of roof assembly; where the proposed skylight area is ((~~3~~)) 5 percent or more of gross area of roof assembly.

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SECTION C408--SYSTEM COMMISSIONING.

C408.1 General. This section covers the commissioning of the building mechanical systems in Section C403, service water heating systems in Section C404, electrical power and lighting systems in Section C405 and energy metering in Section C409. Prior to passing the final mechanical and electrical inspections or obtaining a certificate of occupancy, the *registered design professional* or ((~~approved agency~~)) *qualified commissioning authority* shall provide evidence of systems *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 Sections C408.1.2 and C408.1.3.

C408.1.1 Commissioning plan. A *commissioning plan* shall be developed by a *registered design professional* or *qualified commissioning authority* and shall include the items listed in this section. Items 1 – 4 shall be included with the construction documents, and items 5 – 8

shall be submitted prior to the first mechanical inspection. For projects where no mechanical inspection is required, items 5 – 8 shall be submitted prior to the first electrical inspection.

((~~A commissioning plan shall be developed by a registered design professional or approved agency and shall include the following items:~~))

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.

2. Roles and responsibilities of the commissioning team, including statement of qualifications of the commissioning authority in accordance with Section C408.1.

3. A schedule of activities including systems testing and balancing, functional testing, and supporting documentation.

4. Where the *qualified commissioning authority* 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 *qualified commissioning authority's* contractual relationship with other team members and provide a conflict management plan demonstrating that the *qualified commissioning authority* is free to identify any issues discovered and report directly to the owner.

((~~4)~~) 5. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.

((~~5)~~) 6. Functions to be tested.

((~~6)~~) 7. Conditions under which the test will be performed.

((~~7)~~) 8. Measurable criteria for performance.

((~~**C408.1.2 Preliminary commissioning report.** A preliminary report of commissioning test procedures and results shall be completed and certified by the *registered design professional* or ((approved agency)) *qualified commissioning authority* and provided to the building owner. The report shall be identified as "Preliminary Commissioning Report" and shall~~

~~identify:~~

~~1. Itemization of deficiencies found during testing required by this section that have not been corrected at the time of report preparation.~~

~~2. Deferred tests that cannot be performed at the time of report preparation because of climatic conditions, with anticipated date of completion.~~

~~3. Climatic conditions required for performance of the deferred tests.~~

~~4. Record of progress and completion of operator training.~~))

C408.1.2.1 Acceptance of report. *Buildings*, or portions thereof, shall not pass the final mechanical and electrical inspections or obtain a certificate of occupancy, until such time as the *code official* has received a letter of transmittal from the *building* owner acknowledging that the *building* owner has received the ((~~Preliminary~~)) Commissioning Report required by Section C408.1.3.4 and the completed ((~~. Completion of the~~)) Commissioning Compliance Checklist (Figure C408.1.2.1) ((~~is deemed to satisfy this requirement~~)).

((~~**C408.1.2.2 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.*~~))

C408.1.3 Documentation requirements. The *construction documents* shall specify that the manuals and system balancing report required by Sections C408.1.3.2 and C408.1.3.3 be provided to the *building* owner prior to issuance of the certificate of occupancy, the record *documents* required by Section C408.1.3.1 ((~~described in this section)~~) be provided to the *building* owner within 90 days of the date of receipt of the *certificate of occupancy*, and that the Commissioning Report *documents* described under Section C408.1.3.4 be provided to the *building* owner and the *code official* prior to issuance of the certificate of occupancy.

C408.1.3.1 Record documents. Construction documents shall be updated to convey a record of the alterations to the original design. The updates shall be provided to the *building* owner. Such updates shall include updated mechanical, electrical and control

drawings red-lined, or redrawn if specified, that show all changes to size, type and locations of components, equipment and assemblies.

C408.1.3.2 Manuals. An operating and maintenance manual shall be provided and include all of the following:

1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.

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

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

4. Controls system maintenance and calibration information, including wiring diagrams, schematics, record documents, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.

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

C408.1.3.3 System balancing report. A written report describing the activities and measurements completed in accordance with Section C408.2.2.

C408.1.3.4 ((~~Final c)~~ Commissioning report. A report of test procedures and results identified as "((~~Final))~~ Commissioning Report" shall be delivered to the building owner and *code official* and 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. List and description of any deferred tests which cannot be completed at the time of report preparation because of climatic conditions, including anticipated date of completion, climatic conditions required for performance of the deferred tests, including timeframe for completion and parties to be involved, in checklist format.

5. List and description of any unresolved deficiencies or incomplete tasks, in checklist format.

6. A copy of a Commissioning Permit issued for the completion and resolution of items identified in the lists required by items 4 and 5 above. The permit shall stipulate that all such work shall be completed within one year of issuance of the *certificate of occupancy*.

Exception: If there are no deferred tests, unresolved deficiencies or incomplete tasks to be listed under items 4 and 5, the Commissioning Permit is not required. ((~~Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.~~))

7. Completed Commissioning Compliance Checklist (Figure C408.1.2.1)

8. Record of progress and completion of systems operation training.

C408.1.4 Systems operation training. Training of the maintenance staff for equipment included in the manuals required by Section C408.1.3.2 shall include at a minimum:

1. Review of systems documentation.

2. Hands-on demonstration of all normal maintenance procedures, normal operating modes, and all emergency shutdown and start-up procedures.

3. Training completion report.

Figure C408.1.2.1
Commissioning Compliance Checklist

	Project Name:

Project Information	**Project Address:**
	Commissioning Authority:
Qualifications (Section C408.1)	Statement of commissioning authority's formal training, experience and certification.
Commissioning Plan (Section C408.1.1)	☐ **Commissioning Plan was used during construction and included items below** · A narrative description of activities and the personnel intended to accomplish each one · Measurable criteria for performance · Functions to be tested
	In-House Commissioning Disclosure and Conflict Management Plan, where applicable
Systems Balancing (Section C408.2.2)	☐ **Systems Balancing has been completed** · Air and Hydronic systems are proportionately balanced in a manner to first minimize throttling losses. · Test ports are provided on each pump for measuring pressure across the pump.
Functional Testing (Section C408.2.3, C408.3.1, C408.4.1, C408.4.1.3 and C408.5.1)	☐ **HVAC Systems Equipment Testing has been completed** (Section C408.2.3.1) HVAC equipment has been tested to demonstrate the installation and operation of components, systems and system-to-system interfacing relationships in accordance with approved plans and specifications ☐ **HVAC Controls Functional Testing has been completed** (Section C408.2.3.2)

	HVAC controls have been tested to ensure that control devices are calibrated, adjusted and operate properly. Sequences of operation have been functionally tested to ensure they operate in accordance with approved plans and specifications ☐ **Economizers Functional Testing has been completed** (Section C408.2.3.3) Economizers operate in accordance with manufacturer's specifications ☐ **Lighting Controls Functional Testing has been completed** (Section C408.3.1) Lighting controls have been tested to ensure that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications ☐ **Service Water Heating System Functional Testing has been completed** (Section C408.4.1) Service water heating equipment has been tested to ensure that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications ☐ **Pool and Spa Functional Testing has been completed** (Section C408.4.1.3) Pools and spas have been tested to ensure that service water heating equipment, time switches and heat recovery equipment are calibrated, adjusted and operate in accordance with approved plans and specifications ☐ **Metering System Functional Testing has been completed** (Section C408.5.1) Energy source meters, energy end-use meters, the energy metering data acquisition system and required display are calibrated adjusted and operate in accordance with approved plans and specifications
Supporting Documents	☐ **Manuals, record documents and training have been completed or are scheduled**

(Section 408.1.3.2)	· System documentation has been provided to the owner or scheduled date: · Record documents have been submitted to owner or scheduled date: · Training has been completed or scheduled date:
Commissioning Report ~~(Section C408.1.2)~~	☐ ~~**Preliminary Commissioning Report submitted to Owner and includes items below**~~ ~~· Deficiencies found during testing required by this section which have not been corrected at the time of report preparation~~ ~~· Deferred tests, which cannot be performed at the time of report preparation due to climatic conditions~~
(Section C408.1.3.4)	☐ Commissioning Report submitted to Owner and includes items below
	☐ 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.
	☐ 4. List and description of any deferred tests that cannot be completed at the time of report preparation, including timeframe for completion and parties to be involved
	☐ 5. List and description of any unresolved deficiencies or incomplete tasks noted in the Commissioning Report
	☐ 6. A copy of a Commissioning Permit issued for the completion and resolution of items identified in the lists required by items 4 and 5 above.
	☐ 7. Completed Commissioning Compliance Checklist (Figure C408.1.2.1)
	☐ 8. Record of progress and completion of systems operation training.
Certification	☐ I hereby certify that all requirements for Commissioning have been completed in accordance with the ~~Washington State~~ Seattle Energy Code, including all items above _____ _____ Building Owner or Owner's Representative Date

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C408.3 Lighting system functional testing. Controls for automatic lighting systems shall comply with Section C408.3.1.

Exception: Lighting systems are exempt from the functional testing requirements in buildings where the total installed lighting load is less than 20 kW and less than 10 kW of lighting load controlled by occupancy sensors or automatic daylighting controls.

C408.3.1 Functional testing. Testing shall ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation 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. At a minimum, testing shall affirm operation during normally occupied daylight conditions. The construction documents shall state the party who will conduct the required functional testing.

Where occupant sensors, time switches, programmable schedule controls, photosensors or daylighting controls are installed, the following procedures shall be performed:

1. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.

2. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.

3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified.

SECTION C409--ENERGY METERING AND ENERGY CONSUMPTION MANAGEMENT.

C409.1 General. Buildings with a gross conditioned floor area over ((~~50,000~~)) 20,000 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. For Group R-2 multi-family buildings, the floor area of dwelling units shall be excluded from the total conditioned floor area. Alterations and additions to existing buildings shall conform to Section C409.5.

EXCEPTIONS:

1. Tenant spaces 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~~)) 10,000 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 or kVA shall include the equivalent BTU/h heating and cooling capacity of installed equipment at a conversion factor of 3,412 Btu per kW or 2,730 Btu per kVA ((~~at 50 percent demand~~)).

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.

EXCEPTION: Where site lighting and other exterior non-building electrical loads are served by an electrical service and meter that are separate from the building service and meter, the metering data from those loads is permitted to be either combined with the building's electrical service load data or delivered to a separate data acquisition system.

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, and waste heat reclaimed from sewers or other off-site sources.

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~~)) C409.3.6. These meters shall collect data for the whole building or for each separately metered portion of the building where not exempted by the exceptions to Section C409.1. Not more than 10 percent of the total connected

load of any of the end-use metering categories C409.3.1 through C409.3.5 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 C409.3.1 through C409.3.5 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 sub-metering data shall be provided to the tenant in accordance with Section C409.3.5, and the data shall not be required to be included in other end-use categories.

EXCEPTIONS:

1. HVAC and water heating equipment serving only an individual dwelling 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. Healthcare 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 identified in Article 517 of the Seattle Electrical Code, except that submetering is required for the following load categories:
   4.1 HVAC system energy use per the requirements of section C409.3.1
   4.2 Water heating energy use per the requirements of section C409.3.2
   4.3 Process load system energy per 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 that facility exceeds 100 kVA.
5. End-use metering is not required for electrical circuits serving only sleeping rooms

and guest suites within 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, 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. All 120 volt equipment.
2. 208/120 volt equipment in a building where the main service is 480/277 volt power.
3. Electrical energy fed through variable frequency drives that are connected to the energy metering data acquisition center.

C409.3.2 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: Water heating energy use less than 50 ((~~kWV)~~) 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 Plug load system energy use. This category shall include all energy used by appliances, computers, plugged-in task lighting, and other equipment and devices, but not including vertical transportation equipment or equipment covered by other end-use metering categories listed in 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.

C409.3.5 Process load system energy use. Meters shall collect data for energy used by any non-building process load, including but not limited to nonresidential refrigeration and cooking equipment, laundry equipment, industrial equipment and stage lighting.

Exception: Process load energy use less than 50 kVA does not require end-use metering.

C409.3.6 Full-floor tenant space electrical sub-metering. 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 of the tenant space shall not be included in the tenant space sub-metering. A single display is permitted to serve multiple floors occupied by the same tenant.

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 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, or a web page or other electronic document accessible 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 and peak values for any day, week or year.

C409.4.4 Commissioning. The entire system shall be commissioned in accordance with Section C408.5. 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.

C409.5 Metering for existing buildings.

C409.5.1 Existing buildings that were constructed subject to the requirements of this section. Where new or replacement systems or equipment are installed in an existing building that was constructed subject to the requirements of this section, metering shall be provided for such new or replacement systems or equipment so that their energy use is included in the corresponding end-use category defined in Section C409.2. This includes systems or equipment added in conjunction with additions or alterations to existing buildings.

C409.5.1.1 Small existing buildings. For existing buildings that were constructed subject to the requirements of this code, but were exempt from the requirements of Section C409 due to being smaller than the thresholds set forth in Section C409.1, ((M~~))~~ metering and data acquisition systems shall be provided for additions over ((~~25,000))~~ 10,000 square feet in accordance with the requirements of sections C409.2, ((~~and~~)) C409.3 and C409.4.

C409.5.2 Metering for HVAC Equipment Replacement. Where permits are issued for new or replacement HVAC equipment that has a total heating and cooling capacity greater than 1,200 kBTU/hour and greater than 50 percent of the building's existing HVAC heating and

cooling capacity, within any 12-month period, the following shall be provided for the building:

1. Energy source metering required by Section C409.2.

2. HVAC system end-use metering required by Section C409.3.1

3. Data acquisition and display system per the requirements of Section C409.4.

Each of the building's existing HVAC chillers, boilers, cooling towers, air handlers, packaged units and heat pumps that has a capacity larger than 5 tons or that represents more than 10 percent of the total heating and cooling capacity of the building shall be included in the calculation of the existing heating and cooling capacity of the building. Where heat pumps are configured to deliver both heating and cooling, the heating and cooling capacities shall both be included in the calculation of the total capacity.

Each of the building's existing and new HVAC chillers, boilers, cooling towers, air handlers, packaged units and heat pumps that has a heating or cooling capacity larger than 5 tons or that represents more than 10 percent of the total heating and cooling capacity of the building shall be included in the HVAC system end-use metering.

Construction documents for new or replacement heating and cooling equipment projects shall indicate the total heating and cooling capacity of the building's existing HVAC equipment and the total heating and cooling capacity of the new or replacement equipment. Where permits have been issued for new or replacement heating and cooling equipment within the 12 month period prior to the permit application date, the heating and cooling capacity of that equipment shall also be indicated. For the purpose of this tabulation, heating and cooling capacities of all equipment shall be expressed in kBTU / hour.

C409.5.3 Tenant space electrical sub-metering for existing buildings. For tenant improvements in which a single tenant will occupy a full floor of a building, the electrical consumption for the tenant space on that floor shall be separately metered, and the metering data provided to the tenant with a display system per the requirements of Section C409.4.3.

For the purposes of this section, separate end use categories need not be segregated.

EXCEPTION: Where an existing branch circuit electrical panel serves tenant spaces on multiple full floors of a building, the floors served by that panel are not required to comply with this section.

C409.5.4 Metering for complete electrical system replacement. If all, or substantially all, of the existing electrical system is replaced under a single electrical permit or within a 12-month period, all of the provisions of Section C409 shall be met.

SECTION C410 RENEWABLE ENERGY AND SOLAR READINESS

C410.1 On-site renewable energy systems. Each new 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 PV (photovoltaic) energy production, or 240 kBTU of annual SWH (solar water heating) energy production, per 1,000 square feet of conditioned space 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. This system is permitted to be mounted either within the allocated *solar zone* required by Section C410.2.3, or elsewhere on the building or site.

Exceptions.

1. Higher-efficiency mechanical equipment is permitted to be provided in lieu of on-site renewable energy systems, where the capacity-weighted equipment efficiency for the total capacity of the space heating and space cooling equipment is a minimum of 1.10 times the corresponding minimum efficiency in Tables C403.2.3(1) through C403.2.3(8). The minimum efficiency for this exception shall be in excess of that required elsewhere in the Energy Code, including Section C403.4.1 (economizers). The

Standard Reference Design determination from Section C407 shall be used to establish the baseline case for determination of the 1.10 factor.

2. Additional heat recovery systems beyond those required by this code are permitted to be provided in lieu of on-site renewable energy systems, where the calculated net annual energy savings from the heat recovery systems exceed the calculated net annual energy production of the required on-site renewable energy systems. Acceptable heat recovery systems include but are not limited to: exhaust air heat recovery in excess of that required by this code, waste water or sewer heat recovery, ground source heating and cooling, or heat recovered from other on-site or off-site sources that would otherwise be lost into the sewer or atmosphere.

C410.2 Solar Readiness.

C410.2.1 General. In addition to the requirements of C410.1, a *solar zone* shall be provided on non-residential buildings of any size that are five stories or less in height above grade plane, and 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 C410.2.2 through C410.2.8 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 unobstructed area, as defined in Section C410.2.3, in the same location, as measured by one of the following:

a. Incident solar radiation expressed in kWh/ft²-yr using typical meteorological year (TMY) data;

b. Annual sunlight exposure expressed in cumulative hours per year using TMY data;

c. Shadow studies indicating that the roof area is more than 25 percent in shadow, on September 21 at 10am, 11am, 12pm, 1pm, and 2pm solar time.

C410.2.2 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 shall be 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 PV 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 C410.2.2 to the maximum practicable area.

Example: A building with a 10,000 SF total roof area, 1,000 SF skylight area, and a 400 Amp, 240 volt single phase electrical service is required to provide a *solar zone* area of the smaller of the following:
1. [40% x (10,000 SF roof area – 1,000 SF skylights)] = 3,600 SF; or
2. [400 Amp x 240 Volts x 20% / 10 watts per SF] = 1,920 SF
Therefore, a *solar zone* of 1,920 square feet is required.

C410.2.3 Obstructions. The *solar zone* shall be free of pipes, vents, ducts, HVAC equipment, skylights and other obstructions, except those serving PV or SWH systems within the *solar zone*. PV or SHW systems are permitted to be installed 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* and Seattle Land Use Code.

C410.2.4 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° of true north.

C410.2.5 Contiguous area. The *solar zone* is permitted to be comprised of smaller separated sub-zones. Each subzone shall be at least 5 feet wide in the narrowest dimension.

C410.2.6 Access. Areas contiguous to the *solar zone* shall provide access pathways and provisions for emergency smoke ventilation as required by the International Fire Code.

C410.2.7 Structural integrity. If the *solar zone* is on the roof of the building or another structure on the site, the as-designed dead load and live load for the *solar zone* shall be clearly marked on the record drawings, and shall accommodate future PV or SHW arrays at an assumed dead load of 5 pounds per square foot in addition to other required live and dead loads. For PV systems, 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 PV or SWH systems are installed in the solar zone, structural analysis shall be based upon calculated loads, not upon these assumed loads.

C410.2.8 PV or SWH interconnection provisions. Buildings shall provide for the future interconnection of either a PV system in accordance with Section C410.2.8.1 or an SWH system in accordance with Section C410.2.8.2.

C410.2.8.1 PV interconnection. A capped roof penetration sleeve shall be provided in the vicinity of the future inverter, sized to accommodate the future PV system conduit. Interconnection of the future PV 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:

a. 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.

b. 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 the following:

a. *Solar zone* boundaries and access pathways;

b. Location for future inverters and metering equipment; and

c. Route for future wiring between the PV panels and the inverter, and between the inverter and the main service panel.

C410.2.8.2 SWH interconnection. Two capped pipe tees shall be provided upstream of the domestic water heating equipment to provide plumbing interconnections between a future SWH system and the domestic water heating system. Two roof penetration sleeves shall be provided in the vicinity of the *solar zone*, capable of accommodating supply and return piping for a future SWH system.

The plumbing construction documents shall indicate the following:

a. *Solar zone* boundaries and access pathways;

b. Location for future hot water storage tanks; and

c. Route for future piping between the *solar zone* and the plumbing interconnection point, following the shortest feasible pathway.

Section 6. The following sections of Appendix A of WAC 51-11-60000 are amended as follows:

Section A103--Above grade walls.

A103.1 General. Tables A103.1(1) through A103.3.3(2), A103.3.6(1) through A103.3.6(2), ((~~A103.1(2))~~ and A103.7.1(1) through A103.3.7.1(3) list heat loss coefficients for the opaque portion of above-grade wood stud frame walls, metal stud frame walls and concrete masonry walls (Btu/h · ft^2 · °F) respectively. They are derived from procedures listed in the ASHRAE Fundamentals Handbook. For intermediate floor slabs which penetrate the insulated wall, use the concrete ((~~wall)~~ peripheral edge U-factors in Table ((~~A103.1(2))~~ A103.3.7.2.

Insulation is assumed to uniformly fill the entire cavity and to be installed as per manufacturer's directions. All walls are assumed to be finished on the inside with 1/2 inch gypsum wallboard, and on the outside with either beveled wood siding over 1/2 inch plywood sheathing or with 5/8 inch T1-11 siding. Insulated sheathing (either interior or exterior) is assumed to cover the entire opaque wall surface, except where modified in accordance with footnote h to Table C402.1.1.

Metal building walls have a different construction and are addressed in Table A103.3.6.3.

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A103.3.7 Concrete and masonry walls.

A103.3.7.1 Concrete masonry walls. The nominal R-values in Table A103.3.7.1(1) or Table A103.3.7.1(3) may be used for purposes of calculating concrete masonry wall section U-factors in lieu of the ASHRAE isothermal planes calculation method as provided in Chapter 27 of the ASHRAE Fundamentals Handbook. The nominal U-values in Table A103.3.7.1(2) are permitted to be used for purposes of calculating concrete wall U-factors.

Table A105.3.7.1(1)
Default U-Factors for Concrete Masonry (CMU) Walls

	8-inch Medium-Weight (115 lb/CF) CMU								
	All Cells Grouted	Grout @ 16-inches OC		Grout @ 32 inches OC		Grout @ 48 inches OC		No Grout (unreinforced)	
Additional Insulation		Cores Empty	Cores Filled	Cores Empty	Cores Filled	Cores Empty	Cores Filled	Cores Empty	Cores Filled
None	0.58	0.52	0.43	0.48	0.35	0.46	0.27	0.43	0.21
R-5 continuous insulation	0.15	0.14	0.14	0.14	0.12	0.14	0.11	0.14	0.10
R-10 continuous insulation	0.09	0.08	0.08	0.08	0.07	0.08	0.07	0.08	0.07
R-15 continuous insulation	0.06	0.06	0.06	0.06	0.05	0.06	0.05	0.06	0.05
R-13 insulation 2x4 wood studs	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.07
R-21 insulation 2x6 wood studs	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.05
R-13 insulation 3-5/8" metal studs	0.16	0.15	0.14	0.14	0.13	0.14	0.12	0.14	0.11
R-21 insulation 6" metal studs	0.12	0.11	0.11	0.11	0.10	0.11	0.09	0.11	0.09

	12-inch Medium-Weight (115 lb/CF) CMU								
	All Cells Grouted	Grout @ 16 inches OC		Grout @ 32 inches OC		Grout @ 48 inches OC		No Grout (unreinforced)	
Additional Insulation	Cores Filled	Cores Empty	Cores Filled	Cores Empty	Cores Filled	Cores Empty	Cores Filled	Cores Empty	Cores Filled
None	0.47	0.44	0.34	0.42	0.28	0.41	0.21	0.40	0.15
R-5 continuous insulation	0.14	0.14	0.12	0.14	0.11	0.13	0.10	0.13	0.09
R-10 continuous insulation	0.08	0.08	0.08	0.08	0.07	0.08	0.07	0.08	0.06
R-15 continuous insulation	0.06	0.06	0.06	0.06	0.05	0.06	0.05	0.06	0.05
R-13 insulation 2x4 wood studs	0.08	0.08	0.08	0.08	0.07	0.08	0.07	0.08	0.06
R-21 insulation 2x6 wood studs	0.06	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05
R-13 insulation 3-5/8" metal studs	0.15	0.14	0.13	0.14	0.12	0.14	0.11	0.14	0.11
R-21 insulation 6" metal studs	0.11	0.11	0.10	0.11	0.09	0.11	0.08	0.11	0.09

Notes:
1. Interpolation is allowed between 8-inch and 12-inch CMU values (for 10-inch CMU).
2. Interpolation is allowed between 16 and 32-inch grout spacing (for 24-inch spacing)
3. Interpolation is allowed between 32 and 48-inch grout spacing (for 40-inch spacing)
4. "Cores filled" means that all cores not grouted are filled with perlite or vermiculite insulation.
5. Values are based on stud spacing of 16 inches on center
6. Values are based on horizontal grout spacing of 48 inches OC
7. Stud wall values include one layer of gypsum board on the interior.

Table A103.3.7.1(~~1~~ 2) Default U-factors for Concrete ~~((and Masonry))~~ Walls

~~((8" Concrete Masonry~~

~~Wall Description~~	~~CORE TREATMENT~~			
	~~Partial Grout with Ungrouted Cores~~			
		~~Loose-fill insulated~~		
	~~Empty~~	~~Perlite~~	~~Vermiculite~~	~~Solid Grout~~
~~Exposed Block, Both Sides~~	~~0.40~~	~~0.23~~	~~0.24~~	~~0.43~~
~~R-5 Interior Insulation, Wood Furring~~	~~0.14~~	~~0.11~~	~~0.12~~	~~0.15~~
~~R-6 Interior Insulation, Wood Furring~~	~~0.14~~	~~0.11~~	~~0.11~~	~~0.14~~
~~R-10.5 Interior Insulation, Wood Furring~~	~~0.11~~	~~0.09~~	~~0.09~~	~~0.11~~
~~R-8 Interior Insulation, Metal Clips~~	~~0.11~~	~~0.09~~	~~0.09~~	~~0.11~~
~~R-6 Exterior Insulation~~	~~0.12~~	~~0.10~~	~~0.10~~	~~0.12~~
~~R-10 Exterior Insulation~~	~~0.08~~	~~0.07~~	~~0.07~~	~~0.08~~
~~R-9.5 Rigid Polystyrene Integral Insulation, Two Webbed Block~~	~~0.11~~	~~0.09~~	~~0.09~~	~~0.12~~

~~12" Concrete Masonry~~

~~Wall Description~~	~~CORE TREATMENT~~			
	~~Partial Grout with Ungrouted Cores~~			
		~~Loose-fill insulated~~		
	~~Empty~~	~~Perlite~~	~~Vermiculite~~	~~Solid Grout~~
~~Exposed Block, Both Sides~~	~~0.35~~	~~0.17~~	~~0.18~~	~~0.33~~
~~R-5 Interior Insulation, Wood Furring~~	~~0.14~~	~~0.10~~	~~0.10~~	~~0.13~~
~~R-6 Interior Insulation, Wood Furring~~	~~0.13~~	~~0.09~~	~~0.10~~	~~0.13~~
~~R-10.5 Interior Insulation, Wood Furring~~	~~0.11~~	~~0.08~~	~~0.08~~	~~0.10~~
~~R-8 Interior Insulation, Metal Clips~~	~~0.10~~	~~0.08~~	~~0.08~~	~~0.09~~
~~R-6 Exterior Insulation~~	~~0.11~~	~~0.09~~	~~0.09~~	~~0.11~~

R-10 Exterior Insulation	0.08	0.06	0.06	0.08
R-9.5 Rigid Polystyrene Integral Insulation, Two Webbed Block	0.11	0.08	0.09	0.12

8" Clay Brick

	CORE TREATMENT			
	Partial Grout with Ungrouted Cores			
		Loose-fill insulated		
Wall Description	Empty	Perlite	Vermiculite	Solid Grout
Exposed Block, Both Sides	0.50	0.31	0.32	0.56
R-5 Interior Insulation, Wood Furring	0.15	0.13	0.13	0.16
R-6 Interior Insulation, Wood Furring	0.15	0.12	0.12	0.15
R-10.5 Interior Insulation, Wood Furring	0.12	0.10	0.10	0.12
R-8 Interior Insulation, Metal Clips	0.11	0.10	0.10	0.11
R-6 Exterior Insulation	0.12	0.11	0.11	0.13
R-10 Exterior Insulation	0.08	0.08	0.08	0.09))

6" Concrete Poured or Precast

Wall Description	*CORE TREATMENT*			
	Partial Grout with Ungrouted Cores			
		Loose-fill insulated		
	Empty	**Perlite**	**Vermiculite**	**Solid Grout**
Exposed Concrete, Both Sides	NA	NA	NA	0.61
R-5 Interior Insulation, Wood Furring	NA	NA	NA	0.16
R-6 Interior Insulation, Wood Furring	NA	NA	NA	0.15
R-10.5 Interior Insulation, Wood Furring	NA	NA	NA	0.12
R-8 Interior Insulation, Metal Clips	NA	NA	NA	0.12
R-6 Exterior Insulation	NA	NA	NA	0.13
R-10 Exterior Insulation	NA	NA	NA	0.09

~~((1. Grouted cores at 40" x 48" on center vertically and horizontally in partial grouted walls.~~

~~2. Interior insulation values include 1/2" gypsum board on the inner surface.~~

~~3. Furring and stud spacing is 16" on center. Insulation is assumed to fill furring space and is not compressed.~~

~~4. Intermediate values may be interpolated using this table. Values not contained in this table may be computed using the procedures listed in the ASHRAE Fundamentals Handbook.~~

~~5. Concrete Masonry Unit (CMU) assembly U-values are based on local test data for Washington state CMU block material using the ASTM C-236-87 steady state thermal conductance test. Tests included an 8"x8"x16" CMU with all cells filled with vermiculite (1995) and 8"x8"x16" CMU with all cells filled with polymaster foam in place insulation (1996). Refer to ASHRAE Standard 90.1 for additional nationally recognized data on the thermal performance of CMU block walls.))~~

Section 7. The following section of Appendix C of WAC 51-11-80000 is amended as follows:

Appendix C--Exterior design conditions. As required by Sections C302.2 and R302.2, the heating or cooling outdoor design temperatures shall be selected from Table C-1.

Table C-1
Outdoor Design Temperatures

Location	Outdoor Design Temp. Heating (°F)	Outdoor Design Temp. Cooling (°F)
Aberdeen 20 NNE	25	83
Anacortes	24	72
Anatone	-4	89
Auburn	25	84
Battleground	19	91
Bellevue	24	83
Bellingham 2 N	19	78
Blaine	17	73
Bremerton	29	83
Burlington	19	77
Chehalis	21	87
Chelan	10	89
Cheney	4	94
Chesaw	-11	81
Clarkston	10	94
Cle Elum	1	91
Colfax 1 NW	2	94
Colville AP	-2	92
Concrete	19	83
Connell 4 NNW	6	100
Cougar 5 E	25	93

Dallesport AP	14	99
Darrington RS	13	85
Davenport	5	92
Edmonds	24	82
Ellensburg AP	2	90
Elma	24	88
Ephrata AP	7	97
Everett Paine AFB	21	79
Forks 1 E	23	81
Glacier RS	13	82
Glenoma (Kosmos)	18	89
Goldendale	7	94
Grays River Hatchery	24	86
Greenwater	1.4	84
Grotto	21	84
Hoquiam AP	26	79
Inchelium 2 NW	0	92
John Day Dam	19	100
Kent	21	85
Kirkland	17	83
La Grande	23	88
Leavenworth	-3	93
Little Goose Dam	22	101
Long Beach 3 NNE	25	77
Longview	24	87

Lower Granite Dam	14	98
Lower Monument Dam	18	103
Marysville	23	79
Metaline Falls	-1	89
Methow 2 W	1	89
Nespelem 2 S	-4	93
Newhalem	19	89
Newport	-5	92
Northport	2	92
Oak Harbor	16	74
Odessa	7	100
Olga 2 SE	24	71
Olympia, AP	17	85
Omak 2 NW	3	90
Oroville	5	93
Othello	9	98
Packwood	16	90
Plain	-3	89
Pleasant View	16	98
Pomeroy	3	95
Port Angeles	28	75
Port Townsend	25	76
Prosser	12	97
Puyallup	19	86

Quilcene 2 SW	23	83
Quinault RS	25	84
Rainier, Longmire	15	85
Paradise RS	8	71
Raymond	28	81
Redmond	17	83
Republic	-9	87
Richland	11	101
Ritzville	6	99
Satus Pass	10	90
Seattle: Sea-Tac AP	24	~~((83))~~ 82 Dry bulb 66 Wet bulb
Sedro Woolley 1 E	19	78
Sequim	23	78
Shelton	23	85
Smyrna	8	102
Snohomish	21	81
Snoqualmie Pass	6	80
Spokane AP	4	92
Spokane CO	10	96
Stampede Pass	7	76
Stehekin 3 NW	12	85
Stevens Pass	6	77
Tacoma CO	29	82
Tatoosh Island	31	63

Toledo AP	17	84
Vancouver	22	88
Vashon Island	28	78
Walla Walla AP	6	96
Waterville	1	88
Wellpinit	1	93
Wenatchee CO	10	92
Whidbey Island	11	71
Willapa Harbor	26	81
Wilson Creek	3	96
Winthrop 1 WSW	-12	91
Yakima AP	11	94

ABBREVIATIONS:
AFB Air Force Base
AP Airport
CO City Office
RS Ranger Station
Typical: "4(miles)NE"

Section 8. A new Appendix D to WAC 51-11 is added as follows:

Appendix D – Total Building Performance Reporting Format.

(Note – This entire appendix is a Seattle amendment and is not underlined.)

The reporting format has been developed to guide both staff and applicants through the energy analysis process. The report (three copies are to be submitted) begins with a text summary including project description, methodology description, and a discussion of the estimated energy consumption differences. These are accompanied by an appendix which has summary forms, calculations to support the inputs, and copies of the computer inputs and outputs (all with numbered pages).

The text and summary forms are among the most important parts of the submittal. This information is read prior to any review of the computer inputs and outputs to give an overall orientation to the project. The first evaluation of the project is based on a review of the text and summary forms. These indicate what the key energy efficiency strategies are and form the basis for a more detailed review of the drawings and of the computer analysis. Information for statistical summaries or other evaluations is drawn from the text and summary forms. While these may be the last items completed by the applicant prior to submittal, the importance of having the complete and accurate cannot be overemphasized.

REPORTING FORMAT OUTLINE

(See detailed description below)

I. Executive Summary

II. Project Description

III. Methodology Description

IV. Discussion of Estimated Energy Consumption Differences

Appendices (Supporting Material)

A. Energy Analysis Summary Form

    1. Energy Consumption by End-use portion

    2. Design Parameter Comparison portion

B. General Information

    1. Site Plan

    2. HVAC Zoning Diagram

C. Building Envelope

1. Fenestration: NFRC Certification Authorization Report (CAR) or Simulation Report for U-factor and SHGC

2. Opaque Elements: Cross-sections and U-factor Calculations

3. Shading Diagrams

D. Lighting System

1. Lighting for Interior

2. Lighting for Parking and Outdoor Areas

3. Lighting for Façade

E. Space Heating and Space Cooling

1. Equipment Efficiency – Manufacturer's Specifications

F. Ventilation

G. Interior Exhaust Fans

H. Parking Ventilation Fans

I. Service Water Heating

J. Other End-uses

1. Office Equipment

2. Elevators and Escalators

3. Refrigeration

4. Cooking

5. Other

K. Computer Printout of Inputs and Outputs

I. Executive Summary

The executive summary is the condensed version of the text. This is usually several paragraphs long, never more than one page, and includes:

1. A brief description of the project with name, address, number of stories, and total square footage, as well as a listing of the various uses and the square footage of each use.

2. An explanation about why the systems analysis compliance option was chosen (i.e. what elements of the Proposed Design do not comply with the prescriptive option).

3. A listing of the key energy efficiency features that are being used to compensate for the elements that do not comply.

4. The total energy consumption on a Btu-per-conditioned-square-foot-per-year basis for both the Standard Reference Design and the Proposed Design, and the percentage ratio of the Proposed Design to the Standard Reference Design (i.e. what the energy efficiency improvement has been).

II. Project Description

The project description is a detailed summary of the project. First is the name and the street address as well as adjacent cross-streets or streets on all four sides of the building if it is a full-block development. Indicate the number of stories and total square footage. A listing of the various uses and square footage of each use should be done on a floor-by-floor or a system-by-system basis. Thus, for mixed-use floors, specify how much is office and how much is retail, or how much is office and how much is lab. Include parking garage number of floors and area in the listing. The description should also include information on the energy efficiency of the Proposed Design systems.

1. For the building envelope: indicate the glazing area, and how the fenestration U-factor and SHGC compare with the Standard Reference Design requirements; and point out any opaque component U-factors or R-values which are better than the Standard Reference Design requirements.

2. For each HVAC system: provide an explanation of the system including area served, key features, economizer percentage, control strategies, etc. Indicate any differences

between the Standard Reference Design and the Proposed Design, such as equipment efficiency.

3. For the lighting: indicate whether any tradeoffs are included in this analysis, and, if so, what they are.

4. For other end-uses: indicate any differences between the Standard Reference Design and the Proposed Design. It is intended that the material in this section be descriptive, supporting calculations are to be included in the appendices.

III. Methodology Description

The methodology description is an explanation of any aspects of the modeling which are unusual or not perfectly clear. (The algorithms in approved analysis programs are generally acceptable and do not need to be explained.) For example:

1. Explain what shading by adjacent buildings has been included in the analysis and how it has been modeled (e.g. either using the program capabilities or as a north-facing wall, etc.).

2. If there are below-grade walls and floors, explain how the heat loss has been modeled for these (e.g. either as an exterior wall with a limited ground temperature variation or as a constant negative load to a zone, etc.)

3. If a program cannot model a system exactly, explain why the modeling assumptions used are the best representation of that system. It is intended that the material in this section provide a heads-up for anything unusual. Again, it is intended that the material in this section be descriptive, supporting calculations are to be included in the appendices.

IV. Discussion of Estimated Energy Consumption Differences

The discussion of estimated energy consumption differences is a summary and explanation of the energy savings.

1. First, list the total energy consumption on a Btu-per-conditioned-square-foot-per-year basis for both the Standard Reference Design and the Proposed Design, and the percentage ratio of the Proposed Design to the Standard Reference Design (i.e. what the energy efficiency improvement would be).

2. Then, review the energy savings by end-use, starting with the end-use which has the largest difference as a percent of the Standard Reference Design total. Attempt to correlate the differences by end-use with the strategies used. While some changes will have a simple, direct correlation with consumption, other end-use differences may have a more complex explanation due to interactive effects. For example:

- Changes in exterior lighting will have a simple, direct correlation with consumption.
- Differences in space heating and space cooling are likely due to a combination of building envelope and HVAC system strategies. (Lacking any better information, the following procedure can provide a rough-cut disaggregation. First, determine the ratio of the design heating load of the Proposed Design to the design heating load of the Standard Reference Design. Multiply the space heating energy consumption of the Standard Reference Design by this ratio and assume that the resulting figure is what the space heating energy consumption would have been for the Proposed Design if only the building envelope had changed. This difference is what could be attributed to the building envelope. Second, determine the ratio of the average equipment efficiency of the Proposed Design to the average equipment efficiency of the Standard Reference Design. Multiply the space heating energy consumption from the first step by this ratio and assume that the resulting figure is what the space heating energy consumption would have been for the Proposed Design if only the building envelope and equipment efficiency had changed. This second difference is what could be attributed to changes in

equipment efficiency. Finally, assume that whatever energy consumption differences remain are due to other HVAC system strategies. Follow this same process for space cooling, starting with a comparison of loads, then equipment efficiency, then system type. Differences in economizer cycle, however, add another layer of complexity.)

This section should, at a minimum, provide confirmation that the results of the analysis are reasonable.

Appendices (Supporting Materials)

A. Energy Analysis Summary Form (required)

1. Complete the Energy Consumption by End-use portion of the form for each project. Where a project has multiple buildings which are individually analyzed, complete the form for each building as well as for the overall project. (An automated electronic spreadsheet version of this page is on the DPD Seattle Energy Code website at: www.seattle.gov/dpd/energy.)

2. Complete the Design Parameter Comparison portion of the form for each project. Where a project has multiple HVAC systems, complete the HVAC information for each system. (An electronic version of these pages is on the DPD Seattle Energy Code website at: www.seattle.gov/dpd/energy.)

B. General Information

1. Site Plan (required) – provide site plan (8½ x 11 preferred) showing location and height, in feet or stories, of all adjacent buildings and also any other buildings and topography which would provide significant shading of the proposed building.

2. HVAC zoning diagram used in the modeling process (required) – provide zoning diagram indicating zone lines and with zones labeled to match the modeling, plus takeoff sheets with area inputs for DPD review.)

C. Building Envelope

1. Glazing and opaque doors, including windows, skylights, sliding/swinging/rollup doors, glass block (required):

a. U-factor, with basis for information (NFRC Certification Authorization Report, simulation report or approved alternate source).

b. Solar Heat Gain Coefficient (SHGC), with basis for information (NFRC Certification Authorization Report, simulation report or approved alternate source)

2. Opaque roof, wall, floor (required):

a. provide cross-sections and U-factor calculations for each different assembly where default U-factors from Chapter 3 and Appendix A have not been used;

b. if multiple elements (e.g.. three wall types) are combined into one value for modeling purposes, provide calculations used to determine weighted-average value.

3. Shading diagrams (required):

a. provide information on how shading by adjacent buildings and topography has been modeled,

b. provide wall and roof sections showing overhangs and setbacks for glazing to justify the shading modeled.

4. Building air leakage:

a. the standard reference design building air leakage test rate shall equal that required by Section C402.4.1.2.3,

b. provide calculation showing how the building air leakage test rate at the standard rating conditions in Section C402.4.1.2.3has been converted to an air leakage test rate appropriate for the energy modeling,

c. for modeling, indicate:

i. what percentage of air leakage is modeled for the hours when the building fan system is off and

ii. what percentage of air leakage is modeled for the hours when the building fan system is on.

D. Lighting

1. Interior lighting (as applicable):

a. explain any special assumptions about interior lighting,

b. discuss lighting inputs to account for any exempt lighting (e.g. retail, kitchen).

2. Parking/outdoor areas lighting (as applicable):

a. provide calculation of areas for parking garages, then multiply by allowed Watts/square foot; provide calculation of areas for surface parking, and other lighted outdoor areas, then multiply by allowed Watts/square foot to obtain Standard Reference Design;

b. provide supporting information for Proposed only if different from Standard Reference Design;

c. if program does not list parking/outdoor area lighting energy consumption separately, then provide calculation of annual energy consumption for this end-use.

3. Façade lighting (required):

a. provide calculation of building façade, then multiply by allowed Watts/square foot to obtain Standard Reference Design;

b. provide supporting information for Proposed only if different from Standard Reference Design;

c. if program does not list facade lighting energy consumption separately, then provide calculation of annual energy consumption for this end-use.

E. Space Heating and Space Cooling Equipment and Plant

1. provide manufacturer's specifications for equipment efficiency,

2. provide calculations per AHRI standards for COP, EER, IPLV,

3. provide list of equipment and size and calculations to justify if Proposed Design includes multiple pieces of equipment and a weighted average equipment efficiency is used in the energy analysis,

4. provide calculations to justify the equipment size for the Standard Reference Design

a. provide calculations of ratio of Proposed Design equipment size to Proposed Design design heating load and design cooling load,

b. provide calculations of ratio of Standard Reference Design equipment size to Standard Reference Design design heating load and design cooling load.

F. Ventilation - interior (required):

1. provide W/CFM calculations for the ventilation system for the Proposed Design and for the Standard Reference Design to justify inputs for the Standard Reference Design,

2. if program does not list energy consumption for interior ventilation separately in the output, then provide calculation of annual energy consumption for this end-use.

G. Interior Exhaust Fans (as applicable):

1. where multiple toilet exhaust and relief fans are to be installed, provide listing of capacity for each and total for the interior exhaust fans,

2. if program does not list energy consumption for interior exhaust fans separately in the output, then provide calculation of annual energy consumption for this end-use.

H. Parking Garage Fans (as applicable):

1. where multiple parking garage fans are to be installed, provide listing of capacity for each and total for the parking garage fans,

2. if program does not list energy consumption for parking garage fans separately in the output, then provide calculation of annual energy consumption for this end-use.

I. Service Water Heating (required):

1. provide calculations used to size equipment (see Appendix B, Table B102, for default assumptions for service hot water quantities in Btuh per person),

2. if program does not list energy consumption for service water heating separately in the output, then provide calculation of annual energy consumption for this end-use.

J. Other End-uses

1. Office/miscellaneous equipment (as applicable):

a. if program requires an input of total equipment capacity rather than capacity on a square foot basis, then provide calculations used to size equipment (see Appendix B, Table B102, for default assumptions for service hot water quantities in Watts/square foot),

b. if program does not list energy consumption for office/miscellaneous equipment separately in the output, then provide calculation of annual energy consumption for this end-use.

2. Elevators and escalators (as applicable):

a. where multiple elevators and escalators are to be installed, provide listing of capacity for each and total for the system,

b. if program does not list energy consumption for elevators and escalators separately in the output, then provide calculation of annual energy consumption for this end-use.

3. Refrigeration - food, etc. (as applicable):

a. where multiple units are to be installed for refrigeration other than for comfort cooling, provide listing of capacity for each and total for the system,

b. if program does not list energy consumption for refrigeration other than for comfort cooling separately in the output, then provide calculation of annual energy consumption for this end-use.

4. Cooking (as applicable):

a. where multiple units are to be installed for cooking, provide listing of capacity for each and total for the system,

b. if program does not list energy consumption for cooking separately in the output, then provide calculation of annual energy consumption for this end-use.

5. Other (as applicable):

a. provide supporting data for other end-uses (e.g. commercial washers and dryers, etc.),

b. if program does not list energy consumption for other end-uses separately in the output, then provide calculation of annual energy consumption for these end-uses.

K. Computer Printout of Inputs and Outputs

Provide inputs and outputs with pages numbered so cross-references can be made to the Energy Analysis Summary Form.

ENERGY ANALYSIS SUMMARY FORM

PROJECT INFORMATION

DPD Project Address:							DPD Project Number:			
Project Name:							Date of this submittal:			
	Conditioned Space						Unconditioned Space			
Bldg Use	Office	Retail	Group R			Subtotal	Parking		Subtotal	
Area (SF)										

ENERGY CONSUMPTION BY END-USE

		STANDARD REFERENCE DESIGN			PROPOSED DESIGN			DIFFERENCES		
END-USE	FUEL SOURCE	Total Energy Use Estimate	BTU/ Cond. Sq.Ft.- Year	% of Standard Design Total	Total Energy Use Estimate	BTU/ Cond. Sq.Ft.- Year	% of Standard Design Total	Total Energy Use Estimate	BTU/ Cond. Sq.Ft. - Year	% of Standard Design Total
Lighting - interior				_____ %			_____%			_____%
Lighting - parking				_____ %			_____%			_____%
Lighting - façade				_____ %			_____%			_____%
Space Heating (1)				_____ %			_____%			_____%
Space Heating (2)				_____ %			_____%			_____%
Space Cooling				_____ %			_____%			_____%
Fans – interior ventilation				_____ %			_____%			_____%
Fans – interior				_____ %			_____%			_____%

exhaust											
Fans – parking garage				_____ %			_____%			_____%	
Service water heating				_____ %			_____%			_____%	
Office equipment				_____ %			_____%			_____%	
Elevators & escalators				_____ %			_____%			_____%	
Refrigeration (food, etc.)				_____ %			_____%			_____%	
Cooking (commercial)				_____ %			_____%			_____%	
_____				_____ %			_____%			_____%	
_____				_____ %			_____%			_____%	
Total				100%			100%			100%	

Percent of Standard Reference Design: 100% = _____ % + _____% = _____%

INSTRUCTIONS:

Electronic Version:

A spreadsheet version is available on the Seattle Energy Code website @ www.seattle.gov/dpd/energy

Project Information:

Enter DPD address, project number, and date of this Energy End-use Summary Form.

Enter the space uses in the building and the gross square footage of each.

(Add/revise headings as necessary.) Spreadsheet automatically calculates subtotals and total.

Energy Consumption by End-use:

Enter fuel source for each end-use (e.g. electric, gas, oil, steam, etc.).

Enter total energy consumption in **BTU** for each end-use for both the Standard Reference Design and Proposed Design.

(Spreadsheet calculates the BTU/conditioned-square-foot-year, percentages, and differences

DESIGN PARAMETER COMPARISON

Element	**Standard Design Value**	**(Page)**	**Proposed Design Value**	**(Page)**
Building Envelope				
Space heat type (electric resistance vs. other):				
Glazing: total vertical + overhead area (sq. feet):				
Glazing area as a percentage of gross wall (%):				
Overhead: total area (square feet):				
Overhead U-factor (weighted-average):				
Overhead SHGC (weighted-average):				

Vertical: total area (square feet):				
Vertical U-factor (weighted-average):				
Vertical SHGC (weighted-average):				
Roof: total area (square feet):				
Opaque roof: net area (square feet):				
Opaque roof U-factor (weighted-average):				
Wall: total above-grade area (square feet):				
Opaque above-grade wall: net area (square feet):				
Above-grade wall U-factor (weighted-average):				
Below-grade wall: net area (square feet):				
Below-grade wall U-factor (weighted-average):				
Opaque door: area (sq. feet):				
Opaque door U-factor (weighted-average):				
Floor over unconditioned space: area (sq. feet):				
Floor U-factor (weighted-average):				
Slab-on-grade floor: perimeter (lineal feet):				
Slab-on-grade F-factor (weighted-average):				
Below-grade slab floor: net area (square feet):				
Below-grade floor U-factor (weighted-average):				
Infiltration rate:				
Design heating load:				
Design cooling load:				
Lighting				

Interior				
Watts/sq.ft.: Office				
Watts/sq.ft.: Retail				
Watts/sq.ft.:				
Watts/sq.ft.:				
Parking/outdoor: total area (square feet)				
Watts/square foot				
Façade: total area (square feet)				
Watts/square foot				
Space Heating and Space Cooling System				
Space Heating: system type:				
Peak equipment efficiency:				
Output capacity:				
Percent of design heating load:				
Other features:				
Space Cooling: system type:				
Peak equipment efficiency:				
Output capacity:				
Percent of design cooling load:				
Other features:				
Ventilation				
Interior ventilation fans				

Economizer type (air or water):				
Economizer percentage:				
Supply fan: total CFM:				
Fan KW:				
Return fan: total CFM:				
Fan KW:				
Exhaust fan: total CFM:				
Fan KW:				
System Watts/CFM:				
Other features:				
Other features				
Service Water Heating				
Capacity:				
Other End-uses				
Fans – toilet and other exhaust: capacity (KW)				
Fans – parking garage: capacity (KW)				
Elevator and escalator: capacity				
Refrigeration: capacity				
Cooking: capacity				
_____: capacity				
_____: capacity				
_____: capacity				

Section 9. The following sections of Chapter 1 of WAC 51-11R-10000 are amended as follows:

CHAPTER 1 SCOPE AND ADMINISTRATION

SECTION R101

SCOPE AND GENERAL REQUIREMENTS.

R101.1 Title. This code, consisting of Chapter 1 [RE] through Chapter 5 [RE] and Appendices A through C, shall be known as the "Residential Portions of the *International Energy Conservation Code* of Seattle" ((**[NAME OF JURISDICTION]**)) or the "Seattle Residential Energy Code", and shall be cited as such. It is referred to herein as "this code."

***

SECTION R101.4

APPLICABILITY.

R101.4 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.

R101.4.1 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.

R101.4.2 ((Historic)) *Landmark* buildings. The building official may modify the specific requirements of this code for ((historic buildings)) *landmarks* and require in lieu thereof alternate requirements which that the *code official* determines will not have an adverse effect on the designated historic features of the building and 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.~~))

R101.4.3 Additions, alterations, renovations or repairs. Additions, alterations, renovations or repairs 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(s) of the existing building or building system to comply with this code. Additions, alterations, renovations or repairs 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.

EXCEPTION: The following need not comply provided the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Glass only replacements in an existing sash and frame.
3. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation. 2x4 framed walls shall be insulated to a minimum of R-15 and 2x6 framed walls shall be insulated to a minimum of R-21.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. Reroofing for roofs where neither the sheathing nor the insulation is exposed. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.

6. 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.

7. Alterations that replace less than ((~~60~~)) 20 percent of the luminaires in a space, provided that such alterations do not increase the installed interior lighting power.

8. Alterations that replace only the bulb and ballast within the existing luminaires in a space provided that the *alteration* does not increase the installed interior lighting power.

The building official may approve designs of alterations or repairs which do not fully conform with all of the requirements of this code where in the opinion of the building official full compliance is physically impossible and/or economically impractical and:

1. The alteration or repair improves the energy efficiency of the building; or

2. The alteration or repair is energy efficient and is necessary for the health, safety, and welfare of the general public.

R101.4.3.1 Mechanical systems. When a space-conditioning system is altered by the installation or replacement of space-conditioning equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger), the duct system that is connected to the new or replacement space conditioning equipment shall be tested as specified in WSU RS-33. The test results shall be provided to the building official and the homeowner.

EXCEPTIONS.

1. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in WSU RS-33.

2. Ducts with less than 40 linear feet in unconditioned spaces.

3. Existing duct systems constructed, insulated or sealed with asbestos.

4. Additions of less than 750 square feet.

R101.4.4 Change in occupancy or use. Any space not within the scope of Section R101.2 which is converted to space that is within the scope of Section R101.2 shall be brought into full compliance with this code. Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code.

***

R102.1 General. This code does not ((~~is not intended to~~)) prevent the use of any material, method of construction, design or insulating system prohibited by this code or not specifically allowed herein, provided that such construction, design or insulating system has been *approved* by the *code official* ((~~as meeting the intent of this code~~)).

The *code official* may approve an alternate material, method of construction, design or insulating system, provided the *code official* finds that the proposed alternate complies with the provisions of this code, and that the alternate, when considered together with other safety features of the building or other relevant circumstances, will provide at least an equivalent level of strength, effectiveness, fire resistance, durability, safety and sanitation.

The *code official* may require that sufficient evidence or proof be submitted to reasonably substantiate any claims regarding the use or suitability of the alternate. The *code official* may, but is not required to, record the approval of modifications and any relevant information in the files of the *code official* or on the approved permit plans.

R102.2 Modifications. The *code official* may modify the requirements of this code for individual cases provided the code *official* finds: (1) there are practical difficulties involved in carrying out the provisions of this code; (2) the modification is in conformity with the intent and purpose of this code; (3) the modification will provide a reasonable level of fire protection and

structural integrity when considered together with other safety features of the building or other relevant circumstances, and (4) the modification maintains or improves the energy efficiency of the building. The *code official* may, but is not required to, record the approval of modifications and any relevant information in the files of the *code official* or on the approved permit plans.

SECTION R103

APPLICATIONS AND PERMITS ((~~CONSTRUCTION DOCUMENTS.~~))

R103.1 General. A permit for work performed according to this code shall be obtained in accordance with Chapter 1 of the International Residential Code, International Building Code, International Mechanical Code or Seattle Electrical Code.

R103.2 Construction documents. Construction documents and other supporting data shall comply with this section and the International Residential Code, the International Building Code, the International Mechanical Code, the International Existing Buildings Code and the Seattle Electrical Code. ((~~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 exist, 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.~~))

R103.2.1 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, insulation materials and their *R*-values; *fenestration U*-factors and SHGCs; area-weighted *U*-factor and SHGC calculations; mechanical system design criteria; mechanical and service water heating system and equipment types, sizes and efficiencies; economizer description; equipment and systems controls; fan motor horsepower (hp) and controls; duct sealing, duct and pipe insulation and location; lighting fixture schedule with wattage and control narrative; and air sealing details.

((R103.3 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.~~

~~**R103.3.1 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.~~

~~**R103.3.2 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.~~

~~**R103.3.3 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.~~

~~**R103.4 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.~~

~~**R103.5 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.~~))

SECTION R104

INSPECTIONS.

R104.1 General. Construction or work for which a permit is required shall be subject to inspection by the *code official* in accordance with this section and the International Residential Code and the Seattle Electrical Code.

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((~~R104.8 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*.~~

~~**R104.8.1 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.~~))

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SECTION R106

REFERENCED STANDARDS.

R106.1 Referenced codes and standards. The codes and standards referenced in this code shall be those listed in Chapter 5, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections R106.1.1 and R106.1.2.

R106.1.1 References to other codes. Whenever an International, National or Uniform Code is referenced in this code, it means the Seattle edition of that code, including local amendments. References to the "Residential Code", "Fire Code", "Electrical Code", "Mechanical Code" and "Plumbing Code" mean the Seattle editions of those codes. **((~~Conflicts.~~** ~~Where differences occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.~~))

R106.1.2 Provisions in referenced codes and standards. Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

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R106.4 Other laws. The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law. ((~~In addition to the requirements of this code, all occupancies shall~~

~~conform to the provisions included in the State Building Code (chapter 19.27 RCW). In case of conflicts among the codes enumerated in RCW 19.27.031 (1) through (4) and this code, an earlier named code shall govern over those following.~~)) In the case of conflict between the duct sealing and insulation requirements of this code and the duct insulation requirements of Sections 603 and 604 of the *International Mechanical Code*, the duct insulation requirements of this code, or where applicable, a local jurisdiction's energy code shall govern.

SECTION R107

FEES.

R107.1 Fees. A fee for each permit and for other activities related to the enforcement of this code shall be paid as set forth in the Fee Subtitle, Seattle Municipal Code Title 22, Subtitle IX.

((~~A permit shall not be issued until the fees prescribed in Section R107.2 have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.~~

~~**R107.2 Schedule of permit fees.** A fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.~~

~~**R107.3 Work commencing before permit issuance.** Any person who commences any work before obtaining the necessary permits shall be subject to an additional fee established by the *code official*, which shall be in addition to the required permit fees.~~

~~**R107.4 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.~~

~~**R107.5 Refunds.** The *code official* is authorized to establish a refund policy.~~))

SECTION R108

((~~STOP WORK ORDER.~~)) ENFORCEMENT

R108.1 Authority. The *code official* is authorized to enforce this code in accordance with the International Residential Code, International Building Code, International Mechanical Code and Seattle Electrical Code. ((~~Whenever the *code official* finds any work regulated by this code being performed in a manner either contrary to the provisions of this code or dangerous or unsafe, the *code official* is authorized to issue a stop work order.~~

~~R108.2 Issuance.~~ ~~The stop work order shall be in writing and shall be given to the owner of the property involved, or to the owner's agent, or to the person doing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order, and the conditions under which the cited work will be permitted to resume.~~

~~R108.3 Emergencies.~~ ~~Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.~~

~~R108.4 Failure to comply.~~ ~~Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be liable to a fine of not less than **[AMOUNT]** dollars or more than **[AMOUNT]** dollars.~~))

SECTION R109

((~~BOARD OF APPEALS.~~)) ADMINISTRATIVE REVIEW

R109.1 Administrative review by the *code official*. Applicants may request administrative review by the *code official* of decisions or actions pertaining to the administration and enforcement of this code. Requests shall be addressed to the *code official*.

R109.2 Administrative review by the Construction Codes Advisory Board. Applicants may request review by the Construction Codes Advisory Board of decisions or actions pertaining to

the application and interpretation of this code. The review will be performed by a panel of three or more members of the Construction Codes Advisory Board, chosen by the Board Chair. The Chair shall consider the subject of the review and members' expertise when selecting members to conduct a review. The decision of the review panel is advisory only; the final decision is made by the *code official*.

((~~**General.** In order to hear and decide appeals of orders, decisions or determinations made by the *code official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The *code official* shall be an ex officio member of said board but shall have no vote on any matter before the board. The board of appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *code official*.~~

~~**R109.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. The board shall have no authority to waive requirements of this code.~~

~~**R109.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training and are not employees of the jurisdiction.~~))

SECTION R110

VIOLATIONS.

It shall be unlawful for any person, firm, or corporation to erect or construct any building, or remodel or rehabilitate any existing building or structure in the state, or allow the same to be done, contrary to or in violation of any of the provisions of this code. Violations shall be

administered according to the procedures set forth in Section 103 of the International Building Code or Section R103 the International Residential Code, as applicable.

SECTION R111

LIABILITY.

Nothing contained in this code is intended to be nor shall be construed to create or form the basis for any liability on the part of any city or county or its officers, employees or agents for any injury or damage resulting from the failure of a building to conform to the provisions of this code, or by reason or as a consequence of any inspection, notice, order, certificate, permission or approval authorized or issued or done in connection with the implementation or enforcement of this code, or by reason of any action or inaction on the part of the City related in any manner to the enforcement of this code by its officers, employees or agents.

This code shall not be construed to relieve or lessen the responsibility of any person owning, operating or controlling any building or structure for any damages to persons or property caused by defects, nor shall the Department of Planning and Development or the City of Seattle be held to have assumed any such liability by reason of the inspections authorized by this code or any permits or certificates issued under this code.

Section 10. Sections 2 – 18 of Ordinance 123430 are repealed.

Section 11. During the transition period, an applicant who submits a valid and fully complete building permit application may elect to have the application considered under the provisions of Ordinance 123430 rather than this Ordinance. The transition period begins on the effective date of this Ordinance and extends through the later of: (a) October 11, 2013; or (b) the 60th day following the effective date of this Ordinance (unless the 60th day is a Saturday, Sunday, or

federal or City holiday, in which case the 60th day shall be deemed to be the next day that is not a Saturday, Sunday, or federal or City holiday).

Section 12. The provisions of this ordinance are declared to be separate and severable. The invalidity of any clause, sentence, paragraph, subdivision, section or portion of this ordinance, or the invalidity of the application thereof to any person, owner, or circumstance shall not affect the validity of the remainder of this ordinance, or the validity of its application to other persons, owners, or circumstances.

Section 13. This ordinance shall take effect and be in force 30 days after its approval by the Mayor, but if not approved and returned by the Mayor within ten days after presentation, it shall take effect as provided by Seattle Municipal Code Section 1.04.020.

Passed by the City Council the ____ day of _____, 2013, and signed by me in open session in authentication of its passage this _____ day of _____, 2013.

_____

President _____of the City Council

Approved by me this ____ day of _____, 2013.

_____

Michael McGinn, Mayor

Filed by me this ____ day of _____, 2013.

_____

Monica Martinez Simmons, City Clerk

(Seal)